

**ACADEMIC CURRICULA**

**UNDERGRADUATE/ INTEGRATED POST  
GRADUATE DEGREE PROGRAMMES**

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume - 11

(Syllabi for School of Computing Programme Courses)



**SRM**

INSTITUTE OF SCIENCE & TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

## Contents (Volume-11)

### Syllabi for Higher Semester (3 - 8) CSE Courses

<u>No</u>	<u>Title</u>	<u>Page No</u>
<b>1</b>	<b>Engineering Science Course</b>	<b>10</b>
	21CSS201T Computer Organization and Architecture.....	11
<b>2</b>	<b>Professional Core Courses.....</b>	<b>13</b>
	21CSC201J Data Structures and Algorithms.....	14
	21CSC202J Operating Systems.....	16
	21CSC203P Advanced Programming Practice.....	18
	21CSC204J Design And Analysis of Algorithms.....	20
	21CSC205P Database Management Systems.....	22
	21CSC301T Formal Language and Automata.....	24
	21CSC302J Computer Networks.....	26
	21CSC303J Software Engineering and Project Management.....	28
	21CSC304J Compiler Design.....	30
	21CSC305P Machine Learning.....	32
	 <b>Volume-11A – CSE Courses</b>	 <b>34</b>
<b>1</b>	<b>Professional Elective Courses.....</b>	<b>35</b>
	21CSE251T Digital Image Processing.....	36
	21CSE252T Biometrics.....	38
	21CSE253T Internet of Things.....	40
	21CSE254T Bio Inspired Computing.....	42
	21CSE255T Computer Graphics and Animation.....	44
	21CSE351T Computational Logic.....	46
	21CSE352T Neuro Fuzzy and Genetic Programming.....	48
	21CSE353T Augmented, Virtual and Mixed Reality.....	50
	21CSE354T Full Stack Web Development.....	52
	21CSE355T Data Mining and Analytics.....	54
	21CSE356T Natural Language Processing.....	56
	21CSE357T Distributed Computing.....	58
	21CSE358T Network Security and Cryptography.....	60
	21CSE359T Information Storage Management.....	62
	21CSE360T High Performance Computing.....	64
	21CSE361T Database Security and Privacy.....	66

21CSE362T	Cloud Computing.....	68
21CSE399T	Advanced Mobile Communications.....	70
21CSE451T	Pattern Recognition Techniques.....	72
21CSE452T	Semantic Web.....	74
21CSE453T	Speech Recognition.....	76
21CSE454T	Computer Vision.....	78
21CSE455T	Social Network Analysis.....	80
21CSE456T	Software Defined Networks.....	82
21CSE457T	Service Oriented Architecture.....	84
21CSE458T	Wireless and Mobile Communication.....	86
21CSE459T	Wireless Sensor Networks.....	88
21CSE460T	Network Protocols and Algorithms.....	90
	<b>Volume-11B – CSE (AIML) Courses</b>	<b>92</b>
<b>1</b>	<b>Professional Core Courses.....</b>	<b>93</b>
21CSC401J	Deep Learning Techniques.....	94
21CSC402P	Report Writing.....	96
<b>2</b>	<b>Professional Elective Courses.....</b>	<b>98</b>
21CSE271T	Programming in Java.....	99
21CSE272T	Genetic Algorithm and its Applications.....	101
21CSE291T	Introduction to Cognitive Neuroscience.....	103
21CSE311P	Robot Programming.....	105
21CSE312P	Software Engineering in Artificial Intelligence.....	107
21CSE313P	Accelerated Data Science.....	109
21CSE323T	Marketing Analytics.....	111
21CSE326T	Artificial Neural Networks.....	113
21CSE371T	Advanced Algorithms.....	115
21CSE375T	Computational Neuroscience.....	117
21CSE376T	Nature Inspired Computing Techniques.....	119
21CSE377T	Information Retrieval.....	121
21CSE396T	Design Principles of Smart Space Management.....	123
21CSE397T	Philosophy of Cognitive Science.....	125
21CSE398T	Logic and Knowledge Representation.....	127
21CSE411T	Artificial Intelligence in Genomics and Disease Prediction.....	129
21CSE412T	Machine Learning in Drug Discovery.....	131
21CSE414T	IoT Concepts and Applications.....	133
21CSE415T	Fuzzy Logic and its Applications.....	135
21CSE416T	Robotics: Computational Motion Planning.....	137
21CSE417T	Reinforcement Learning Techniques.....	149

21CSE418T Cyber Physical Systems.....	141
21CSE421T Business Intelligence and Analytics.....	143
<b>Volume-11C – CSE (SWE) Courses</b>	<b>145</b>
<b>1 Professional Core Courses.....</b>	<b>146</b>
21CSC309J Software Architecture and Design.....	147
21CSC403T Software Measurements and Metrics.....	149
21CSC404T Software Verification and Validation.....	151
<b>2 Professional Elective Courses.....</b>	<b>153</b>
21CSE275T Requirements Engineering.....	154
21CSE276T Software Quality Management.....	156
21CSE277T Software Process.....	158
21CSE271T Programming in Java.....	160
21CSE391P User Interface Design.....	162
21CSE392P Visual Programming.....	164
21CSE393P Machine Learning Techniques.....	166
21CSE312P Software Engineering in Artificial Intelligence.....	168
21CSE391T Object Oriented Software Engineering.....	170
21CSE392T Python for Software Engineering.....	172
21CSE393T Analysis of Software Artifacts.....	174
21CSE396T Design Principles of Smart Space Management	176
21CSE421T Business Intelligence and Analytics.....	178
21CSE493T Software Security.....	180
21CSE495T Artificial Intelligence in Agile Systems.....	182
21CSE496T Deep Learning.....	184
21CSE497T Gaming and Virtual Reality.....	186
21CSE498T Smart Phone Computing and its Applications.....	188
<b>Volume-11D – CSE (CC) Courses</b>	<b>190</b>
<b>1 Professional Core Courses.....</b>	<b>191</b>
21CSC314P Big Data Essentials .....	192
21CSC316J Cloud Architecture and Protocols.....	194
<b>2 Professional Elective Courses.....</b>	<b>196</b>
21CSE261T Fundamentals of Cloud Computing.....	197
21CSE262T Communication Systems Engineering.....	199
21CSE263T Digital Communication Systems.....	201
21CSE330T Cloud Architecture.....	203
21CSE329T Service Oriented Architecture and Microservices.....	205
21CSE363T Aws Solution Architect.....	207

21CSE364T Data Centric Networking and System Design.....	209
21CSE461T Cloud Security.....	211
21CSE463T Cloud Strategy Planning and Management.....	213
21CSE464T Fog Computing Analytics.....	215
21CSE465T Cloud Application Development.....	217
21CSE466T Network Design and Management.....	219
<b>Volume-11E – CSE (CN) Courses</b>	<b>221</b>
<b>1 Professional Core Courses.....</b>	<b>222</b>
21CSC311J Wireless Networks .....	223
21CSC312J Mobile Adhoc Networks.....	225
<b>2 Professional Elective Courses.....</b>	<b>227</b>
21CSE273T Distributed Operating Systems.....	228
21CSE274T Pervasive Computing.....	230
21CSE347T Network Protocols and Programming.....	232
21CSE348T Network Routing Algorithms.....	234
21CSE349T Optical Networks.....	236
21CSE350T Principles Of Cloud Computing.....	238
21CSE450T Network Security.....	240
21CSE466T Network Design and Management.....	242
<b>Volume-11F – CSE (CS) Courses</b>	<b>244</b>
<b>1 Professional Core Courses.....</b>	<b>245</b>
21CSC308T Security Risk Management Principles .....	246
21CSC310J Malware Analysis.....	248
<b>2 Professional Elective Courses.....</b>	<b>249</b>
21CSE229J Check Point System Administration.....	251
21CSE281T Cryptography and Network Security.....	253
21CSE282T Information Security.....	255
21CSE283T Cyber Law.....	257
21CSE381T Forensics and Incident Response.....	259
21CSE382T Security Management.....	261
21CSE383T Security Governance, Risk and Compliance.....	263
21CSE384J Security Audit and Risk Assessment.....	265
21CSE385J Advanced Malware Analysis.....	267
21CSE386J Penetration Testing and Vulnerability Assessment.....	269
21CSE387J Hacker Techniques, Tools, and Incident Handling.....	271
21CSE399J Comprehensive Linux for All.....	273

21CSE485T	Database Security.....	275
21CSE486T	Operation System Security.....	277
21CSE487T	Cyber Warfare.....	279
21CSE488T	Hacker Mind: Profiling the it Criminal.....	281
21CSE489T	Mobile and Wireless Security.....	283
21CSE490J	Windows and Linux Internals.....	285
21CSE491T	Cyber Crimes and Digital Forensic.....	287
21CSE492T	Cyber Crimes and Cyber Security.....	289
	<b>Volume-11G – CSE (IT) Courses</b>	<b>291</b>
<b>1 Professional Core Courses.....</b>		<b>292</b>
21CSC314P	Big Data Essentials.....	293
21CSC317J	Information Retrieval Techniques.....	295
<b>2 Professional Elective Courses.....</b>		<b>297</b>
21CSE267T	Statistics for Machine Learning.....	298
21CSE310J	Quantum Computation.....	300
21CSE373T	Streaming Analytics.....	302
21CSE475T	Applied Graph Theory.....	304
21CSE476T	Logical Deduction and Non-Verbal Reasoning.....	306
21CSE477T	Cloud Native Architecture for Modern Platforms.....	308
21CSE479T	Fault Tolerant Systems.....	310
21CSE480T	Image and Video Processing.....	312
	<b>Volume-11H – CSE (IoT) Courses</b>	<b>314</b>
<b>1 Professional Core Courses.....</b>		<b>315</b>
21CSC313J	Cloud Computing for IoT.....	316
21CSC315J	Fog Computing.....	318
<b>2 Professional Elective Courses.....</b>		<b>320</b>
21CSE264T	Introduction to IoT: Sensors, Actuators and Microcontrollers.....	321
21CSE265T	Introduction to Embedded Programming and Embedded OS.....	323
21CSE266T	Internet of Things Architecture and Protocols.....	325
21CSE365T	Machine Learning for IoT.....	327
21CSE366T	Introduction to Cloud Application Development for IoT.....	329
21CSE367T	IoT Forensics.....	331
21CSE368J	Network Programming for IoT.....	333
21CSE369J	Introduction to Security of Internet of Things and Cyber-Physical Systems.....	335
21CSE370J	Data Visualization for IoT.....	337
21CSE371J	IoT Techniques, Tools and its Application.....	339

21CSE467T Advanced Database Systems.....	341
21CSE468T Edge Computing.....	343
21CSE469T Energy Management for IoT Devices.....	345
21CSE470T Applied Software Techniques in IoT Engineering.....	347
21CSE471T Fundamentals of Cyber Security.....	349
21CSE472J Full Stack Development for IoT.....	351
21CSE473T Deep Learning for IoT.....	353
21CSE474T IoT Privacy.....	355
<b>Volume-11I – CSE (BCT) Courses</b>	<b>357</b>
<b>1 Professional Core Courses.....</b>	<b>358</b>
21CSC305T Blockchain Using Cryptography.....	359
<b>2 Professional Elective Courses.....</b>	<b>361</b>
21CSE231T Fundamentals of Blockchain.....	362
21CSE232T IoT And Blockchain.....	364
21CSE233T Distributed Systems and Applications.....	366
21CSE234T Principles of Cryptography.....	368
21CSE331T Cryptocurrencies and Blockchain Technology.....	370
21CSE332T Fundamentals of Ethereum.....	372
21CSE333T AI And Blockchain.....	374
21CSE334T Container Management.....	376
21CSE335T Advanced Cryptography.....	378
21CSE336T Cloud Computing with Blockchain.....	380
21CSE337T Web3 Development.....	382
21CSE338T Trust Based Computing.....	384
21CSE431T Building Private Blockchain.....	386
21CSE432T Blockchain Technology with Hyperledger.....	388
21CSE433T Blockchain Business Models.....	390
21CSE434T Distributed Ledger Technology.....	392
21CSE435T Smart Contracts and Application Development.....	394
21CSE436T Bitcoin Essentials and Use Cases.....	396
21CSE437T Decentralized Applications on Block Chain.....	398
21CSE438T Web Security.....	400
<b>Volume-11J – CSE (GT) Courses</b>	<b>402</b>
<b>1 Professional Core Courses.....</b>	<b>403</b>
21CSC306J Software Engineering Perspectives in Computer Game Development.....	404
21CSC307T Deep Learning in Gaming and Application.....	406

<b>2 Professional Elective Courses.....</b>	<b>408</b>
21CSE235T Game Design, Prototyping and Development.....	409
21CSE236T GPU Programming.....	411
21CSE237T Art Creation for Games.....	413
21CSE238T Storytelling for Marketing.....	415
21CSE339T Game Artificial Intelligence.....	417
21CSE340T Analytics and Decision Making.....	419
21CSE341T Computer Graphics.....	421
21CSE342T Gaming Studio for Business.....	423
21CSE343T Web Services Development for Games.....	425
21CSE344T 3D Game Development with Unity.....	427
21CSE345T Game System Integration.....	429
21CSE346T Design Art and Theory.....	431
21CSE439T Virtual Reality and Augmented Reality.....	433
21CSE440T Computer Animation and Simulation.....	435
21CSE441T Mobile Game Development.....	437
21CSE442T Game Monetization Techniques.....	439
21CSE443T Game Production and Publishing.....	441
21CSE444T Applied Gamification.....	443
21CSE445T Metaverse Fundamentals.....	445
21CSE446T Digital Marketing and Publishing.....	447
 <b>Volume-11K – CSE (BD &amp; DS) Courses</b>	 <b>449</b>
<b>1 Engineering Science Course</b>	<b>450</b>
21CSS202T Fundamentals of Data Science.....	451
21CSS301T Full Stack Development .....	453
<b>2 Professional Core Courses.....</b>	<b>455</b>
21CSC206P Advanced Object Oriented and Programming.....	456
21CSC307P Machine Learning for Data Analytics.....	458
<b>3 Professional Elective Courses.....</b>	<b>460</b>
21CSE222T Big Data Tools and Techniques.....	461
21CSE224T Computer Architecture.....	463
21CSE321T Data Warehousing and Data Mining.....	465
21CSE322T Multivariate Techniques for Data Analytics.....	467
21CSE323T Marketing Analytics.....	469
21CSE325T Applied Social Network Analysis.....	471
21CSE326T Artificial Neural Networks.....	473
21CSE327T Cloud Computing for Data Analytics.....	475

21CSE373T	Streaming Analytics.....	477
21CSE421T	Business Intelligence and Analytics.....	479
21CSE422T	Convolutional Neural Networks.....	481
21CSE423T	Big Data Visualization.....	483
21CSE424T	Deep Learning for Data Analytics.....	485
21CSE425T	Advanced Machine Learning.....	487
21CSE426T	Financial Machine Learning.....	489
21CSE427T	Augmented and Virtual Reality.....	491
21CSE428T	Healthcare Analytics.....	493
21CSE429T	Data Science for Internet of Things.....	495
21CSE430T	Automatic Speech Recognition.....	497
21CSE447T	Robotics: Computational Motion Planning.....	499
21CSE448T	Bio-Inspired Computing and Fuzzy Logic.....	501
21CSE449T	Risk Analytics.....	503
 <b>Volume-11L – M.Tech(Int) CSE (CC) Courses</b>		 504
<b>1</b>	<b>Professional Core Courses.....</b>	<b>505</b>
21CSC505T	Computer Graphics and Vision.....	506
21CSC506J	Computation and Cognition: the Probabilistic Approach.....	508
<b>2</b>	<b>Professional Elective Courses.....</b>	<b>510</b>
21CSE541T	Probabilistic Graphical Models: Principles and Techniques.....	512
21CSE542T	Deep Generative Models.....	514
21CSE543T	Brain Machine Interface: Science, Technology and Application.....	516
21CSE544T	Data Analysis and Visualization.....	518
21CSE545T	Computational Perception and Cognition.....	520
21CSE546T	Medical Signal Processing.....	522
21CSE547T	Deep Multitask and Meta Learning.....	524
21CSE548T	Spatial and Temporal Computing.....	526
21CSE549T	Decision Making Under Uncertainty.....	528
21CSE553T	Neural Network Models of Cognition.....	530
21CSE552T	Computational Linguistics.....	532
21AIE536T	Artificial Intelligence Engines.....	534
21AIE538T	Artificial Intelligence for Industrial Applications.....	536
21AIE539T	Artificial Intelligence in Medical Imaging.....	538
21AIE541T	Multimodal Machine Learning.....	540

<b>Volume-11M – M.Tech(Int) CSE (CS &amp; DF) Courses</b>	<b>542</b>
<b>1 Professional Core Courses.....</b>	<b>543</b>
21CSC503T Security Service Management.....	544
21CSC504J Android Malware Analysis.....	546
<b>2 Professional Elective Courses.....</b>	<b>548</b>
21CSE531T Cyber Security Operations.....	549
21CSE532T Network Management and Protocols.....	551
21CSE533T Firewalls and Access Controls.....	553
21CSE534T Network Programming and Management.....	555
21CSE535T Network Intrusions and Computer Forensics.....	557
21CSE536T Mobile Forensics.....	559
21CSE537T Digital Forensics.....	561
21CSE538T Security Scripting and Analysis.....	563
21CSE539T Principles of Secure Coding Principles.....	565
21CSE540T Android Security and Design Internals.....	567
<b>Volume-11N – M.Tech(Int) CSE (DS) Courses</b>	<b>569</b>
<b>1 Professional Core Courses.....</b>	<b>570</b>
21CSC501T Natural Language Processing Techniques.....	571
21CSC502J Applied Deep Learning.....	573
<b>2 Professional Elective Courses.....</b>	<b>575</b>
21CSE521T Advanced Algorithms Analysis.....	576
21CSE522T Functional Programming.....	578
21CSE524T Computer Vision Techniques.....	580
21CSE527T Text Mining and Analytics.....	582
21CSE529T Web Intelligence.....	584

# ACADEMIC CURRICULA

Engineering Science Course

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**(Deemed to be University u/s 3 of UGC Act, 1956)**

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

<b>Course Code</b>	21CSS201T	<b>Course Name</b>	COMPUTER ORGANIZATION AND ARCHITECTURE	<b>Course Category</b>	S	ENGINEERING SCIENCES	<b>L</b>	T	P	C
							3	1	0	4

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the Fundamentals of computers, Memory operations and Addressing Modes												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Know about Functions of Arithmetic and Logic unit															
<b>CLR-3:</b>	Explore the Operations of Control Unit, Execution of Instruction and Pipelining															
<b>CLR-4:</b>	Classify the Need for Parallelism, Multicore and Multiprocessor Systems															
<b>CLR-5:</b>	Understand the Concepts and functions of Memory unit, I/O unit															
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Identify the computer hardware and how software interacts with computer hardware												3	2	1	-
<b>CO-2:</b>	Apply Boolean algebra as related to designing computer logic, through simple combinational and sequential logic circuits												3	2	-	-
<b>CO-3:</b>	Examine the detailed operation of Basic Processing units and the performance of Pipelining												3	-	-	-
<b>CO-4:</b>	Analyze concepts of parallelism and multi-core processors.												3	-	-	-
<b>CO-5:</b>	Classify the memory technologies, input-output systems and evaluate the performance of memory system												3	2	-	-

**Unit-1 – Introduction to Number System** 12 Hour  
 Introduction to Number System and Logic Gates: Number Systems- Binary, Decimal, Octal, Hexadecimal; Codes- Grey, BCD, Excess-3, ASCII, Parity; Binary Arithmetic- Addition, Subtraction, Multiplication, Division using Sign Magnitude, 1's compliment, 2's compliment, BCD Arithmetic; Logic Gates-AND, OR, NOT, NAND, NOR, EX-OR, EX-NOR.

**Unit-2 - Architectures** 12 Hour  
 Basic structure of computers: Functional Units of a computer, Operational concepts, Bus structures, Memory addresses and operations, assembly language, Instructions, Instruction sequencing, Addressing modes. Case study: 8086.

**Unit-3 - Design of ALU** 12 Hour  
 De Morgan's Theorem, Adders, Multiplier – Unsigned, Signed, Fast, Carry Save Addition of summands; Division–Restoring and Non-Restoring; IEEE 754 Floating point numbers and operations

**Unit-4 - Control Unit** 12 Hour  
 Basic processing unit, ALU operations, Instruction execution, Branch instruction, Multiple bus organization, Hardwired control, Generation of control signals, Micro-programmed control; Pipelining: Basic concepts of pipelining, Performance, Hazards-Data, Instruction and Control, Influence on instruction sets.

**Unit-5 - Parallelism** 12Hour  
 Need, types, applications and challenges, Architecture of Parallel Systems-Flynn's classification; ARM Processor: The thumb instruction set, Processor and CPU cores, Instruction Encoding format, Memory load and Store instruction, Basics of I/O operations. Case study: ARM 5 and ARM 7 Architecture.

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Computer Organization, 5th ed., McGraw-Hill, 2015</li> <li>Kai Hwang, Faye A. Briggs, Computer Architecture and Parallel Processing, 3rd ed., McGrawHill, 2016</li> <li>Ghosh T.K., Computer Organization and Architecture, 3rd ed., Tata McGraw-Hill, 2011</li> <li>P. Hayes, Computer Architecture and Organization, 3rd ed., McGrawHill, 2015.</li> <li>William Stallings, Computer Organization and Architecture – Designing for Performance, 10th ed., Pearson Education, 2015</li> <li>David A. Patterson and John L. Hennessy, Computer Organization and Design – A Hardware Software Interface, 5th ed., Morgan Kaufmann, 2014</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	30%	-	30%	-	30%	-		
Level 2	Understand	30%	-	30%	-	30%	-		
Level 3	Apply	20%	-	20%	-	20%	-		
Level 4	Analyze	20%	-	20%	-	20%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. Saminath Sanjai, Borgs Technologies, Inc. Bengaluru		<ol style="list-style-type: none"> <li>Dr. K. Vijaya, , SRMIST</li> <li>Dr. Anitha D, SRMIST</li> </ol>

# ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021



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Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

<b>Course Code</b>	21CSC201J	<b>Course Name</b>	DATA STRUCTURES AND ALGORITHMS	<b>Course Category</b>	C	PROFESSIONAL CORE	L 3	T 0	P 2	C 4
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		Program Outcomes (PO)												<b>Program Specific outcomes</b>												
CLR-1:	Know about searching and sorting techniques used to handle a set of data along with time and space complexity												PSO-1	PSO-2	PSO-3											
CLR-2:	Utilize various categories of list structures to develop solutions																									
CLR-3:	Explore usage of Stack and Queues in processing data for real time applications																									
CLR-4:	Understand tree structure and its applications																									
CLR-5:	Utilize hash tables for data storage and use graphs to solve real time problems																									
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	
CO-1:	Devise algorithms to arrange the data in required order and retrieve a specific datum in efficient manner													-	-	-	-	-	-	-	-	3	3	-	-	
CO-2:	Determine the type of list structure that could be used for solving a problem and implement it using C programming language													2	3	3	-	-	-	-	-	-	3	3	-	-
CO-3:	Devise solutions using linear structures Stack and Queue													2	3	3	-	-	-	-	-	-	3	3	-	-
CO-4:	Express proficiency in usage of tree for solving problems													2	3	3	-	-	-	-	-	-	3	3	-	-
CO-5:	Implement Hash tables for storing data and algorithms to find shortest path between nodes in a graph													3	2'	3	-	-	-	-	-	-	3	3	-	-

<b>Unit-1 - Introduction</b>	<b>15 Hour</b>
Programming in C - Primitive data types, Structures, Self-referential structures, Pointers and structures, Dynamic memory allocation, Matrix multiplication; Data Structure – Definition, Types, ADT, Operations; Mathematical notations - Big O, Omega and Theta, Complexity – Time, Space, Trade off.	
<b>Unit-2 - List Structure</b>	<b>15 Hour</b>
Operations on List ADT – Create, Insert, Search, Delete, Display elements; Implementation of List ADT– Array, Cursor based and Linked; Types – Singly, Doubly, Circular; Applications - Sparse Matrix, Polynomial Arithmetic, Joseph Problem	
<b>Unit-3 - Stack and Queue</b>	<b>15 Hour</b>
Operations on Stack ADT – Create, Push, Pop, Top; Implementation of Stack ADT – Array and Linked; Applications - Infix to Postfix Conversion, Postfix Evaluation, Balancing symbols, Function Calls, Tower of Hanoi; Operations on Queue ADT - Create, Enqueue and Dequeue; Implementation of Queue ADT – Array and Linked; Types of Queue - Circular, Double ended and Priority Queue, Applications – Scheduling	
<b>Unit-4 - Trees and Hashing</b>	<b>15 Hour</b>
Introduction to Trees, Tree traversals, Complete Binary Tree and its height, Binary Search Trees, Need for Balance, Rotation, AVL trees, B Trees, Heaps, trees and array implementations and applications; Hash functions - Introduction, functions, Collision avoidance, Separate chaining, Open Addressing, Linear Probing, Quadratic probing.	
<b>Unit-5 - Graph</b>	<b>15 Hour</b>
Introduction to Graph, Graph Traversal, Topological sorting, Minimum spanning tree – Prims Algorithm, Kruskal's Algorithm, Shortest Path Algorithm - Dijkstra's Algorithm	

#### **Lab Experiments**

- Lab 1: Implementation of Structures  
 Lab 2: Implementation of Structures using Pointers  
 Lab 3: Implementation of Matrix Multiplication – Dynamic Memory allocation  
 Lab 4: Array Implementation of List  
 Lab 5: Implementation of Linked List  
 Lab 6: Implementation of Doubly linked List  
 Lab 7: Implementation of Stack using array and Linked List  
 Lab 8: Implementation of Queue using array and Linked list  
 Lab 9: Applications of Stack, Queue  
 Lab 10: Implementation of Tree using array  
 Lab 11: Implementation of BST using linked list  
 Lab 12: Implementation of B-Trees  
 Lab 13: Implementation of Graph using Array  
 Lab 14: Implementation of Shortest path Algorithm  
 Lab 15: Implementation of Minimal Spanning Tree

<b>Learning Resources</b>	1. Seymour Lipschutz, <i>Data Structures with C</i> , McGraw Hill, 2014 2. R.F.Gilberg, B.A.Forouzan, <i>Data Structures</i> , 2nd ed., Thomson India, 2005 3. A.V.Aho, J.E Hopcroft , J.D.Ullman, <i>Data structures and Algorithms</i> , Pearson Education, 2003	4. Mark Allen Weiss, <i>Data Structures and Algorithm Analysis in C</i> , 2nd ed., Pearson Education, 2015 5. Reema Thareja, <i>Data Structures Using C</i> , 1st ed., Oxford Higher Education, 2011, 6. Thomas H Cormen, Charles E Leiserson, Ronald L Rivest, Clifford Stein, <i>Introduction to Algorithms</i> 3rd ed., The MIT Press Cambridge, 2014
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
Bloom's Level of Thinking	Formative CLA-1 Average of unit test (45%)	Life-Long Learning CLA-2 (15%)							
		Theory	Practice	Theory	Practice				
		Level 1	Remember	25%	-	-	10%		
Level 2	Understand	25%	-	-	-	20%	25%		
Level 3	Apply	20%	-	-	-	30%	20%		
Level 4	Analyze	20%	-	-	-	30%	20%		
Level 5	Evaluate	10%	-	-	-	10%	10%		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

#### **Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Mariappan Vaithilingam, Senior Engineering Manager, Uber India Research and Development Pvt Centre, Bangalore.	1. Dr. Venkatesh Raman, Professor, Mathematical Institute of Science	1. Dr. K. Vijaya, SRMIST
		2. Dr. S. Poornima, SRMIST 3. Dr. P. Saranya, SRMIST

<b>Course Code</b>	21CSC202J	<b>Course Name</b>	OPERATING SYSTEMS	<b>Course Category</b>	C	PROFESSIONAL CORE	L 3	T 0	P 2	C 4
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		Program Outcomes (PO)												<b>Program Specific outcomes</b>									
1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CLR-1:</b> Outline the structure of OS and basic architectural components involved in OS design																					PSO-1	PSO-2	PSO-3
<b>CLR-2:</b> Introduce the concept of deadlock and various memory management mechanism																							
<b>CLR-3:</b> Familiarize the scheduling algorithms, file systems, and I/O schemes																							
<b>CLR-4:</b> Identify and tell the various embedded operating systems and computer security concepts																							
<b>CLR-5:</b> Name the various computer security techniques in windows and Linux																							
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>																						
<b>CO-1:</b> Use the appropriate concepts of operating system for resource utilization	3	3	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	3	2	-	-		
<b>CO-2:</b> Choose the relevant process and thread concepts for solving synchronization problems	3	3	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	3	2	-	-		
<b>CO-3:</b> Exemplify different types of scheduling algorithms and deadlock mechanism.	3	3	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	3	2	-	-		
<b>CO-4:</b> Experiment the performance of different algorithms used in management of memory, file and I/O and select the appropriate one.	3	3	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	3	2	-	-		
<b>CO-5:</b> Demonstrate different device and resource management techniques for memory utilization with security mechanisms	3	2	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	3	2	-	-		

**Unit-1 - Introduction** **15 Hour**  
 Computer-System Organization, Computer-System Architecture, Operating-System Structure, Operating-System Operations, Process Management, Memory Management, Storage Management, Protection and Security, Kernel Data Structures, Computing Environments, Open-Source Operating Systems, Operating-System Services, User and Operating-System Interface, System Calls, Types of System Calls, System Programs, Operating-System Design and Implementation, Operating-System Structure, Operating-System Debugging, Operating-System Generation, System Boot.

**Unit-2 - Process Management** **15 Hour**  
 Process Concept, Process Scheduling, Operations on Processes, Interprocess Communication, Communication in Client- Server Systems, Threads: Multicore Programming, Multithreading Models, Thread Libraries, Implicit Threading, Threading Issues. Process Synchronization: The Critical-Section Problem, Peterson's Solution, Synchronization Hardware, Mutex Locks, Semaphores, Classic Problems of Synchronization, Monitors

**Unit-3 - CPU Scheduling:** **15 Hour**  
 Basic Concepts, Scheduling Criteria, Scheduling Algorithms, Thread Scheduling, Multiple-Processor Scheduling, Real-Time CPU Scheduling. Deadlocks: System Model, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock

**Unit-4 - Memory Management** **15 Hour**  
 Main Memory, Swapping, Contiguous Memory Allocation, Segmentation, Paging, Structure of the Page Table. Virtual Memory: Introduction, Demand Paging, Copy-on-Write, Page Replacement, Allocation of Frames, Thrashing, Memory-Mapped Files, Allocating Kernel Memory. STORAGE MANAGEMENT: Disk Structure, Disk Attachment, Disk Scheduling, Disk Management, Swap-Space Management, RAID Structure. File-System Interface: File Concept, Access Methods, Directory and Disk Structure, File-System Mounting, File Sharing, Protection. .

**Unit-5 - Protection and Security** 15 Hour

Goals of Protection, Principles of Protection, Domain of Protection, Access Matrix, Implementation of the Access Matrix, Access Control, Revocation of Access Rights, Capability-Based Systems, Language-Based Protection, The Security Problem, Program Threats, System and Network Threats, Cryptography as a Security Tool, User Authentication, Implementing Security Defenses, Firewalling to Protect Systems and Networks, Computer-Security Classifications.

**Lab Experiments**

Lab 1: Operating system Installation, Basic Linux commands	Lab 6: Dining Philosopher problem	Lab 11: LRU and LFU Page Replacement Algorithm
Lab 2: Process Creation using fork() and Usage of getpid(), getppid(), wait() functions	Lab 7: Bankers Algorithm for Deadlock avoidance	Lab 12: Best fit and Worst fit memory management policies
Lab 3: Multithreading	Lab 8: FCFS and SJF Scheduling	Lab 13: Disk Scheduling algorithm
Lab 4: Mutual Exclusion using semaphore and monitor	Lab 9: Priority and Round robin scheduling	Lab 14: Sequential and Indexed file Allocation
Lab 5: Reader-Writer problem	Lab 10: FIFO Page Replacement Algorithm	Lab 15: File organization schemes for single level and two-level directory

<b>Learning Resources</b>	1. Abraham Silberschatz, Peter Baer Galvin, and Greg Gagne, "Operating System Concepts", John Wiley & Sons (Asia) Pvt. Ltd, Tenth Edition, 2018	6. Charles Crowley, "Operating Systems: A Design-Oriented Approach", Tata McGraw Hill Education, 2017
	2. RamazElmasri, A. Gil Carrick, David Levine, "Operating Systems – A Spiral Approach ", Tata McGraw Hill Edition, 2010	7. <a href="https://nptel.ac.in/courses/106/105/106105214/">https://nptel.ac.in/courses/106/105/106105214/</a>
	3. Dhananjay M. Dhamdhere, "Operating Systems – A Concept Based Approach", Third Edition, Tata McGraw Hill Edition, 2019	8. <a href="https://nptel.ac.in/courses/106/106/106106144/">https://nptel.ac.in/courses/106/106/106106144/</a>
	4. Andrew S. Tanenbaum, "Modern Operating Systems", Fourth Edition, Global Edition, Pearson, 2015.	9. <a href="https://nptel.ac.in/courses/106/102/106102132/">https://nptel.ac.in/courses/106/102/106102132/</a>
	5. William Stallings, "Operating Systems: Internals and Design Principles", Pearson Education, Sixth Edition, 2018.	10. <a href="https://onlinecourses.nptel.ac.in/noc21_cs44/preview">https://onlinecourses.nptel.ac.in/noc21_cs44/preview</a>
		11. <a href="https://nptel.ac.in/courses/106/105/106105172/">https://nptel.ac.in/courses/106/105/106105172/</a>

Learning Assessment						
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)		
		Theory	Practice	Theory	Practice	Theory
Level 1	Remember	20%	-	-	0%	20%
Level 2	Understand	40%	-	-	40%	40%
Level 3	Apply	20%	-	-	40%	20%
Level 4	Analyze	20%	-	-	10%	10%
Level 5	Evaluate	-	-	-	10%	10%
Level 6	Create	-	-	-	-	-
	Total	100 %		100 %		100 %

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.T.Madhan, Team Leader, Tata Consultancy Services, siruseri Campus, Chennai, <a href="mailto:madhan.tk@gmail.com">madhan.tk@gmail.com</a>	1. Dr. S. Janakiraman, Associate Professor, Pondicherry University, <a href="mailto:sj.dbt@pondiuni.edu.in">sj.dbt@pondiuni.edu.in</a>	1. Dr. N. Prasath, SRMIST
2. Mrs.K.Saranya, IT Analyst, Tata Consultancy Services, siruseri Campus, Chennai, <a href="mailto:saranya.k6@gmail.com">saranya.k6@gmail.com</a>	2. Dr. R.Shyamala, Associate Professor, Anna University College of Engineering Tindivanam, <a href="mailto:vasuchaaru@gmail.com">vasuchaaru@gmail.com</a>	2. Dr. M. Eliazer, SRMIST

<b>Course Code</b>	21CSC203P	<b>Course Name</b>	ADVANCED PROGRAMMING PRACTICE	<b>Course Category</b>	C	PROFESSIONAL CORE	<b>L</b>	T	P	C
							3	1	0	4

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		Program Outcomes (PO)												<b>Program Specific outcomes</b>													
<b>CLR-1:</b>	Understand the paradigm functionalities and their hierarchy											1	2	3	4	5	6	7	8	9	10	11	12				
<b>CLR-2:</b>	Deploy structural, procedural, and Object-Oriented Programming Paradigm											Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSC-1	PSC-2	PSC-3	
<b>CLR-3:</b>	Demonstrate the event, Graphical User Interface, and declarative Paradigm with a java application.																										
<b>CLR-4:</b>	Extended knowledge on logic, functional, network and concurrent Paradigm																										
<b>CLR-5:</b>	Symbolic, Automata-based, and Event with a python application.																										
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>																										
<b>CO-1:</b>	Devise solutions to the various programming paradigm																3	2	-	-	-	-	-	-	2	-	-
<b>CO-2:</b>	Express proficiency in the usage of structural, procedural, and Object-Oriented Program																3	2	-	1	-	-	-	-	2	-	-
<b>CO-3:</b>	Determine the Java application using declarative, event, and graphical user interface paradigm																3	-	2	1	2	-	-	-	1	-	-
<b>CO-4:</b>	Express proficiency in the usage of logic, functional, network, and concurrent Paradigm																3	2	-	1	-	-	-	-	2	-	-
<b>CO-5:</b>	Determine the Python application using symbolic, automata-based, and graphical user interface programming paradigms																3	-	2	1	2	-	-	-	1	-	-

**Unit-1 - Introduction to Programming Paradigm** 12 Hour  
 Programming Languages – Elements of Programming languages - Programming Language Theory - Bohm- Jacopini structured program theorem - Multiple Programming Paradigm – Programming Paradigm hierarchy – Imperative Paradigm: Procedural, Object-Oriented and Parallel processing – Declarative programming paradigm: Logic, Functional and Database processing - Machine Codes – Procedural and Object-Oriented Programming – Suitability of Multiple paradigms in the programming language - Subroutine, method call overhead and Dynamic memory allocation for message and object storage - Dynamically dispatched message calls and direct procedure call overheads – Object Serialization – parallel Computing

**Unit-2 - Java Programming Paradigms** 12 Hour  
 Object and Classes; Constructor; Data types; Variables; Modifier and Operators - Structural Programming Paradigm: Branching, Iteration, Decision making, and Arrays - Procedural Programming Paradigm: Characteristics; Function Definition; Function Declaration and Calling; Function Arguments - Object-Oriented Programming Paradigm: Abstraction; Encapsulation; Inheritance; Polymorphism; Overriding - Interfaces: Declaring, implementing; Extended and Tagging - Package: Package Creation.

**Unit-3 - Advanced Java Programming Paradigms** 12 Hour  
 Concurrent Programming Paradigm: Multithreading and Multitasking; Thread classes and methods - Declarative Programming Paradigm: Java Database Connectivity (JDBC); Connectivity with MySQL – Query Execution; - Graphical User Interface Based Programming Paradigm: Java Applet: Basics and Java Swing: Model View Controller (MVC) and Widgets; Develop a java project dissertation based on the programming paradigm.

**Unit-4 - Pythonic Programming Paradigm** 12 Hour  
 Functional Programming Paradigm: Concepts; Pure Function and Built-in Higher-Order Functions; Logic Programming Paradigm: Structures, Logic, and Control; Parallel Programming Paradigm: Shared and Distributed memory; Multi-Processing – Ipython; Network Programming Paradigm: Socket; Socket Types; Creation and Configuration of Sockets in TCP / UDP – Client / Server Model.

**Unit-5 - Formal and Symbolic Programming Paradigm****12 Hour**

Automata Based programming Paradigm: Finite Automata – DFA and NFA; Implementing using Automaton Library - Symbolic Programming Paradigm: Algebraic manipulations and calculus; Sympy Library - Event Programming Paradigm: Event Handler; Trigger functions and Events – Tkinter Library. Develop a python-based project dissertation based on the programming paradigm.

<b>Learning Resources</b>	1. Elad Shalom, <i>A Review of Programming Paradigms throughout the History: With a suggestion Toward a Future Approach</i> , Kindle Edition, 2018 2. Maurizio Gabbielli, Simone Martini, <i>Programming Languages: Principles and Paradigms</i> , 2010.	3. Herbert Schildt, <i>Java: The Complete Reference</i> Seventh Edition, 2016. 4. Mark Lutz, <i>Programming Python: Powerful Object-Oriented Programming</i> , 2011.
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Learning Assessment		Continuous Learning Assessment (CLA)						Final Examination (0% weightage)			
Bloom's Level of Thinking	Formative CLA-1 Average of unit test (20%)	Project Based Learning CLA-2 (60%)		Report and Viva Voce (20% weightage)							
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	30%	-	--	20%	-	10%	-	-		
Level 2	Understand	30%	-	-	20%	-	10%	-	-		
Level 3	Apply	20%	-	-	20%	-	10%	-	-		
Level 4	Analyze	20%	-	-	20%	-	10%	-	-		
Level 5	Evaluate	-	-	-	10%	-	30%	-	-		
Level 6	Create	-	-	-	10%	-	30%	-	-		
	Total	100 %		100 %		100 %		-			

**Course Designers****Experts from Industry**

1. Mr. N. Venkatesh, Tech Lead, Honeywell, Bengaluru, Karnataka, India

**Experts from Higher Technical Institutions**

1. Dr. Sudeepa Mishra, Assistant Professor, Computer Science and Engineering, Indian Institute of Information Technology, Ropar, Punjab.

**Internal Experts**

1. Dr Ramkumar J, SRMIST

<b>Course Code</b>	21CSC204J	<b>Course Name</b>	DESIGN AND ANALYSIS OF ALGORITHMS	<b>Course Category</b>	C	PROFESSIONAL CORE	L 3	T 0	P 2	C 4
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	The purpose of learning this course is to:												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-1:</b>	Design efficient algorithms in solving complex real time problems	1	Problem Analysis	2	Design/development of solutions	3	Conduct investigations of complex problems	4	5	6	7	8	9	10	11	12
<b>CLR-2:</b>	Analyze various algorithm design techniques to solve real time problems in polynomial time	2	-	1	-	-	-	-	-	-	-	-	3	-	3	3
<b>CLR-3:</b>	Utilize various approaches to solve greedy and dynamic algorithms	2	-	1	-	-	-	-	-	-	-	-	3	-	3	1
<b>CLR-4:</b>	Utilize back tracking and branch and bound paradigms to solve exponential time problems	2	-	1	-	-	-	-	-	-	-	-	3	-	3	1
<b>CLR-5:</b>	Analyze the need of approximation and randomization algorithms, utilize the importance Non polynomial algorithms	2	-	1	-	-	-	-	-	-	-	-	3	-	3	1

<b>Course Outcomes (CO):</b>		<b>At the end of this course, learners will be able to:</b>														
<b>CO-1:</b>	Apply efficient algorithms to reduce space and time complexity of both recurrent and non-recurrent relations	2	1	2	1	-	-	-	-	-	-	-	3	-	3	3
<b>CO-2:</b>	Solve problems using divide and conquer approaches	2	1	2	1	-	-	-	-	-	-	-	3	-	3	1
<b>CO-3:</b>	Apply greedy and dynamic programming type's techniques to solve polynomial time problems.	2	1	2	1	-	-	-	-	-	-	-	3	-	3	1
<b>CO-4:</b>	Create exponential problems using backtracking and branch and bound approaches.	2	1	2	1	-	-	-	-	-	-	-	3	-	3	1
<b>CO-5:</b>	Interpret various approximation algorithms and interpret solutions to evaluate P type, NP Type, NPC, NP Hard problems	2	1	2	1	-	-	-	-	-	-	-	3	-	3	1

**Unit-1 - Introduction to Algorithm Design** 15 Hour  
Fundamentals of Algorithms- Correctness of algorithm - Time complexity analysis - Insertion sort-Line count, Operation count Algorithm Design paradigms - Designing an algorithm And its analysis-Best, Worst and Average case - Asymptotic notations Based on growth functions.  $O, O, \Theta, w, \Omega$  - Mathematical analysis - Induction, Recurrence relations -Solution of recurrence relations - Substitution method - Solution of recurrence relations - Recursion tree - Solution of recurrence relations - examples.

**Unit-2 - Divide and Conquer** 15 Hour  
Maximum Subarray Problem Binary Search - Complexity of binary search Merge sort - Time complexity analysis -Quick sort and its Time complexity analysis Best case, Worst case, Average case analysis - Strassen's Matrix multiplication and its recurrence relation - Time complexity analysis of Merge sort - Largest sub-array sum - Time complexity analysis of Largest sub- array sum - Master Theorem Proof - Master theorem examples - Finding Maximum and Minimum in an array - Time complexity analysis-Examples - Algorithm for finding closest pair problem - Convex Hull problem

**Unit-3 - Greedy and Dynamic Programming** 15 Hour  
- Examples of problems that can be solved by using greedy and dynamic approach Huffman coding using greedy approach Comparison of brute force and Huffman method of encoding - Knapsack problem using greedy approach Complexity derivation of knapsack using greedy - Tree traversals - Minimum spanning tree – greedy Kruskal's algorithm - greedy - Minimum spanning tree - Prims algorithm Introduction to dynamic programming - 0/1 knapsack problem - Complexity calculation of knapsack problem - Matrix chain multiplication using dynamic programming - Complexity of matrix chain multiplication - Longest common subsequence using dynamic programming - Explanation of LCS with an example - Optimal binary search tree (OBST)using dynamic programming - Explanation of OBST with an example.

<b>Unit-4 - Backtracking</b>	<b>15 Hour</b>
branch and bound - N queen's problem – backtracking - Sum of subsets using backtracking Complexity calculation of sum of subsets Graph introduction Hamiltonian circuit - backtracking - Branch and bound - Knapsack problem Example and complexity calculation. Differentiate with dynamic and greedy Travelling salesman problem using branch and bound - Travelling salesman problem using branch and bound example - Travelling salesman problem using branch and bound example - Time complexity calculation with an example - Graph algorithms - Depth first search and Breadth first search - Shortest path introduction - Floyd-Warshall Introduction - Floyd-Warshall with sample graph - Floyd-Warshall complexity	
<b>Unit-5 - Randomized and Approximation Algorithm</b>	<b>15 Hour</b>
Randomized hiring problem Randomized quick sort Complexity analysis String matching algorithm Examples - Rabin Karp algorithm for string matching Example discussion - Approximation algorithm - Vertex covering - Introduction Complexity classes - P type problems - Introduction to NP type problems - Hamiltonian cycle problem - NP complete problem introduction - Satisfiability problem - NP hard problems - Examples	
<b>Lab Experiments</b>	
Lab 1: Simple Algorithm-Insertion sort Lab 2: Bubble Sort Lab 3: Recurrence Type-Merge sort, Linear search Lab 4: Quicksort, Binary search Lab 5: Strassen Matrix multiplication Lab 6: Finding Maximum and Minimum in an array, Convex Hull problem Lab 7: Huffman coding, knapsack and using greedy Lab 8: Various tree traversals,	Lab 9: Longest common subsequence Lab 10: N queen's problem Lab 11: Travelling salesman problem Lab 12: BFS and DFS implementation with array Lab 13: Randomized quick sort Lab 14: String matching algorithms Lab 15: Discussion over analyzing a real time problem

<b>Learning Resources</b>	1. Thomas H Cormen, Charles E Leiserson, Ronald L Rivest, Clifford Stein, <i>Introduction to Algorithms</i> , 3rd ed., The MIT Press Cambridge, 2014 2. Mark Allen Weiss, <i>Data Structures and Algorithm Analysis in C</i> , 2nd ed., Pearson Education, 2006	3. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, <i>Fundamentals of Computer Algorithms</i> , Galgotia Publication, 2010 4. S. Sridhar, <i>Design and Analysis of Algorithms</i> , Oxford University Press, 2015
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<b>Learning Assessment</b>							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice		
Level 1	Remember	30%	-	-	30%	30%	
Level 2	Understand	70%	-	-	30%	30%	
Level 3	Apply	-	-	-	40%	40%	
Level 4	Analyze	-	-	-	-	-	
Level 5	Evaluate	-	-	-	-	-	
Level 6	Create	-	-	-	-	-	
	Total	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. G. Venkiteswaran, Wipro Technologies, gvenki@pilani.bits-pilani.ac.in 2. Dr. Sainarayanan Gopalakrishnan, HCL Technologies, sai.jgk@gmail.com	1. Mitesh Khapra, IITM Chennai, miteshk@cse.iitm.ac.in 2. V. Masilamani. IIITDM, masila@iiitdm.ac.in	1. Dr. K. Senthil Kumar, SRMIST 2. Dr. V. Sivakumar, SRMIST 3. Dr. R. Vidhya, SRMIST

<b>Course Code</b>	21CSC205P	<b>Course Name</b>	DATABASE MANAGEMENT SYSTEMS	<b>Course Category</b>	C	PROFESSIONAL CORE	L 3	T 1	P 0	C 4
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the fundamentals and need of Database systems, Architecture, Languages												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Conceive database design through Relational model, Relational Algebra												-	-	-	
<b>CLR-3:</b>	Design Logical schema with constraints, Familiarize SQL Queries												-	-	-	
<b>CLR-4:</b>	Standardization of Database through Normalization												-	-	-	
<b>CLR-5:</b>	Understand Storage Management, the practical problems of Concurrency control, Failures and recovery, NoSQL database												-	-	-	
<b>Course Outcomes (CO):</b>		<b>At the end of this course, learners will be able to:</b>														
<b>CO-1:</b>	Acquire knowledge on DBMS architecture and languages												-	2	1	-
<b>CO-2:</b>	Acquire knowledge on Relational languages and design a database												1	2	-	-
<b>CO-3:</b>	Implement the Database structure with SQL												1	-	2	1
<b>CO-4:</b>	Removal of anomalies using Normalization concepts												1	-	2	1
<b>CO-5:</b>	Visualizing storage structure, handling concurrency, Failure and recovery principles, NoSQL concept												1	2	-	-

<b>Unit-1 - Introduction</b>	<b>12 Hour</b>
Issues in File Processing System, Need for DBMS, Basic terminologies of Database, Database system Architecture, Various Data models, ER diagram basics and extensions, Case study: Construction of Database design using Entity Relationship diagram for an application such as University Database, Banking System, Information System	
<b>Unit-2 – Relational DBMS</b>	<b>12 Hour</b>
Conversion of ER model to Relational Table, Case study: Apply conversion concept. Discussion of various design issues. Pitfalls in Relational Database systems, Understanding various Relational languages such as Tuple Relational calculus, Domain relational calculus, Calculus Vs Algebra, Computational capabilities. Case Study: Applying Relational Algebra for all the queries of application Designed.	
<b>Unit-3 – SQL</b>	<b>12 Hour</b>
SQL commands, Constraints, Joins, set operations, Sub queries, Views, PL – SQL, Triggers, and Cursors. Case Study: Implement all the queries using SQL, PL-SQL, Cursor and Triggers	
<b>Unit-4 - Normalization</b>	<b>12 Hour</b>
Normalization, Need for Normalization, NF1, NF2, NF3, NF4, NF5. Case study: Apply Conversion rules and normalize the Database	
<b>Unit-5 – Concurrency Control</b>	<b>12 Hour</b>
Storage Structure, Transaction control, Concurrency control algorithms, Issues in Concurrent execution, Failures and Recovery algorithms Case study: Demonstration of Entire project by applying all the concepts learnt with minimum Front end requirements, NoSQL Databases-Document Oriented, Key value pairs, Column Oriented and Graph	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>Abraham Silberschatz, Henry F. Korth, S. Sudharshan, <i>Database System Concepts</i>, Seventh Edition, Tata McGraw Hill, 2019.</li> <li>Ramez Elmasri, Shamkant B. Navathe, <i>Fundamentals of Database Systems</i>, Sixth Edition, Pearson Education, 2011.</li> <li>CJ Date, A Kannan, S Swamynathan, <i>An Introduction to Database Systems</i>, Eighth Edition, Pearson Education, 2006.</li> <li>Raghurama Krishnan, Johannes Gehrke, <i>Database Management Systems</i>, 3rd Edition, McGrawHill Education, 2003.</li> <li><i>Principles of Database Systems</i>, J.D. Ullman, Galgoti, 1982</li> <li>NoSQL Distilled, A brief guide to the emerging world of Polygot persistence, First Edition, Promod J.Sadalage Martin Fowler, 2012</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)						<b>Final Examination (0% weightage)</b>			
	<i>Bloom's Level of Thinking</i>	Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20% weightage)					
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	20%	-	-	-	-	-	-	-		
Level 2	Understand	40%	-	-	-	-	-	-	-		
Level 3	Apply	40%	-	-	30%	-	-	-	-		
Level 4	Analyze	-	-	-	30%	-	-	-	-		
Level 5	Evaluate	-	-	-	-	-	50%	-	-		
Level 6	Create	-	-	-	40%	-	50%	-	-		
	Total	100 %		100 %		100%		-			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Ms.Sangeetha Jayaprakash, Database Architect, BOSCH India 2. Dr.Manipoonchelvi, Senior Technical Manager, HCL Technologies	1. Dr.J.Sheeba Rani, Indian Institute of Space Science and Technology, Trivandrum 2. Dr.K.Nandhini, Central University of Thiruvarur	1. Dr.M.Thenmozhi,NWC 2. Ms.K.Srividya, DSBS

<b>Course Code</b>	21CSC301T	<b>Course Name</b>	FORMAL LANGUAGE AND AUTOMATA	<b>Course Category</b>	C	PROFESSIONAL CORE	L 3	T 0	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	PSO-1	PSO-2	PSO-3	
<b>CLR-1:</b> Construct automata for any equivalent regular expressions	-	1	1	-	-	-	-	-	-	-	-	-	-	1	3	-
<b>CLR-2:</b> Acquire brief knowledge about automata languages	-	3	3	-	-	-	-	-	-	-	-	-	-	1	3	-
<b>CLR-3:</b> Analyze about context free grammars and its implementation in Push down automata	-	2	2	-	-	-	-	-	-	-	-	-	-	1	3	-
<b>CLR-4:</b> Interpret the power of Turing machine and the decidable nature of a problem	-	2	2	-	-	-	-	-	-	-	-	-	-	1	3	-
<b>CLR-5:</b> Categorize undecidable problems and NP class problems	-	3	3	-	-	-	-	-	-	-	-	-	-	1	3	-

<b>Course Outcomes (CO):</b>		<b>At the end of this course, learners will be able to:</b>												<b>Program Specific outcomes</b>		
1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	PSO-1	PSO-2	PSO-3	
<b>CO-1:</b> Summarize the basic concepts of deterministic and non-deterministic finite automata and its applications.	-	1	1	-	-	-	-	-	-	-	-	-	-	1	3	-
<b>CO-2:</b> Analyze the formal relationships among machines, languages and Context free grammars and its normalization	-	3	3	-	-	-	-	-	-	-	-	-	-	1	3	-
<b>CO-3:</b> Construct the Push down stack machine and its context free language acceptance and its equivalence with CFG	-	2	2	-	-	-	-	-	-	-	-	-	-	1	3	-
<b>CO-4:</b> Analyze the techniques for Turing machine construction and its recursive languages and functions	-	2	2	-	-	-	-	-	-	-	-	-	-	1	3	-
<b>CO-5:</b> Evaluate the computational complexity of various problems	-	3	3	-	-	-	-	-	-	-	-	-	-	1	3	-

#### **Unit-1 - Finite Automata and Regular Expressions** 9 Hour

Deterministic and Non-Deterministic Finite Automata, Finite Automata with  $\epsilon$ -moves, regular expressions – equivalence of NFA and DFA, two-way finite automata, Moore and Mealy machines, Equivalence of Moore and Mealy machines, applications of finite automata.

#### **Unit-2 - Regular Sets and Context Free Grammars** 9 Hour

Properties of regular sets, context-Free Grammars, and Languages – derivation trees, Simplification of CFG: Elimination of Useless Symbols Simplification of CFG: Unit productions, Null productions - Chomsky Normal Forms and Greibach Normal Forms, ambiguous and unambiguous grammars; minimization of finite automata

#### **Unit-3 - Pushdown Automata and Parsing Algorithms** 9 Hour

Deterministic Push Down Automata – Non-Deterministic Push Down Automata – Equivalence of Pushdown Automata and context-free languages; Properties of CFL; Applications of pumping lemma — closure properties of CFL and decision algorithms; Overview of Top-down parsing and Bottom-up parsing

#### **Unit-4 - Turing machines** 9 Hour

Turing machines (TM) – computable languages and functions – turing machine constructions – storage in finite control – variations of TMs – Church-Turing thesis – Universal Turing machine– recursive and recursively enumerable languages

#### **Unit-5 - Introduction to Computational Complexity** 9 Hour

Time and Space complexity of TMs – complexity classes – introduction to NP-Hardness and NP-Completeness Post Correspondence Problems (PCP) – Modified PCP – Halting Problems – Undecidability Problems

<b>Learning Resources</b>	1. Hopcroft J.E., Motwani R. and Ullman J.D, "Introduction to Automata Theory, Languages and Computations", Second Edition, Pearson Education, 2008. 2. Michael Sipser, "Introduction to the Theory of Computation" Cengage Learning, 2012	3. John.C. Martin, "Introduction to Languages and the Theory of Computation" McGraw-Hill Education, 01- May-2010. 4. Peter Linz, "An introduction to formal languages and automata", Jones & Bartlett Learning, Sixth Edition, 2017
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Santhosh Muniswami, Cisco Systems, Inc. 2. B. Divya, TCS	1. Dr. P. Victer Paul, Indian Institute of Information Technology Kottayam 2. Dr.C. Punitha Devi, Pondicherry University,	1. Dr. N. Arunachalam 2. Dr. K. Vijaya

<b>Course Code</b>	21CSC302J	<b>Course Name</b>	COMPUTER NETWORKS	<b>Course Category</b>	C	PROFESSIONAL CORE	L 3	T 0	P 2	C 4
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		Program Outcomes (PO)												<b>Program Specific outcomes</b>			
1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3			
<b>CLR-1:</b> Define the layered network architecture																	
<b>CLR-2:</b> Produce knowledge in IP addressing																	
<b>CLR-3:</b> Identify suitable routing algorithms based on geographical location of the devices																	
<b>CLR-4:</b> Apply the concept of Error detection to identify the errors in data.																	
<b>CLR-5:</b> Exploring reliable and unreliable protocols																	
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>																	
<b>CO-1:</b> Apply the knowledge of communication	3	-	-												1	-	-
<b>CO-2:</b> Construct the network using addressing schemes	3	-	-	2	-	-	-	-	-	-	-	-	-	-	1	-	-
<b>CO-3:</b> Design and implement the various Routing Protocols	3	-	-	2	3	-	-	-	-	-	-	-	-	-	1	-	-
<b>CO-4:</b> Identify and correct the errors in transmission	3	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
<b>CO-5:</b> Analyze the services provided by Transport and Application layers	3	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-

<b>Unit-1 - Introduction to Networks</b>	<b>15 Hour</b>
Network Types: LAN, MAN, PAN, WAN - Network Topology : BUS, STAR, RING, MESH, HYBRID - Switching : Circuit Switching, Packet Switching - OSI Layered Architecture - TCP/IP Model - Physical Layer Overview - Latency, Bandwidth, Delay - Guided Media : Twisted pair, Coaxial cable, Fiber optic cable - Unguided Media : Radio waves, Microwaves, Infrared.	
Lab 1: Introduction to Packet Tracer, Peer to Peer communication, study of cables and its colour codes	
Lab 2: Implementation of Network Topologies	
Lab 3: Router Configuration (Creating Passwords, Configuring Interfaces)	
<b>Unit-2 - Addressing</b>	<b>15 Hour</b>
IPV4 Addressing - Address space - Classful addressing - Subnet mask - FLSM - Classless Addressing - VLSM – NAT – Super netting - Network Devices: Hub, Repeaters, Switch, Bridge, Router	
Lab 4: IP addressing and Sub netting (VLSM)	
Lab 5: Static and Default Routing	
Lab 6: NAT Configuration	
<b>Unit-3 - Routing</b>	<b>15 Hour</b>
Forwarding of IP Packets — Static and Default Routing — Unicast Routing Algorithms: Distance Vector Routing, Link State Routing, Path Vector Routing — Protocols: RIP V1, RIP V2, OSPF, BGP, EIGRP — Multicasting Basics — IPV6 Addressing Basics	
Lab 7: Implementation of RIP version 1	
Lab 8: Implementation of RIP version 2	
Lab 9: Implementation of Single Area OSPF	

<b>Unit-4 – Medium Access Control</b>	<b>15 Hour</b>
ALOHA ,CSMA/CD, CSMA/CA, Ethernet, Token Ring - Flow Control :Stop and Wait, Sliding Window - Error Control: Stop and Wait ARQ, Sliding Window ARQ - Error Detection : Parity Check, Checksum, CRC - Error Correction: Hamming codes - Data-Link Layer Protocols : HDLC, PPP.	
Lab 10: Implementation of Multi Area OSPF	
Lab 11: PPP Configuration	
Lab 12: HDLC Configuration	
<b>Unit-5 – Transport and Application Layer Protocols</b>	<b>15 Hour</b>
Port Numbers — User Datagram Protocol — Transmission Control Protocol — WWW and HTTP — FTP— Email –Telnet – DNS.	
Lab 13: Implementation of BGP	
Lab 14: Implementation of EIGRP	
Lab 15: Telnet Configuration	

<b>Learning Resources</b>	1. Behrouz A. Forouzan, "Data Communication and Networking",5th ed.,2010 2. Bhushan Trivedi, " Data Communication and Networks" 2016	3. William Stallings, " Data and Computer Communications",9th ed.,2010 4. Todd Lammle, "CCNA Study Guide",7th ed.,2011
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	20%	-	-	20%	20%	-		
Level 2	Understand	40%	-	-	40%	40%	-		
Level 3	Apply	40%	-	-	40%	40%	-		
Level 4	Analyze	-	-	-	-	-	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. Srinivasan Varadharajan, Senior Principal Software Engineer, Manhattan Associates, Atlanta, United States	1. Dr. I.Joe Louis Paul, Associate Professor, SSN College of Engineering, TamilNadu	1. Dr. S. Metilda Florence, SRMIST

<b>Course Code</b>	21CSC303J	<b>Course Name</b>	SOFTWARE ENGINEERING AND PROJECT MANAGEMENT	<b>Course Category</b>	C	PROFESSIONAL CORE	L 2	T 0	P 2	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3		
<b>CLR-1:</b>	Familiarize the software life cycle models and software development process															
<b>CLR-2:</b>	Illustrate the various techniques for requirements, planning and managing a technology project															
<b>CLR-3:</b>	Examine basic methodologies for software design, development, testing, and implementation															
<b>CLR-4:</b>	Understand manage user's expectations and the software development team															
<b>CLR-5:</b>	Apply the project management and analysis principles to software project development															
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Identify the process of project life cycle model and process															
<b>CO-2:</b>	Analyze and translate end-user requirements into system and software requirements															
<b>CO-3:</b>	Identify and apply appropriate software architectures and patterns to carry out high level design of a system															
<b>CO-4:</b>	Develop Test plans and incorporate suitable testing strategies															
<b>CO-5:</b>	Examine the risk strategies and maintenance measures															

<b>Unit-1 - Introduction to Software Engineering</b>	<b>12 Hour</b>
The evolving role of software, changing nature of software, Generic view of process: Software engineering- a layered technology, a process framework, Software Project Management - life cycle activities, Process models: The waterfall model, incremental process models, evolutionary process models, the unified process, Conventional- Agile, XP, Scrum, Project Initiation management – Project Charter, Project Scope, Project Objectives, Practical considerations.	

<b>Unit-2 - Software Requirements</b>	<b>12 Hour</b>
Functional and non-functional requirements, user requirements, system requirements, interface specification, the software requirements document. Requirements engineering process: Feasibility studies, requirements elicitation and analysis, requirements validation, requirements management, Software project effort and cost estimation – Cocomo model I, Cocomo Model II, LOC, Function point metrics	

<b>Unit-3 - Software Design</b>	<b>12 Hour</b>
Software Design Fundamentals, Design process – Design Concepts-Design Model- Design Heuristic , Design techniques– Architectural Design - Architectural styles, Creating an architectural design- software architecture, data design, architectural styles and patterns, architectural design, conceptual model of UML, basic structural modeling, class diagrams, sequence diagrams, collaboration diagrams, use case diagrams, component diagrams, Design of User Interface design Elements of good design, Design issues Features of modern GUI - Menus, Scroll bars, windows, Buttons, icons, panels, error Messages etc.	

<b>Unit-4 - Software Construction</b>	<b>12 Hour</b>
Coding Standards, Coding Frameworks. Reviews: Deskchecks, Walkthroughs, Code Reviews, Inspections, Coding Methods, Testing Strategies: A strategic approach to software testing, test strategies for conventional software, black-box and white-box testing, validation testing, system testing, Unit Testing – Integration Testing – Validation Testing – System Testing and Debugging	

<b>Unit-5 – Product Management</b>	<b>12 Hour</b>
Product Release Management, Risk management: Reactive Vs proactive risk strategies, software risks, risk identification, risk projection, risk refinement, RMMM, RMMM plan, Maintenance and Reengineering	

<b>Lab Experiments</b>
Lab 1: Identify the Software Project, Create Business Case, Arrive at a Problem Statement
Lab 2: Analyse Stakeholder and User Description and Identify the appropriate Process Model
Lab 3: Identify the Requirements, System Requirements, Functional Requirements, Non-Functional Requirements and develop a SRS Document
Lab 4: Prepare Project Plan based on scope, Find Job roles and responsibilities, Calculate Project effort based on resources
Lab 5: Prepare the Work, Breakdown Structure based on timelines, Risk Identification and Plan
Lab 6: Design a System Architecture, Use Case Diagram, ER Diagram (Database)
Lab 7: DFD Diagram (process) (Upto Level 1), Class Diagram (Applied For OOPS based Project),
Lab 8: Interaction Diagrams, State chart and Activity Diagrams
Lab 9: State and Sequence Diagram, Deployment Diagram,
Lab 10: Sample Frontend Design (UI/UX)
Lab 11: Sample code implementation
Lab 12: Master Test Plan, Test Case Design (Phase 1)
Lab 13: Manual Testing
Lab 14: User Manual, Analysis of Costing, Effort and Resource
Lab 15: Project Demo and Report Submission with the team

<b>Learning Resources</b>	1. Roger S. Pressman, <i>Software Engineering – A Practitioner Approach</i> , 6th ed., McGraw Hill, 2005 2. Ian Sommerville, <i>Software Engineering</i> , 8th ed., Pearson Education, 2010 3. Rajib Mall, <i>Fundamentals of Software Engineering</i> , 4th ed., PHI Learning Private Limited, 2014	4. Ramesh, Gopalaswamy, <i>Managing Global Projects</i> , Tata McGraw Hill, 2005 5. Ashfaque Ahmed, <i>Software Project Management: a process-driven approach</i> , Boca Raton, Fla: CRC Press, 2012 6. Walker Royce, <i>Software Project Management</i> , Pearson Education, 1999 7. Jim Smith <i>Agile Project Management: Creating Innovative Products</i> , Pearson 2008
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<b>Learning Assessment</b>						
Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	20%	20%
Level 2	Understand	20%	-	-	20%	20%
Level 3	Apply	40%	-	-	40%	40%
Level 4	Analyze	20%	-	-	20%	20%
Level 5	Evaluate	-	-	-	-	-
Level 6	Create	-	-	-	-	-
	Total	100 %		100 %		100 %

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. DHINAKAR JACOB SELWYN, CAP GEMINI TECHNOLOGY		1. Mrs. Anupama C G
2. Mr. Girish Raghavan, Wipro Technologies		

<b>Course Code</b>	21CSC304J	<b>Course Name</b>	COMPILER DESIGN	<b>Course Category</b>	C	PROFESSIONAL CORE	L 2	T 0	P 2	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		Program Outcomes (PO)												<b>Program Specific outcomes</b>		
1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3		
<b>CLR-1:</b> Outline the implementation of Lexical Analyzer																
<b>CLR-2:</b> To learn the various parsing techniques																
<b>CLR-3:</b> Familiarize the intermediate code generation and run-time environment																
<b>CLR-4:</b> To learn the implementation of code generator																
<b>CLR-5:</b> Identify the various methods for Code Optimizer																
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>																
<b>CO-1:</b> Acquire knowledge of Lexical Analyzer from a specification of a language's lexical rules	3	2	-			2	-	-	-	-	-	-	-	-	1	-
<b>CO-2:</b> Apply different parsing algorithms to develop the parsers for a given grammar	3	3	-	-	2	-	-	-	-	-	-	-	-	-	1	-
<b>CO-3:</b> Gain knowledge to translate a system into various intermediate codes	3	2	-	-	2	-	-	-	-	-	-	-	-	-	1	-
<b>CO-4:</b> Analyze the methods of implementing a Code Generator for compilers	3	2	-	3	-	-	-	-	-	-	-	-	-	-	1	-
<b>CO-5:</b> Design the methods of developing a Code Optimizer	3	-	2	3	-	-	-	-	-	-	-	-	-	-	1	-

#### **Unit-1 - Introduction** 12 Hour

Compilers-Phases of Compiler-Cousins of the Compiler-Grouping of Phases-Compiler construction tools- Lexical Analysis-Role of Lexical Analyzer-Input Buffering -Specification of Tokens -LEX -Finite Automata-Regular Expressions to Automata -Minimizing DFA.

#### **Unit-2 – Top Down Parsing** 12 Hour

Role of Parser-Grammars-Error Handling-Context-Free Grammars-Writing a grammar- Elimination of Ambiguity-Left Recursion- Left Factoring-Top Down Parsing — Recursive Descent Parser- Predictive Parser-LL(1) Parser- Computation of FIRST-Computation of FOLLOW-Construction of a predictive parsing table-Predictive Parsers LL(1) Grammars- Predictive Parsing Algorithm- Problems related to Predictive Parser -Error Recovery in Predictive Parsing.

#### **Unit-3 – Bottom-Up Parsing** 12 Hour

Bottom Up Parsing-Reductions-Handle Pruning-Shift Reduce Parser-Problems related to Shift Reduce Parsing-Operator Precedence Parser, LEADING,.TRAILING -LR Parser- LR Parsers- Need of LR Parsers-LR (0)Item-Closure of Item Sets- Construction of SLR Parsing Table -Problems related to SLR-Construction of Canonical LR(1)- Problems related to CLR - LALR Parser — Problems related to LALR-YACC.

#### **Unit-4 – Code Generation** 12 Hour

Intermediate Code Generation- prefix – postfix notation- Quadruple - triple - indirect triples Representation- Syntax tree- Evaluation of expression - Three-address code- Synthesized attributes – Inherited attributes - Intermediate languages – Declarations- Assignment Statements- Boolean Expressions- Case Statements- Back patching – Procedure calls- Code Generation- Issues in the design of code generator- The target machine – Runtime Storage management- A simple Code generator- Code Generation Algorithm- Register and Address Descriptors.

#### **Unit-5 – Code Optimization** 12 Hour

Code optimization -Principal Sources of Optimization- Function Preserving Transformation- Loop Optimization- Peephole optimization — DAG- Basic Blocks- Flow Graphs- Global Data Flow Analysis — Efficient Data Flow Algorithm- Runtime Environments- Source Language issues- Storage Organization- Activation Records- Storage Allocation strategies.

<b>Lab Experiments</b>	
Lab 1 - Implementation of Lexical Analyzer Lab 2 conversion from Regular Expression to NFA Lab 3 Conversion from NFA to DFA Lab 4 Elimination of Ambiguity, Left Recursion and Left Factoring Lab 5-FIRST AND FOLLOW computation Lab 6 Predictive Parsing Table Lab 7 - Shift Reduce Parsing Lab 8- Computation of LEADING AND TRAILING	Lab 9 Computation of LR (0) items Lab 10-Intermediate code generation – Postfix, Prefix Lab 11 Intermediate code generation – Quadruple, Triple, Indirect triple Lab 12: A simple code Generator Lab 13 Implementation of DAG Lab 14: Implementation of Global Data Flow Analysis Lab 15: Implement any one storage allocation strategies (heap, stack, static)

<b>Learning Resources</b>	1. Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman, <i>Compilers: Principles, Techniques and Tools</i> , Second Edition, Pearson Education, 2011. 2. S. Godfrey Winster, S. Aruna Devi, R. Sujatha, "Compiler Design", Yesdee Publishing Pvt.Ltd, 2016. 3. K .Muneeswaran,"CompilerDesign", Oxford Higher Education, Fourth Edition, 2015.	4. David Galles, "Modern Compiler Design", Pearson Education, Reprint 2012. 5. Raghavan V., "Principles of CompilerDesign", Tata McGraw Hill Education Pvt. Ltd., 2010.
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
Bloom's Level of Thinking		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	-	15%	15%	-		
Level 2	Understand	25%	-	-	20%	25%	-		
Level 3	Apply	30%	-	-	25%	30%	-		
Level 4	Analyze	30%	-	-	25%	30%	-		
Level 5	Evaluate	-	-	-	10%	-	-		
Level 6	Create	-	-	-	5%	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Saranya Baskar, Lead Software Testing Engineer, EPAM Systems India Private Limited, Hyderabad. saranya_baskar@epam.com	1. Dr. E. Ilavarasan, Professor, Department of Computer Science and Engineering, Puducherry Technological University, Puducherry.  2. Dr. M. Shyamala Devi, Professor, Department of Computer Science and Engineering, Vel Tech Rangarajan Dr. Sagunthala R & D Institute of Science and Technology, Chennai.	1. Dr. M. Baskar, SRMIST  2. Dr. Godfrey Winster S SRMIST

<b>Course Code</b>	21CSC305P	<b>Course Name</b>	MACHINE LEARNING	<b>Course Category</b>	C	PROFESSIONAL CORE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>													
<b>CLR-1:</b>	Explore the fundamental mathematical concepts of machine learning algorithms												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>												
<b>CLR-2:</b>	Apply linear machine learning model to perform regression and classification												-	-	-	-											
<b>CLR-3:</b>	Utilize mixture models to group similar data items												-	-	-	2											
<b>CLR-4:</b>	Develop machine learning models for time –series data prediction												-	-	-	2											
<b>CLR-5:</b>	Design ensemble learning models using various machine learning algorithms												-	-	-	3											
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>												Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
<b>CO-1:</b>	Understand the basics of machine learning using probability theory												-	2	-	-	-	-	-	-	-	-	-	1	-	-	
<b>CO-2:</b>	Implement machine learning models using supervised learning algorithms												-	2	-	2	-	-	-	-	-	-	-	-	-	2	
<b>CO-3:</b>	Implement machine learning models using unsupervised learning algorithms												-	3	-	3	-	-	-	-	-	-	-	-	-	2	
<b>CO-4:</b>	Implement machine learning models for sequential data analysis and prediction												-	3	-	3	-	-	-	-	-	-	-	-	-	3	
<b>CO-5:</b>	Develop ensemble learning models for supervised and unsupervised learning												-	3		3	-	-	-	-	-	-	-	-	-	3	

#### **Unit-1 - Introduction**

**9 Hour**

machine learning what and why?, supervised and unsupervised learning, polynomial curve fitting, probability theory- discrete random variables, fundamental rules,Bayes rule, Independence and conditional independence, continuous random variables, Quantiles, Mean and variance, probability densities, Expectation and covariance.

Practice:

1. Devise a program to import, load and view dataset
2. Create a program to display the summary and statistics of the dataset

#### **Unit-2 - Linear models for regression**

**9 Hour**

Maximum likelihood estimation – least squares, robust linear expression, ridge regression, Bayesian linear regression. Linear models for classification: Discriminant function – Probabilistic generative models, Probabilistic discriminative models, Laplacian approximation, Bayesian logistic regression, Kernels functions, using kernels in GLMs, Kernel trick, SVMs.

Practice:

1. Implement linear regression to perform prediction
2. Implement Bayesian logistic regression and SVM for classification

#### **Unit-3 - Mixture models and EM**

**9 Hour**

K-means clustering, mixtures of Gaussians, An alternative view of EM, Factor analysis, PCA, choosing the number of latent dimensions. Clustering – measuring dissimilarity, evaluating the output of clustering methods, Hierarchical clustering.

Practice:

1. Implement K-means clustering, mixtures of Gaussians and Hierarchical clustering algorithm to categorize data.
2. Create a program to perform PCA

<b>Unit-4 – Hidden Markov Models</b>	<b>9 Hour</b>
Sequential data – Markov models, HMM – maximum likelihood for the HMM, The forward and Backward algorithm, the sum-product algorithm, scaling factors, Viterbi algorithm, linear dynamical systems.	
Practice:	
1. Implement HMM to predict the sequential data	

  

<b>Unit-5 – Combining Models</b>	<b>9 Hour</b>
Bayesian model averaging, Boosting, Adaptive basis function models, CART, generalized additive models, Ensemble learning.	
Practice:	
1. Implement CART learning algorithms to perform categorization 2. Implement Ensemble learning models to perform classification	

<b>Learning Resources</b>	1. Pattern Recognition and Machine Learning, Christopher M Bishop, Springer, 2006. 2. Machine Learning- A probabilistic perspective, Kevin P.Murphy, The MIT Press, 2012.
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<b>Learning Assessment</b>		<b>Continuous Learning Assessment (CLA)</b>						<b>Final Examination (0% weightage)</b>			
		<b>Formative CLA-1 Average of unit test (20%)</b>		<b>Project Based Learning CLA-2 (60%)</b>		<b>Report and Viva Voce (20% weightage)</b>					
		<b>Theory</b>	<b>Practice</b>	<b>Theory</b>	<b>Practice</b>	<b>Theory</b>	<b>Practice</b>				
Level 1	<i>Remember</i>	15%	-	-	15%	-	15%	-	-		
Level 2	<i>Understand</i>	25%	-	-	20%	-	20%	-	-		
Level 3	<i>Apply</i>	30%	-	-	25%	-	25%	-	-		
Level 4	<i>Analyze</i>	30%	-	-	25%	-	25%	-	-		
Level 5	<i>Evaluate</i>	-	-	-	10%	-	10%	-	-		
Level 6	<i>Create</i>	-	-	-	5%	-	5%	-	-		
	<b>Total</b>	100 %		100 %		100 %		-			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr.Vaisakh. P.S, Assistant executive manager, Samsung Electronics, Bangalore vaishakhps@samsung.com	1. Dr.C.Oswald, Assistant professor, NIT, Trichy,Oswald.mecse@gmail.com	1. A.Jackulin Mahariba, SRMIST

**ACADEMIC CURRICULA**

**UNDERGRADUATE/ INTEGRATED POST  
GRADUATE DEGREE PROGRAMMES**

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume - 11A  
(Syllabi for CSE Programme Courses)



**SRM**

INSTITUTE OF SCIENCE & TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

# ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021



**SRM**

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Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

<b>Course Code</b>	21CSE251T	<b>Course Name</b>	DIGITAL IMAGE PROCESSING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		Program Outcomes (PO)												<b>Program Specific outcomes</b>			
1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3			
Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning						
<b>CLR-1:</b> Outline the fundamentals of various image processing concepts	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>CLR-2:</b> Familiarize on multiple image enhancement techniques and methodologies	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>CLR-3:</b> Learn different image segmentation methodologies	3	-	2	3	-	-	-	-	-	-	-	-	-	2	-	-	-
<b>CLR-4:</b> Learn the art of on feature extraction and compression	3	-	3	3	-	-	-	-	-	-	-	-	-	2	-	-	-
<b>CLR-5:</b> Master various Deep learning algorithms for Image processing	3	3	-	-	-	-	-	-	-	-	-	-	-	3	-		

<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>
<b>CO-1:</b>	Apply various Fundamental techniques and methodologies image processing systems
<b>CO-2:</b>	Apply the image quality through different image enhancement algorithms
<b>CO-3:</b>	Gain knowledge on image segmentation algorithms
<b>CO-4:</b>	Apply feature extraction and compression models
<b>CO-5:</b>	Apply Deep learning principles for image processing

#### **Unit-1 - Fundamentals of Digital Image Processing** 9 Hour

Steps in Digital Image Processing – Components – Elements of Visual Perception – Image Sensing and Acquisition – Image Sampling and Quantization. Relationships between pixels - Color image fundamentals - RGB, HSI models, Two-dimensional mathematical preliminaries, 2D transforms - DFT, DCT.

#### **Unit-2 - Image Enhancement (Spatial and Frequency Domain)** 9 Hour

Spatial Domain: Basic relationship between pixels- Basic Gray level Transformations – Histogram Processing – Smoothing spatial filters- Sharpening spatial filters. Frequency Domain: Smoothing frequency domain filters- sharpening frequency domain filters Homomorphic filtering.

#### **Unit-3 - Image Restoration Techniques** 9 Hour

Introduction to Image Restoration- degradation model, Properties, Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering – Inverse Filtering – Wiener filtering

#### **Unit-4 - Concepts on Image Segmentation** 9 Hour

Region of interest (ROI) selection - Feature extraction: Histogram based features - Intensity Features-Color, Shape Features-Local Binary Patterns (LBP), Texture descriptors- Grey Level Occurrence Matrix (GLCM). Fundamentals of Image Compression models – Error Free Compression – Variable Length Coding – Bit – Plane Coding – Lossless Predictive Coding – Lossy Compression – Lossy Predictive Coding.

#### **Unit-5 - Feature Extraction** 9 Hour

Extracting Interest Points and Their Descriptors (with Harris, SIFT and SURF) in Image Pairs, Principal Component Analysis (PCA) and Linear Discriminant Analysis for Image Recognition- Image Classification using SVM-ANN- Feedforward and Back propagation-Object Detection using CNN-RCNN.

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing", Pearson Education, Third Edition, 2010.</li> <li>2. S. Sridhar, "Digital Image Processing", Second Edition, Oxford University, 2016.</li> <li>3. Anil Jain K. "Fundamentals of Digital Image Processing", PHI Learning Pvt. Ltd., 2011.</li> <li>4. Jayaraman S., Esaki Rajan S., T.Veera Kumar, "Digital Image Processing", Tata McGraw Hill Pvt. Ltd., Second Reprint, 2010.</li> <li>5. Bhabatosh Chanda, Dwejesh Dutta Majumder, "Digital Image Processing and analysis", PHI Learning Pvt. Ltd., Second Edition, 2011.</li> <li>6. Malay K.Pakhira, "Digital Image Processing and Pattern Recognition", PHI Learning Pvt. Ltd., First Edition, 2011.</li> </ol>
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	30%	-	20%	-	20%	-		
Level 2	Understand	40%	-	30%	-	30%	-		
Level 3	Apply	30%	-	50%	-	50%	-		
Level 4	Analyze	-	-	-	-	-	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. SheebaBackiamary Huawei, Sweden. Sheeba.backia.mary@huawei.com	1. Dr.Venningstun NIT, J&K, India venningstonk@gmail.com 2. Dr. Jayashree P, Anna University, India pjshree@annauniv.edu	1. Dr.Kottilingam, SRMIST kottilik@srmist.edu.in 2. Dr.Arivazhagan, SRMIST arivazhn@srmist.edu.in
2. Dr. Gopal, Ceri, CHENNAI agopalceeri@gmail.com		

<b>Course Code</b>	21CSE252T	<b>Course Name</b>	BIOMETRICS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the basic concept of biometrics.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Gain knowledge on the basics of biometric traits, sensors, data acquisition and finger print process															
<b>CLR-3:</b>	Introduce the process of Multibiometric system															
<b>CLR-4:</b>	Acquire knowledge on biometric system authentication															
<b>CLR-5:</b>	Understand the real time application of biometrics															
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Acquire the knowledge on basics of biometric traits												3	PSO-1		
<b>CO-2:</b>	Ability to identify pattern recognition system and its features												3	PSO-2		
<b>CO-3:</b>	Understand about multi model biometric traits												3	PSO-3		
<b>CO-4:</b>	Apply the knowledge of biometrics on developing authentication system												3			
<b>CO-5:</b>	Apply the knowledge for designing biometric systems												3			

<b>Unit-1 - Introduction</b>	<b>9 Hour</b>
Basics of biometric systems, Biometric functionalities: verification, identification- Introduction to unimodal system, Introduction to multimodal system, what is image, acquisition, type, point operations, Geometric transformations-First and Second Derivatives- steps in edge detection, smoothening, enhancement, thresholding, localization, Low level feature extraction, Describing image motion- High level feature extraction, Template matching	

<b>Unit-2 - Process of Biometric System</b>	<b>9 Hour</b>
Biometrics Sensors, Data Acquisition and Database, Biometrics Pre-processing Techniques-Image restoration and segmentation, Pattern Extraction and Classification, Fingerprint Identification Technology- Fingerprint Patterns, Fingerprint Features, Fingerprint Image, width between two ridges -Fingerprint Image Processing – Minutiae Determination – Fingerprint Matching: Fingerprint Classification, Matching policies.	

<b>Unit-3 - Multibiometric System</b>	<b>9 Hour</b>
Introduction to Multibiometric – Information Fusion in Biometrics – Issues in Designing a Multibiometric System – Sources of Multiple Evidence – Levels of Fusion in Biometrics – Sensor level, Feature level, Rank level, Decision level fusion – Score level Fusion. Introduction to various matching methods – LDA, PCA, Eigen Vectors and Values-Covariance, Correlation- Introduction to decision theory and their examples	

<b>Unit-4 - Authentication Procedure</b>	<b>9 Hour</b>
physiological and behavioral properties of biometric system, Software biometrics systems, Hardware biometrics systems, Security of biometric systems- Advisory,insider,infrastructure attacks- Attacks at the user interface- impersonation ,obfuscation, spoofing Attacks on system module and interconnections- Counter measure: Biometric template security- Challenges in biometric systems like fool proofing, false positives	

<b>Unit-5 - Applications</b>	<b>9 Hour</b>
access control like a lock or an airport check-in area- immigration and naturalization- welfare distribution- military application- banking, e.g., check cashing, credit card, ATM- computer login; intruder detection; smart card- multi-media Communication; WWW and an electronic purse- sensor fusion; decision fusion- categorization: e.g., age and gender- industrial automation - efficient enrollment gesture interpretation; on-line shopping- other commercialized service: Fingerprint, Face detection, Iris Recognition.	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. James Wayman, Anil Jain, Davide Maltoni, Dario Maio, <i>Biometric Systems, Technology Design and Performance Evaluation</i>, Springer, 2005.</li> <li>2. James wayman, Anilk.Jain, ArunA.Ross, Karthik Nandakumar, – <i>Introduction to Biometrics</i>, Springer, 2011</li> <li>3. Mark S.Nixon, Alberto S.Aguado, <i>Feature Extraction and image processing for computer vision, Third Edition</i>, , Elsevier 2012</li> <li>4. <i>Digital Image Processing using MATLAB</i>, By: Rafael C. Gonzalez, Richard Eugene Woods, 2nd Edition, Tata McGraw-Hill Education 2019</li> <li>5. <i>Guide to Biometrics</i>, By: Ruud M. Bolle, Sharath Pankanti, Nalini K. Ratha, Andrew W. Senior, Jonathan H. Connell, Springer 2009</li> <li>6. <i>Pattern Classification</i>, By: Richard O. Duda, David G. Stork, Peter E. Hart, Wiley 2007</li> <li>7. Shimon K.Modi , – <i>Biometrics in Identity Management :concepts to applications</i>, Artech House 2011</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>	
<b>Bloom's Level of Thinking</b>	<b>Formative CLA-1 Average of unit test (50%)</b>	<b>Life-Long Learning CLA-2 (10%)</b>					
		<b>Theory</b>	<b>Practice</b>	<b>Theory</b>	<b>Practice</b>	<b>Theory</b>	<b>Practice</b>
Level 1	Remember	40%	-	30%	-	30%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	20%	-	30%	-	30%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr.L.Parthiban, Excellility Technologies	1. Dr.S.P.Raja, Associate Professor, VIT, Vellore,	1. Dr.E.Poongothai, SRMIST

<b>Course Code</b>	21CSE253T	<b>Course Name</b>	INTERNET OF THINGS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand Smart Objects and IoT Architectures												<b>PSC-1</b>	<b>PSC-2</b>	<b>PSC-3</b>	
<b>CLR-2:</b>	Learn about various IOT-related protocols															
<b>CLR-3:</b>	Build simple IoT Systems using Arduino and Raspberry Pi.															
<b>CLR-4:</b>	Understand data analytics and cloud in the context of IoT															
<b>CLR-5:</b>	Develop IoT infrastructure for popular applications															
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Explain the concept of IoT.															2
<b>CO-2:</b>	Analyze various protocols for IoT.															2
<b>CO-3:</b>	Design a PoC of an IoT system using Raspberry Pi/Arduino															2
<b>CO-4:</b>	Apply data analytics and use cloud offerings related to IoT.															2
<b>CO-5:</b>	Analyze applications of IoT in real time scenario															2

#### **Unit-1 - Fundamentals of IoT** 9 Hour

Evolution of Internet of Things - Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models – Simplified IoT Architecture and Core IoT Functional Stack – Fog, Edge, and Cloud in IoT – Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects

#### **Unit-2 - IoT Protocols** 9 Hour

IoT Access Technologies: Physical and MAC layers, topology, and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks – Application Transport Methods: Supervisory Control and Data Acquisition – Application Layer Protocols: CoAP and MQTT

#### **Unit-3 - Design and Development** 9 Hour

Design Methodology - Embedded computing logic - Microcontroller, System on Chips - IoT system building blocks - Arduino - Board details, IDE programming - Raspberry Pi- Interfaces and Raspberry Pi with Python Programming.

#### **Unit-4 - Data Analytics and Supporting Services** 9 Hour

Structured Vs Unstructured Data and Data in Motion Vs Data in Rest – Role of Machine Learning – No SQL Databases – Hadoop Ecosystem – Apache Kafka, Apache Spark – Edge Streaming Analytics and Network Analytics – Xively Cloud for IoT, Python Web Application Framework – Django – AWS for IoT – System Management with NETCONF-YANG

#### **Unit-5 - Case Studies/Industrial Applications** 9 Hour

Cisco IoT system - IBM Watson IoT platform – Manufacturing - Converged Plantwide Ethernet Model (CPwE) – Power Utility Industry – GridBlocks Reference Model - Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture and Smart Traffic Control

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, –IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017</li> <li>Arshdeep Bahga, Vijay Madisetti, –Internet of Things – A hands-on approach, Universities Press, 2015</li> <li>Olivier Hervé, David Boswarthick, Omar Elloumi, –The Internet of Things – Key applications and Protocols, Wiley, 2012 (for Unit 2).</li> <li>An Ho Iler, Vlasis Tsatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand, David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.</li> <li>Dieter Uckelmann, Mark Harrison, Michael Helles, Florian (Eds), –Architecting the Internet of Things, Springer, 2011.</li> <li>Michael Margolis, Arduino Cookbook, Recipes to Begin, Expand, and Enhance Your Projects, 2nd Edition, O'Reilly Media, 2011.</li> </ol>
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)	Life-Long Learning CLA-2 (10%)							
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Shreyas Lakshminarayanan, Systems Engineer Tata Consultancy Services Pvt Ltd, Chennai	1. Dr. G.R. Sakthidharan, Professor/GRIET, Hyderabad	1. M. Arulprakash, SRMIST
2. Shaishav Tayde, IT Analyst Tata Consultancy Services Pvt Ltd, Ahmedabad	2. Dr. Arunraj, Associate Prof./Crescent University, Chennai	2. J. Ramaprabha, SRMIST

<b>Course Code</b>	21CSE254T	<b>Course Name</b>	BIO INSPIRED COMPUTING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the basics of biological systems												<b>PSC-1</b>	<b>PSC-2</b>	<b>PSC-3</b>	
<b>CLR-2:</b>	Acquire knowledge on working of Evolutionary algorithms												-	-	3	2
<b>CLR-3:</b>	Gain the knowledge on the fundamentals and topological working of Artificial Neural Networks												-	-	3	2
<b>CLR-4:</b>	Conceive the the fundamentals and working of Swarm Intelligence												-	-	3	2
<b>CLR-5:</b>	Explore the working of Immuno Computing Techniques												-	-	3	2
<b>Course Outcomes (CO):</b>		<b>At the end of this course, learners will be able to:</b>														
<b>CO-1:</b>	Exhibit knowledge on fundamental concepts of bio inspired computing												3	2	2	9
<b>CO-2:</b>	Apply evolutionary algorithms and perform computing												2	2	-	2
<b>CO-3:</b>	Design and develop simple neural network models												3	-	3	2
<b>CO-4:</b>	Recommend appropriate swarm algorithm for building an AI model												2	2	2	2
<b>CO-5:</b>	Apply suitable Immuno Computing algorithm for a given problem												2	-	2	2

**Unit-1 - Introduction** 9 Hour  
 Models of Life and Intelligence - Fundamentals of bio-inspired models and bio-inspired computing. Evolutionary models and techniques, Swarm models and its self-Organization, swarm, and evolutionary algorithms. Optimization problems – single and multi-objective optimization, heuristic, meta-heuristic, and hyper heuristic functions

**Unit-2 - Evolutionary Computing** 9 Hour  
 Evolutionary Computing, Hill Climbing and Simulated Annealing, Darwin's Dangerous Idea, Genetics Principles, Standard Evolutionary Algorithm -Genetic Algorithms, Reproduction-Crossover, Mutation, Evolutionary Programming, Genetic Programming

**Unit-3 - Neural Models** 9 Hour  
 Biological nervous systems, artificial neural networks, evolution of neural networks,neuron models, architecture, unsupervised learning, supervised learning, reinforcement learning,Linear separability problem, signal encoding, synaptic plasticity, hybrid neural systems

**Unit-4 - Swarm Intelligence** 9 Hour  
 Introduction - Ant Colonies, Ant Foraging Behavior, Ant Colony Optimization, SACO, and scope of ACO algorithms, Ant Colony Algorithm (ACA), Swarm Robotics, Foraging for food, Social Adaptation of Knowledge, Particle Swarm Optimization (PSO)

**Unit-5 - Immuno Computing Systems** 9 Hour  
 Introduction- Immune System, Physiology and main components, Pattern Recognition and Binding, biological immune systems, lessons for artificial immune systems, algorithms and applications, shape space, negative selection algorithm, clonal selection algorithm, Bone Marrow Models, Forest's Algorithm

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>Leandro Nunes de Castro - "Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications", Chapman &amp; Hall/CRC, Taylor, and Francis Group, 2007</li> <li>Floreano, D. and C. Mattiussi -"Bio-Inspired Artificial Intelligence: Theories methods, and Technologies"IT Press, 2008</li> <li>Albert Y.Zomaya - "Handbook of Nature-Inspired and Innovative Computing", Springer, 2006</li> <li>Marco Dorigo, Thomas Stutzle -"Ant Colony Optimization", Prentice Hall of India, New Delhi, 2005</li> <li>D. E. Goldberg, "Genetic algorithms in search, optimization, and machine learning", Addison-Wesley, 1989.</li> <li>Simon O. Haykin, "Neural Networks and Learning Machines", Third Edition, Prentice Hall, 2008.</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	30%	-	30%	-		
Level 4	Analyze	30%	-	30%	-	30%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. Muthukumarasamy S, Capgemini India Pvt Ltd,Chennai	1. Deivamani Mallaya, College of Engineering, Guindy, Chennai.	1. Ms.S.Kiruthika devi, SRMIST 2. Dr. K. Deeja, SRMIST

<b>Course Code</b>	21CSE255T	<b>Course Name</b>	COMPUTER GRAPHICS AND ANIMATION	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Identify various computer graphics drawing algorithms												<b>PSC-1</b>	<b>PSC-2</b>	<b>PSC-3</b>	
<b>CLR-2:</b>	Provide understanding of 2D transformations and viewing methods												-	-	-	-
<b>CLR-3:</b>	Learn 3D transformations and viewing methods												-	-	-	-
<b>CLR-4:</b>	Explore Visible surface detection methods												-	-	-	-
<b>CLR-5:</b>	Acquire the knowledge of animation and image processing methods												-	-	-	-
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>												-	<b>PSC-1</b>	<b>PSC-2</b>	<b>PSC-3</b>
<b>CO-1:</b>	Accrue the basic knowledge of computer graphics and various algorithms												3	2	3	3
<b>CO-2:</b>	Implement 2D transformations and viewing methods												3	3	3	3
<b>CO-3:</b>	Demonstrate various 3D transformations and viewing methods												3	3	3	3
<b>CO-4:</b>	Apply various visible surface detection methods												3	2	3	3
<b>CO-5:</b>	Develop various computer animations												3	-	3	2

**Unit-1 - Introduction to Computer Graphics** 9 Hour  
 Overview of Computer Graphics, Computer Graphics Application and Software - Video Display devices - Raster scan systems - Random Scan systems - Graphics Monitors and Workstations - Input Devices - Hard-Copy Devices - Graphics Software - Output Primitives - Points and Lines - Line-Drawing Algorithms - Circle-Generating Algorithms - Ellipse-Generating Algorithms - Parallel Curve Algorithms - Curve Functions - Pixel Addressing - Filled-Area Primitives - Scan-Line Polygon Fill Algorithm Inside-Outside Tests Scan-Line Fill of Curved Boundary Areas - Boundary-Fill Algorithm - Flood-Fill Algorithm - Overview of various attributes

**Unit-2 - 2D Transformations** 9 Hour  
 Introduction to 2D transformations Basic transformations - Matrix representations - Composite Transformations - Transformations - Shear- Affine- Reflection - 2D viewing - The Viewing Pipeline-viewing functions - Clipping operations - Point clipping - Line Clipping - Cohen-Sutherland - Liang-Barsky- Nicholl-Lee-Nicholl - Line Clipping Using Nonrectangular Clip Windows - Splitting Concave Polygons - Polygon Clipping - Other Clipping methods

**Unit-3 - 3D Transformations** 9 Hour  
 Introduction to 3D transformations Translations - Rotations - Reflections- shearing - Scaling - other transformations - Matrix Representation of 3D Transformations - 3D Viewing - Viewing Pipeline- Coordinates - Projections - Parallel- Perspective -View Volumes and General Projection Transformations-General Parallel-Projection Transformations- Clipping-Hardware Implementations Three-Dimensional Viewing-Functions

**Unit-4 - Visible-Surface Detection Methods** 9 Hour  
 Introduction- Classification of Visible-Surface Detection Algorithms - Back-Face Detection-Depth-Buffer Method-Buffer Methods-Scan-Line Method-Depth-Sorting Method BSP-Tree Method-Area-Subdivision Method-Octree Methods Ray-Casting Method-Curved Surfaces-Wireframe Methods-Visibility-Detection Functions- Illumination Models and Surface-Rendering Methods-Light Sources Basic Illumination Models-Displaying Light Intensities-Halftone Patterns and Dithering Techniques -Polygon-Rendering Methods-Ray-Tracing Methods -comparison of the methods.

<b>Unit-5 - Computer Animation and Color Models</b>		<b>9 Hour</b>
Principles of Animation, Key framing, Deformations- Motion Specifications S3- Color models - Properties of light- types - Color model conversion - applications - Mathematics for computer Graphics - Coordinate- Reference Frames-Points and Vectors - Basis Vectors and the Metric Tensor- Matrices - Digital Image- File formats - Compression standard - JPEG- Enhancement and Contrast stretching- Practices on open source image processing software		

<b>Learning Resources</b>	1. Donald Hearn and Pauline Baker M, – Computer Graphics”, Prentice Hall, 2nd Edition, New Delhi, 2007 2. Fundamentals of Computer Graphics by Steve Marschner and Peter Shirley, 4th Edition, A K Peters/CRC Press, 2018 ISBN: 9781315360201	3. Computer Graphics Principles and Practice Third Edition by John F. Hughes, Andries Van Dam, Morgan McGuire, David F. Sklar, James D. Foley, Steven K. Feiner Kurt Akeley, Addison- Wesley, 3rd Edition, 2008 4. Andleigh, P. K and Kiran Thakrar, – Multimedia Systems and Design, Pearson Education, 2015
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
Bloom's Level of Thinking		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	30%	-	30%	-		
Level 4	Analyze	30%	-	30%	-	30%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. N. Madhu, Senior Analyst, Tata Elexsi, Siruseri.	1. Dr. N. Brindha, Associate Professor, Department of Computer Science and Engineering, NIT, Trichy 2. Dr. Asha, Associate Professor, Department of Computer Science and Engineering, VIT, Chennai	1. Dr. P. Murali, Associate Professor, Department of Computing Technologies, School of computing, SRMIST, Kattankulathur

<b>Course Code</b>	21CSE351T	<b>Course Name</b>	COMPUTATIONAL LOGIC	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Explore the basics of Propositional logic												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Provide skills on rules to handle Propositional logic and various deduction rules												-	-	-	
<b>CLR-3:</b>	Learn the First order Logic and its applications												-	-	-	
<b>CLR-4:</b>	Acquire the art of applying various inference rules in First Order Logic												-	-	-	
<b>CLR-5:</b>	Introduce Modal logic and its Inference rules												-	-	-	
<b>Course Outcomes (CO):</b>		<b>At the end of this course, learners will be able to:</b>														
<b>CO-1:</b>	Apply the skills acquired on propositional logic to solve examples at hand												3	3	3	-
<b>CO-2:</b>	Analyze the rules learnt towards problem solving												3	3	3	-
<b>CO-3:</b>	Acquire mastery over FOL and Meta theorems and apply the same with confidence												3	3	3	-
<b>CO-4:</b>	Distinguish the acquired knowledge on AI under appropriate problem-solving contexts												3	3	3	-
<b>CO-5:</b>	Attempt to apply the acquired knowledge on modal logics under appropriate problem-solving contexts												3	3	3	-

**Unit-1 -** 9 Hour  
Propositional Logic-Introduction-Syntax of PL-Is It a Proposition? - Interpretations-Models-Interpretations-Equivalences and Consequences-More About Consequence-A Propositional Calculus-Axiomatic System PC-Five Theorems about PC-Using the Metatheorems-Adequacy of PC to PL-Compactness of PL

**Unit-2 -** 9 Hour  
Normal Forms and Resolution-Truth Functions-CNF and DNF-Logic Gates-Satisfiability Problem-Resolution in PL-Resolution Strategies-Other Proof Systems for PL-Natural Deduction-Gentzen Sequent Calculus-Analytic Tableaux

**Unit-3 -** 9 Hour  
First Order Logic-Syntax of FL-Scope and Binding-Substitutions-Semantics of FL-Translating into FL-Satisfiability and Validity-Some Metatheorems-A First Order Calculus-Axiomatic System FC-Six Theorems about FC-Adequacy of FC to FL-Compactness of FL

**Unit-4 -** 9 Hour  
First Order Logic-Syntax of FL-Scope and Binding-Substitutions-Semantics of FL-Translating into FL-Satisfiability and Validity-Some Metatheorems-A First Order Calculus-Axiomatic System FC-Six Theorems about FC-Adequacy of FC to FL-Compactness of FL

**Unit-5 -** 9 Hour  
Modal Logic K—Introduction-Syntax and Semantics of K-Validity and Consequence in K-Axiomatic System KC-Adequacy of KC to K-Natural Deduction in K-Analytic Tableau for K-Other Modal Logics-Various Modalities-Computation Tree Logic

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Arindama Singh,"Logics for Computer Science", PHI Learning Private Ltd,2nd Edition,2018</li> <li>2. Wasilewska &amp; Anita,"Logics for computer science: classical and non-classical",Springer ,2018</li> <li>3. Huth M and Ryan M, II Logic in Computer Science : Modeling and Reasoning about systemsII,Cambridge University Press, 2005</li> <li>4. Dana Richards &amp; Henry Hamburger,"Logic And Language Models For Computer Science",Third Edition, World Scientific Publishing Co. Pte. Ltd, 2018.</li> <li>5. https://www.cs.cornell.edu/courses/cs3110/2012sp/lectures/lec15-logic-contd/lec15.html</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>	
<b>Bloom's Level of Thinking</b>	<b>Formative CLA-1 Average of unit test (50%)</b>	<b>Life-Long Learning CLA-2 (10%)</b>					
		<b>Theory</b>	<b>Practice</b>	<b>Theory</b>	<b>Practice</b>	<b>Theory</b>	<b>Practice</b>
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
	<ol style="list-style-type: none"> <li>1. Dr.Masilamani , IITKD Kancheepuram</li> <li>2. Dr.G.Venkiteswaran, BITS Pilani</li> </ol>	<ol style="list-style-type: none"> <li>1. Dr.K.Senthil Kumar, CTech, SRMIST</li> </ol>

<b>Course Code</b>	21CSE352T	<b>Course Name</b>	NEURO FUZZY AND GENETIC PROGRAMMING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the core concepts and architectures of Neural Networks												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Recognize Associative Memory and Adaptive Resonance Theory in Neural Networks												-	2	-	
<b>CLR-3:</b>	Articulate the fundamentals and various models of Fuzzy Systems												-	2	-	
<b>CLR-4:</b>	Illustrate the concepts of Genetic Algorithms												-	2	-	
<b>CLR-5:</b>	Integrate Neural Network, Fuzzy Logic, and Genetic Algorithm techniques												-	2	-	
<b>Course Outcomes (CO):</b>		<b>At the end of this course, learners will be able to:</b>														
<b>CO-1:</b>	Apply the concepts of Neural Network for building intelligent systems												2	PSO-1		
<b>CO-2:</b>	Correlate Associative Memory and Adaptive Resonance Theory in Neural Networks												2	PSO-2		
<b>CO-3:</b>	Devise a framework for building Fuzzy Logic Systems												1	PSO-3		
<b>CO-4:</b>	Examine the modelling of Genetic Algorithms												1			
<b>CO-5:</b>	Apply the concepts of Neural Network, Fuzzy Logic, and Genetic Algorithm for developing a framework for hybrid systems												3			

<b>Unit-1 - Neural Networks</b>	<b>9 Hour</b>
Introduction to Artificial Intelligence Systems, Fundamentals of Neural Networks- Basic concepts, Human brain, Model of an Artificial Neuron, Neural Network Architectures, Characteristics of Neural Networks, Learning Methods, Taxonomy of Neural Network Architectures, History of Neural Network Research, Early Neural Network Architectures, McCulloch-Pitts Neuron Model; Back Propagation Networks - Architecture, Backpropagation Learning, Illustration, Applications, Effect of Turning Parameters of the Backpropagation Neural Network, Selection of various parameters in BPN, Variations of Standard Backpropagation Algorithms; Practice of Neural Network Tool - XOR Problem	
<b>Unit-2 - Associative Memory &amp; Adaptive Resonance Theory</b>	
Associative Memory - Autocorrelators, Heterocorrelators, Wang et al.'s Multiple Training Encoding Strategy, Exponential BAM, Associative Memory for Real-coded Pattern Paris, Applications; Adaptive Resonance Theory - Introduction, ART1, ART2, Applications, Sensitivities of Ordering of Data; Practice of Neural Network Tool- Delta Rule	
<b>Unit-3 - Fuzzy Logic</b>	
Fuzzification; Fuzzy Set Theory- Fuzzy versus Crisp, Crisp Sets, Fuzzy Sets, Crisp Relations, Fuzzy Relations; Fuzzy Systems- Crisp Logic, Predicate Logic, Fuzzy Logic, Fuzzy Rule Based System, Defuzzification Methods, Practice of Fuzzy Logic Tool- Fuzzy Functions	
<b>Unit-4 - Genetic Algorithms</b>	
Genetic Algorithms- Basic Concepts, Creation of Offspring, Working Principle, Encoding, Fitness Function, Reproduction; Genetic Modelling - Inheritance Operators, Crossover, Inversion and Deletion, Mutation Operator, Bitwise Operators used in GA, Generation Cycle, Conversion of Genetic Algorithm, Applications, Multilevel Optimization, Advances in GA, Practice of Optimization in Genetic Algorithm Tool	

**Unit-5 - Hybrid Systems****9 Hour**

Introduction, Neural Networks, Fuzzy Logic, and Genetic Algorithms Hybrids; Genetic Algorithm based Back Propagation Networks - GA Based Weight Determination; Fuzzy Backpropagation Networks- LR Type Fuzzy Numbers, Fuzzy Neuron, Fuzzy BP Architecture, Learning in Fuzzy BP; Fuzzy Logic Controlled Genetic Algorithms- GA in Fuzzy Logic Controller Design, Fuzzy Logic Controller, FLC-GA Based Structural Optimization.

<b>Learning Resources</b>	1. S. Rajasekaran, G. A. Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic, and Genetic Algorithms, Synthesis and Applications", PHI Learning Private Limited, 15th Printing, 2011. 2. S. Rajasekaran, G. A. Vijayalakshmi Pai, "Neural Networks, Fuzzy Systems and Evolutionary Algorithms" PHI Learning Private Limited, Second Edition, 2017. 3. L. Fortuna, G. Rizotto, M. Lavorina, G. Nunnari, M. G. Xibilia, and R. Caponetto, "Soft Computing, New Trends and Applications", Springer, 2001.	4. S. N. Sivanandam, S. N. Deepa, "Principles of Soft Computing", Wiley, 3rd edition. 5. Dilip K. Prathihar, "Soft Computing - Fundamentals and Applications", Alpha Science International Limited, 2014. 6. Simon Hawkins, "Neural Networks", Pearson Education, 3rd edition, 2008. 7. Lone, Y. A., Singh, H. (2019). Deep Neuro-Fuzzy Systems with Python: With Case Studies and Applications from the Industry. Germany: Apress.
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Learning Assessment						
Bloom's Level of Thinking	Continuous Learning Assessment (CLA)					Summative Final Examination (40% weightage)
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%
Level 2	Understand	25%	-	25%	-	25%
Level 3	Apply	30%	-	30%	-	30%
Level 4	Analyze	30%	-	30%	-	30%
Level 5	Evaluate	-	-	-	-	-
Level 6	Create	-	-	-	-	-
	Total	100 %		100 %		100 %

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Vinay Ramanath, Principal Key Expert scientist, Simulations and Digital Twins Siemens Technology. 2. Prabakaran, Aerothermal Engineer - India Defence Rolls Royce India Pvt Ltd.	1. Dr. Y. Nancy Jane, Assistant Professor, Madras Institute of Technology, Anna University.	1. Dr. Sindhuja M, Assistant Professor

<b>Course Code</b>	21CSE353T	<b>Course Name</b>	AUGMENTED, VIRTUAL AND MIXED REALITY	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the concepts of Augmented, Virtual and Mixed Realties												<b>PSC-1</b>	<b>PSC-2</b>	<b>PSC-3</b>	
<b>CLR-2:</b>	Apply the concepts to develop real world scenarios and components															
<b>CLR-3:</b>	Practical understanding of concepts of Unity software															
<b>CLR-4:</b>	Apply AR concepts to develop unreal use cases															
<b>CLR-5:</b>	Develop UI model using oculus quest															
<b>Course Outcomes (CO):</b>		<b>At the end of this course, learners will be able to:</b>														
<b>CO-1:</b>	Describe the similarities and differences between the Mixed Reality Technologies												3	Problem Analysis		
<b>CO-2:</b>	Demonstrate ability to develop applications using AR / VR technologies												3	Design/development of solutions		
<b>CO-3:</b>	Build applications using unity												-	Conduct investigations of complex problems		
<b>CO-4:</b>	Develop use cases using unreal												-	Modern Tool Usage		
<b>CO-5:</b>	Create user interface for VR applications												-	The engineer and society	Environment & Sustainability	Ethics
														Individual & Team Work	Communication	Project Mgt. & Finance
																Life Long Learning

**Unit-1 – Introduction to Mixed Reality** 9 Hour  
VR, AR, MR, xR: similarities and differences, Current trends, and state of the art in immersive technologies, The future of human experience - Human Perception and Cognition, Technology on Stereoscopic Display: Immersion and Presence, Developing platforms and consumer devices, Physiology, Psychology and the Human Experience, Adaptation and Artefacts, Ergonomics, Ethics, Guidelines for Proper VR Usage, User-Centered Design, User Experience: Scientific Concerns, VR Health and Safety Issues, Effects of VR Simulations on Users, Cyber sickness, before and now, Ethical Code of Conduct.

**Unit-2 - AR components and Techniques** 9 Hour  
AR Frameworks, Practical understanding of real world AR application development, AR methodologies and project types, VR components and techniques, VR frameworks, Practical Understanding of real world VR application development, VR methodologies and project types, Navigation and Manipulation Interface techniques in Blender

**Unit-3 – Application Using Unity** 9 Hour  
AR advanced SDKs, AR core & Kit, AR spark studio, Vuforia engine, perform preliminary data quality and formatting, Hands on Unity Software and Use case applications, Purpose of Wikitude and 8<sup>th</sup> wall tools

**Unit-4 – Unreal Engine and Techniques** 9 Hour  
Specific aspects of Unreal engine, Unreal engine vs unity, Unreal/Unity engine Physics & optimization techniques, Application demos, The present and the future of MR/xR

**Unit-5 – Modeling the Physical World** 9 Hour  
Geometric Modeling- Kinematics Modeling- Physical Modeling , Locomotion tools, Oculus setup and environment for object interaction, User Interface/Experience developed through Oculus Quest – Audio/video in Immersive Environments, Introduction to Metaverse and applications, Behavior Modeling the functionalities of Metaverse applications through a Real-World Example

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>David Rose, "Super sight: What Augmented Reality Means for our lives, our work, and the way we imagine our future", Nov 2021</li> <li>Lily Sayter, Brain Solis, <i>The augmented Workforce</i>, 2020</li> <li>Hevin W Allen, <i>Meta Verse- A beginner's guide to the new digital revolution</i></li> </ol>	<ol style="list-style-type: none"> <li>Jonathan Linowes, "Augmented Reality with Unity AR Foundation- a practical guide to cross platform AR development with Unity and later versions, 2021</li> <li>Kenneth J. Varnum, <i>Beyond Reality- Augmented Virtual and Mixed Reality in the library</i>, 2020</li> </ol>
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Jagatheeswaran Senthilvelan, Head - IoT and Robotics, Auxo Labs 2. Mr.Gowham, Head - Innovation and Technology, ProtoHubs.io	1. Prof Thuong Hoang Associate Head of School, Research Faculty of Sci Eng & Built Env School of Info Technology Deakin University,Melbourne Burwood Campus, Australia	1. Dr.M.Pushpalatha, Professor 2. Dr.Vaishnavi Moorthy, Assistant Professor

<b>Course Code</b>	21CSE354T	<b>Course Name</b>	FULL STACK WEB DEVELOPMENT	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		Program Outcomes (PO)												<b>Program Specific outcomes</b>		
1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3		
<b>CLR-1:</b>	Introduce the Web Fundamentals															
<b>CLR-2:</b>	Introduce the Client-side scripting with react.js															
<b>CLR-3:</b>	Introduce the Database Connectivity															
<b>CLR-4:</b>	Introduce the Spring Framework with Basic Concepts															
<b>CLR-5:</b>	Introduce the Spring Boot and Micro-Services															
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Understand the Static Web Page Application															
<b>CO-2:</b>	Apply scripting at client side.															
<b>CO-3:</b>	Connect with Database to do CRUD operations.															
<b>CO-4:</b>	Develop, Maintain and applications using Spring Boot Framework.															
<b>CO-5:</b>	Ability to use Microservices															

<b>Unit-1 - HTML, CSS Overview</b>	<b>9 Hour</b>
HTML Overview: Structuring an HTML Document, Validating and debugging your code, Working with Fonts, Text Blocks, Lists and Tables, Using External and Internal Links, Working with Colors, Images, and Multimedia. CSS Overview: Understanding Cascading Style Sheets, Working with Margins, Padding, Alignment and Floating, Understanding the CSS Box Model and Positioning, Using CSS to do more with Lists, Text, and Navigation, Creating Layouts Using modern CSS Techniques, Taking Control of Backgrounds and Borders, Using CSS Transformations and Transitions, Animating with CSS and the Canvas.	

<b>Unit-2 - JavaScript, React JS Overview</b>	<b>9 Hour</b>
JavaScript Overview: Understanding JavaScript, Understanding Dynamic Websites and HTML5 Applications, Getting Started with JavaScript Programming, working with the Document Object Model (DOM), Using JavaScript Variables, Strings, and Arrays, Controlling Flow with Conditions and Loops, Responding to Events and Using Windows, JavaScript Best Practices., Using Third-Party JavaScript Libraries and Frameworks. React JS: The Foundation of React, JSX, All About Components of React, Events, Forms, Refs, Styling React, Routing, Hooks: Rules of Hooks, The Built-in Hooks (useState, useEffect, useContext, useMemo, useRef), Writing Custom Hooks, Labeling Custom Hooks with useDebugValue, Finding and Using Custom Hooks.	

<b>Unit-3 - SQL, JDBC Overview</b>	<b>9 Hour</b>
SQL Overview: Basics of SQL: Data basics, Retrieval: Basic Selection, Joins, Set Queries: UNION, INTERSECT, and EXCEPT, Subqueries, Modifying Data: Insert, Delete, Update, Creating, Deleting, and Altering Tables, JDBC: Introduction to JDBC: Setting up the database, connecting to a Database: The Connection Interface, connecting to the database using Driver Manager, Querying and Updating the Database: Statement Interface, Result Set Interface, Querying and Updating the Database.	

<b>Unit-4 - Spring Boot Framework-Part-1</b>	<b>9 Hour</b>
Spring Boot Framework-Part-1: Basic concepts: Spring, Spring Boot, Testing Basics, Testing in Spring Boot. A Basic Spring Boot Application: Setting up the Development Environment, The Skeleton Web App, and Spring Boot Auto configuration, Three-Tier, Three-Layer Architecture, Modeling our Domain, Business Logic, and Presentation Layer.	

**Unit-5 - Spring Boot Framework-Part-2**
**9 Hour**

Spring Boot Framework-Part-2: The Data Layer: The Data Model, choosing a Database, Spring Boot Data JPA, Entities, Repositories, Storing Users and Attempts. Microservices: Moving to Microservices, Architecture Overview, Designing and Implementing the New Service, User Interface UI

<b>Learning Resources</b>	1. Sams Teach Yourself HTML, CSS, and JavaScript All in One, Julie Meloni, First Edition 2019, Pearson. (Unit - I, Unit - II)	6. Programming the World Wide Web, by Robert W. Sebesta, Eighth Edition - 2014, Published by Pearson.
	2. BEGINNING ReactJS Foundations Building User Interfaces with ReactJS: AN APPROACHABLE GUIDE, Chris Minnick, First Edition 2022, Published by John Wiley & Sons. (Unit - II)	7. Internet and World Wide Web How to Program, Paul Deitel, Harvey Deitel, and Abbey Deitel, Fifth Edition - 2011, Published by Prentice Hall.
	3. SQL Practical Guide for Developers, Michael J. Donahoo & Gregory D. Speegle, 2005, Morgan Kaufmann Publishers an Imprint of Elsevier. (Unit - III)	8. Database Programming with JDBC and Java, by George Reese, Second Edition - 2000, Published by O'Reilly Media.
	4. Oracle Certified Professional JavaSE 8 Programmer, Exam 1Z0-809 A Comprehensive OCPJP 8 Certification Guide, by S G Ganesh, Hari Kiran & Tushar Sharma, 2016, APress publisher. (Unit - III)	9. Expert Oracle JDBC Programming, by R. M. Menon, First Edition - 2005, Published by Apress.
	5. Learn Microservices with Spring Boot: A Practical Approach to RESTful Services Using an Event-Driven Architecture, Cloud-Native Patterns, and Containerization, Moisés Macero García, Second Edition – 2020, APress Publisher.	10. Pro Spring MVC with WebFlux: Web Development in Spring Framework 5 and Spring Boot 2, by Marten Deinum and Iuliana Cosmina, Second Edition - 2022, Published by Apress.
		11. Full stack development with Spring Boot and React: build modern and scalable full stack applications using the power of Spring Boot and React, by Juha Hinkula, Third Edition - 2022, Published by
		12. Spring Boot in Practice, Somnath Musib, First Edition - 2022, Manning Publications.

Learning Assessment						
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)		
		Theory	Practice	Theory	Practice	Theory
Level 1	Remember	15%	-	15%	-	15%
Level 2	Understand	25%	-	20%	-	25%
Level 3	Apply	30%	-	25%	-	30%
Level 4	Analyze	30%	-	25%	-	30%
Level 5	Evaluate	-	-	10%	-	-
Level 6	Create	-	-	5%	-	-
	Total	100 %		100 %		100 %

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr.Mariappan, Uber		1. Mr.Suresh Anand 2. Ms. N.Anbarasi

<b>Course Code</b>	21CSE355T	<b>Course Name</b>	DATA MINING AND ANALYTICS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	The purpose of learning this course is to:												<b>PSC-1</b>	<b>PSC-2</b>	<b>PSC-3</b>	
<b>CLR-1:</b>	Introduce the basic concepts of pattern discovery and data preparation	1	2	3	4	5	6	7	8	9	10	11	12			
<b>CLR-2:</b>	Understand the importance of Association and Correlation Algorithms	1	2	-	-	-	-	-	-	-	-	-	-	2	-	-
<b>CLR-3:</b>	Comprehend and apply various Classifiers	1	2	-	-	3	-	-	-	-	-	-	-	2	-	-
<b>CLR-4:</b>	Work with the foundation for Clustering	1	2	-	-	3	-	-	-	-	-	-	-	2	-	-
<b>CLR-5:</b>	Perform Outlier Analysis and Explore a data mining tool	1	2	-	-	3	-	-	-	-	-	-	-	2	-	-

<b>Course Outcomes (CO):</b>		<b>At the end of this course, learners will be able to:</b>
<b>CO-1:</b>		Do the preprocessing of data before mining of data for patterns
<b>CO-2:</b>		Make use of Association and Correlations Algorithms for framing association rules
<b>CO-3:</b>		Apply as well as Compare the performance of various classifiers
<b>CO-4:</b>		Utilize different Clustering algorithms for generalization
<b>CO-5:</b>		Identify Outliers in the data given

**Unit-1 - Data Mining Introduction** 9 Hour  
 Introduction: Kinds of Data- Kinds of Patterns-Data Objects and Attribute Type- Data Visualization -Data Preprocessing: Data cleaning, Data Integration, Data Transformation, Data Discretization and Data Reduction: Attribute Subset Selection-Histograms, Clustering, Sampling

**Unit-2 - Associations and Correlations** 9 Hour  
 Market Basket Analysis – Apriori Algorithm – Mining Frequent Itemsets without Candidate Generation – Mining Frequent Itemsets Using Vertical Data Format – Mining Closed Frequent Itemsets – Mining Multilevel Association Rules – Mining Multidimensional Association Rules – Correlation Analysis – Constraint-Based Association Mining

**Unit-3 - Classification and Prediction** 9 Hour  
 Basic Concepts- Decision Tree Induction-Attribute selection Measures-ID3 and CART algorithms, Tree Pruning-Bayes Classification Methods: Bayes' Theorem, Naive Bayesian Classification - Classification by Backpropagation- Support Vector Machines-Lazy learners: KNN-Metrics for evaluating classifier performance-Techniques to improve classification accuracy-Prediction: Regression Analysis

**Unit-4 - Cluster Analysis** 9 Hour  
 Cluster Analysis: Partitioning Methods- Hierarchical Methods: Agglomerative versus Divisive Hierarchical Clustering-Probabilistic Model based Clustering - BIRCH, DBSCAN, STING, CLIQUE Techniques- Evaluation of clustering Techniques

**Unit-5 - Outliers and Statistical Approaches in Data Mining** 9 Hour  
 Introduction to outliers, Challenges in detecting Outliers,Outlier Detection Methods - Supervised, Semisupervised, Unsupervised- Statistical Data Mining approaches - Data mining in Recommender Systems,Data mining for Intrusion Detection, Data Mining for Financial Analysis

<b>Learning Resources</b>	1. Jiawei Han and Micheline Kamber, "Data Mining Concepts and Techniques", Third Edition, Elsevier, 2012 2. Ian H. Witten, Eibe Frank and Mark A. Hall "Data Mining: Practical Machine Learning Tools and Techniques", Fourth Edition, Elsevier, 2017.
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)	Life-Long Learning CLA-2 (10%)							
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. T. Russo, Senior Project Lead, HCL Technologies, Chennai	1. Khanna Nehemiah, Associate Professor, Anna University Chennai	

<b>Course Code</b>	21CSE356T	<b>Course Name</b>	NATURAL LANGUAGE PROCESSING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the fundamentals behind the Language processing and perform word level analysis.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Understand the syntactic processing and probabilistic context-free grammars.															
<b>CLR-3:</b>	Conceive the basics of the knowledge representation, inference, and discourse analysis.															
<b>CLR-4:</b>	Recognize the significance of transformer-based models.															
<b>CLR-5:</b>	Understand the natural language processing applications and to learn how to apply basic algorithms in this field.															
<b>Course Outcomes (CO):</b>		<b>At the end of this course, learners will be able to:</b>														
<b>CO-1:</b>	Exhibit knowledge on text preprocessing techniques and perform word level analysis.												3	3	2	3
<b>CO-2:</b>	Illustrate approaches to syntax analysis including probabilistic context-free grammars												3	3	2	3
<b>CO-3:</b>	Apply approaches to semantics and discourse analysis in NLP.												3	3	2	3
<b>CO-4:</b>	Develop models using transfer learning approaches.												3	-	-	3
<b>CO-5:</b>	Implement applications that use Natural Language Processing approaches.												-	-	2	3

<b>Unit-1 - Overview and Word Level Analysis</b>	<b>9 Hour</b>
Introduction to Natural Language Processing, Applications of NLP, Levels of NLP, Regular Expressions, Morphological Analysis, Tokenization, Stemming, Lemmatization, Feature extraction: Term Frequency (TF), Inverse Document Frequency (IDF), Modeling using TF-IDF, Parts of Speech Tagging, Named Entity Recognition, N-grams, Smoothing.	
<b>Unit-2 - Syntax Analysis</b>	<b>9 Hour</b>
Context Free Grammars, Grammar Rules for English, Top-Down Parsing, Bottom-Up Parsing, Ambiguity, CKY Parsing, Dependency Parsing, Earley Parsing - Probabilistic Context-Free Grammars	
<b>Unit-3 - Semantic and Discourse Analysis</b>	<b>9 Hour</b>
Representing Meaning, Lexical Semantics, Word Senses, Relation between Senses, Word Sense Disambiguation, Word Embeddings, Word2Vec, CBOW, Skip-gram and GloVe, Discourse Segmentation, Text Coherence, Discourse Structure, Reference Resolution, Pronominal Anaphora Resolution, Coreference Resolution	
<b>Unit-4 - Language Models</b>	<b>9 Hour</b>
Recurrent Neural Networks (RNN), Long Short-Term Memory (LSTM), Attention mechanism, Transformer Based Models, Self-attention, multi-headed attention, BERT, RoBERTa, Fine Tuning for downstream tasks, Text classification and Text generation.	
<b>Unit-5 - NLP Applications</b>	<b>9 Hour</b>
Introduction to Chatbot Applications, Retrieval based- Conversation based, Information Extraction and its approaches, Information Retrieval, Semantic Search and Evaluation, Question Answering, Summarization, Extractive Vs Abstractive Summarization, Machine Translation.	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Daniel Jurafsky and James H Martin, "Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", Prentice Hall, 2nd Edition, 2018.</li> <li>2. C.Manning and H.Schutze, –Foundations of Statistical Natural Language Processing  , MIT Press, Cambridge, MA,1999</li> <li>3. James Allen, Bejamin/cummings, –NaturalLanguageUnderstanding  ,2ndedition,1995</li> <li>4. Rothman, Denis. Transformers for Natural Language Processing: Build innovative deep neural network architectures for NLP with Python, PyTorch, TensorFlow, BERT, RoBERTa, and more. Packt Publishing Ltd, 2021.</li> <li>5. <a href="http://mccormickml.com/2106/04/19/word2vec-tutorial-the-skip-gram-model/">http://mccormickml.com/2106/04/19/word2vec-tutorial-the-skip-gram-model/</a></li> <li>6. <a href="https://nlp.stanford.edu/pubs/glove.pdf">https://nlp.stanford.edu/pubs/glove.pdf</a></li> </ol>
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<b>Learning Assessment</b>						
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)		
		Theory	Practice	Theory	Practice	Theory
Level 1	Remember	15%	-	15%	-	15%
Level 2	Understand	25%	-	25%	-	25%
Level 3	Apply	30%	-	30%	-	30%
Level 4	Analyze	30%	-	30%	-	30%
Level 5	Evaluate	-	-	-	-	-
Level 6	Create	-	-	-	-	-
	Total	100 %		100 %		100 %

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Dr. J.Balaji, Associate Manager,Allstate Solutions Pvt Ltd, <a href="mailto:jagank.balaji@gmail.com">jagank.balaji@gmail.com</a>	1. Dr. Vani. V, Assistant Professor, National Institute of Technology Puducherry	1. Dr. R. Anita, SRMIST.
		2. Dr.Subalalitha C.N , SRMIST
		3. Ms.Viji D , SRMIST

<b>Course Code</b>	21CSE357T	<b>Course Name</b>	DISTRIBUTED COMPUTING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	The purpose of learning this course is to:												<b>PSC-1</b>	<b>PSC-2</b>	<b>PSC-3</b>	
<b>CLR-1:</b>	Infer knowledge in distributed computing	1	2	3	4	5	6	7	8	9	10	11	12			
<b>CLR-2:</b>	Introduce about snapshot recording and graph algorithm	-	-	2	2	2	-	-	-	-	-	-	-	1	-	-
<b>CLR-3:</b>	Demonstrate about various distributed mutual exclusion algorithms	-	-	2	2	2	-	-	-	-	-	-	-	2	-	-
<b>CLR-4:</b>	Understanding about various Deadlock Detection	-	-	3	3	3	-	-	-	-	-	-	-	2	-	-
<b>CLR-5:</b>	Outline the knowledge about Checkpointing and rollback recovery	-	-	3	3	3	-	-	-	-	-	-	-	2	-	-
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Use the appropriate concepts of Distributed computing for resource utilization	-	-	2	2	2	-	-	-	-	-	-	-	1	-	-
<b>CO-2:</b>	Formulate various Snapshot Recording and Graph Algorithms	-	-	2	2	2	-	-	-	-	-	-	-	2	-	-
<b>CO-3:</b>	Apply appropriate Distributed mutual exclusion algorithms	-	-	3	3	3	-	-	-	-	-	-	-	2	-	-
<b>CO-4:</b>	Design a deadlock system to implement various deadlock detection algorithms	-	-	3	3	3	-	-	-	-	-	-	-	2	-	-
<b>CO-5:</b>	Develop and implement various Checkpointing and rollback recovery	-	-	2	2	2	-	-	-	-	-	-	-	2	-	-

#### **Unit-1 - Introduction to distributed computing** 9 Hour

Primitives for distributed communication, Synchronous versus asynchronous executions, Design issues and challenges, A model of distributed executions, Global state of a distributed system, Cuts of a distributed computation, A framework for a system of logical clocks, Jard–Jourdan's adaptive technique, Physical clock synchronization: NTP, Classifications and basic concepts, Complexity measures and metrics

#### **Unit-2 - Snapshot Recording and Graph Algorithms** 9 Hour

Snapshot algorithms for FIFO channels, Variations of the Chandy–Lamport algorithm, Snapshot algorithms for non-FIFO channels Snapshots in a causal delivery system, monitoring global state, Necessary and sufficient conditions for consistent global Snapshots, Finding consistent global snapshots in a distributed computation, Elementary graph algorithms. A spanning-tree-based termination detection algorithm

#### **Unit-3 - Distributed mutual exclusion algorithms** 9 Hour

Lamport's algorithm, Ricart–Agrawala algorithm, Singhal's dynamic information-structure algorithm, Lodha and Kshemkalyani's fair mutual exclusion algorithm, Quorum-based mutual exclusion algorithms, Maekawa's algorithm, Agarwal–El Abbadi quorum-based algorithm, Token-based algorithms, Suzuki–Kasami's broadcast algorithm, Raymond's tree-based algorithm

#### **Unit-4 - Deadlock Detection** 9 Hour

Models of deadlocks, Knapp's classification of distributed deadlock detection Algorithms, Mitchell and Merritt's algorithm for the single-resource model, Chandy–Misra–Haas algorithm for the AND model, Chandy–Misra–Haas algorithm for the OR model, Kshemkalyani–Singhal algorithm for the P-out-of-Q model

#### **Unit-5 - Checkpointing and rollback recovery** 9 Hour

Background and definitions, Issues in failure recovery, Checkpoint-based recovery, Log-based rollback recovery, Koo–Toueg coordinated checkpointing algorithm, Juang–Venkatesan algorithm for asynchronous checkpointing and recovery, Manivannan–Singhal quasi-synchronous checkpointing algorithm, Peterson–Kearns algorithm based on vector time, Helary–Mostefaoui–Netzer–Raynal communication-induced protocol.

<b>Learning Resources</b>	1. <i>Distributed Computing: Principles, Algorithms, and Systems Paperback – 3 March 2011 by Ajay D. Kshemkalyani (Author), Mukesh Singhal (Author)</i> 2. <i>Tanenbaum S.: Distributed Operating Systems, Pearson Education</i>	3. <i>Tanenbaum S. Maarten V.S.: Distributed Systems Principles and Paradigms, (Pearson Education)</i> 4. <i>George Coulouris, Jean Dollimore. Tim Kindberg: Distributed Systems concepts and design.</i>
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Learning Assessment						
Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%
Level 2	Understand	25%	-	20%	-	25%
Level 3	Apply	30%	-	25%	-	30%
Level 4	Analyze	30%	-	25%	-	30%
Level 5	Evaluate	-	-	10%	-	-
Level 6	Create	-	-	5%	-	-
	Total	100 %		100 %		100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. T. Russo. Senior Project Lead, HCL Technologies, Chennai	1. Dr.T.Sethukarasi, Professor and Head, Dept of CSE, RMK Engineering College	1. Dr.G.Padmapriya

<b>Course Code</b>	21CSE358T	<b>Course Name</b>	NETWORK SECURITY AND CRYPTOGRAPHY	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	The purpose of learning this course is to:												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-1:</b>	Understanding the basic concepts of security services and its mechanisms	1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions
<b>CLR-2:</b>	Apply the different symmetric key cryptographic techniques	-	-	-	-	-	-	-	-	-	-	-	-	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society
<b>CLR-3:</b>	Analyze the various asymmetric key cryptographic techniques	2	3	1	-	-	-	-	-	-	-	-	-	Environment & Sustainability	Ethics	Individual & Team Work
<b>CLR-4:</b>	Apply the message authentication and hash functions	2	3	-	-	-	-	-	-	-	-	-	-	Communication	Project Mgt. & Finance	Life Long Learning
<b>CLR-5:</b>	Develop the security applications in networks	-	3	2	-	-	-	-	-	-	-	-	-	PSO-1	PSO-2	PSO-3

<b>Course Outcomes (CO):</b>		<b>At the end of this course, learners will be able to:</b>														
<b>CO-1:</b>	Acquire the knowledge of security services and techniques	1	2	-	-	-	-	-	-	-	-	-	-	2	-	-
<b>CO-2:</b>	Analyze the symmetric key algorithms	2	3	1	-	-	-	-	-	-	-	-	-	2	-	-
<b>CO-3:</b>	Apply the various asymmetric key algorithms	2	3	-	-	-	-	-	-	-	-	-	-	2	-	-
<b>CO-4:</b>	Evaluate the various MAC and Hash functions	-	3	2	-	-	-	-	-	-	-	-	-	2	-	-
<b>CO-5:</b>	Analyze the security applications	-	-	3	-	2	-	-	-	-	-	-	-	2	-	-

<b>Unit-1 - Introduction to security concepts</b>	<b>9 Hour</b>
The need for security- Security approaches- Principles of security- Types of Security attacks- Security services- Security Mechanisms- A model for Network Security- substitution techniques- transposition techniques- steganography.	
<b>Unit-2 - Symmetric Key Cryptography</b>	<b>9 Hour</b>
Igebraic structures – Divisibility and division algorithm - Euclidean algorithm- Modular arithmetic-Prime numbers - Fermats and Eulers theorem - Congruence and matrices - Block Ciphers and operations - Simplified Data Encryption Standard - Data Encryption Standard - Advanced Encryption Standard	
<b>Unit-3 - Asymmetric Key Cryptography</b>	<b>9 Hour</b>
Groups, Rings, Fields- Finite fields - Principles of public key cryptosystems, RSA algorithm, Elgamal Cryptography, Diffie-Hellman Key Exchange- Elliptic Curve Cryptography	
<b>Unit-4 - Message Authentication Algorithms and Hash Functions</b>	<b>9 Hour</b>
Message Authentication, Secure Hash Algorithm (SHA-3) - Authentication requirements, HMAC, CMAC, Digital signatures, Elgamal Digital Signature Scheme- Kerberos, X.509 Authentication Service, Public – Key Infrastructure.	
<b>Unit-5 - Security in networks</b>	<b>9 Hour</b>
Web security considerations-Secure Socket Layer and Transport Layer Security-Secure electronic transaction- Email security - PGP, S/MIME-Intruders-Intrusion detection- password management -virus and related threats- Countermeasures-Firewall design principles- types of firewalls, Case Studies on Cryptography and security: Secure Inter-branch Payment Transactions, Cross site Scripting Vulnerability, Virtual Elections	

<b>Learning Resources</b>	1. Cryptography and Network Security Principles and Practice Seventh Edition, William Stallings, Pearson 2017. 2. BehrouzA.Foruzan, Cryptography and Network Security, Tata McGraw Hill 2010.	3. Cryptography and Network Security: Atul Kahate, Mc Graw Hill, 3rd Edition, 2013.
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	<i>Bloom's Level of Thinking</i>	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	25%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr. Mariappan, Uber		1. Dr.G.K.Sandhia

<b>Course Code</b>	21CSE359T	<b>Course Name</b>	INFORMATION STORAGE MANAGEMENT	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>												
<b>CLR-1:</b>	Acquire the knowledge on the components of storage infrastructure												<b>PSC-1</b>	<b>PSC-2</b>	<b>PSC-3</b>											
<b>CLR-2:</b>	Learn the various types of Storage evolution architecture												-	-	-	-										
<b>CLR-3:</b>	Understand the business continuity, backup and recovery methods.												-	-	-	-										
<b>CLR-4:</b>	Introduce the working principle of storage infrastructure with monitoring principles												-	-	-	-										
<b>CLR-5:</b>	Understand the structure of cloud computing and its techniques												-	-	-	-										
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>												Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning		
<b>CO-1:</b>	Exhibit knowledge on the components of storage infrastructure												-	3	3	-	1	-	-	-	-	-	-	1	-	-
<b>CO-2:</b>	Gain knowledge to evaluate storage architectures including storage subsystems												-	3	3	-	1	-	-	-	-	-	-	-	2	-
<b>CO-3:</b>	Understand the business continuity, backup and recovery methods.												-	3	3	-	1	-	-	-	-	-	-	-	2	-
<b>CO-4:</b>	Appreciate the concepts of storage security and information security applied to virtual machine												-	3	3	-	1	-	-	-	-	-	-	-	2	-
<b>CO-5:</b>	Acquire the knowledge on structure of cloud computing and its techniques												-	3	3	-	3	-	-	-	-	-	-	-	1	-

<b>Unit-1 - Introduction to Information Storage and Management</b>																	<b>9 Hour</b>
Introduction to Information Storage Management- Evolution of Storage Architecture- Data Centre Infrastructure- Evaluate storage architectures and key data center elements in classic, virtualized and cloud environments- physical and logical components of a storage infrastructure including storage subsystems, RAID and intelligent storage systems- Intelligent Storage Array T1: A hospital application stores the Patient records with core elements of the data center. Discussion of typical challenges the storage management team may face in meeting the service-level demands of the hospital staff																	

<b>Unit-2 - Introduction to San, Ipsan and Cas</b>																	<b>9 Hour</b>
storage networking technologies -SAN- FCSAN- IP-SAN, IPSAN-iSCSI components FCoE- NAS and object-based, and unified storage (CAS) – NAS I/O Operations- NAS Implementations T5: USRobotics Mini NAS provides easy backup and remote access for college office setting T6: SAN Infrastructure implementation at Heterogeneous environment T7: Configuration and Tracing of FC scan and iSCSI scan																	

<b>Unit-3 - Introduction to Electronic Storage Information</b>																	<b>9 Hour</b>
Electronically Stored Information and the Federal Rules of Civil Procedure- Changes to the Federal Rules of Civil Procedure-Federal Rules of Evidence-The (Long) List of Stakeholders-Ownership of Data-Data Control Considerations-Business Continuity (BC) Terminology, BC Planning life cycle- Failure Analysis, Business Impact Analysis-Automatic Path fail over-Backup granularities T7: Discussion of Social Media Cases and Spoliation Cases T8: Use Backup techniques for archived data T9: Implement appropriate backup and restore model in virtual environments for sensitive information																	

<b>Unit-4 - Introduction to Storage Security, Recovery and Acquisition</b>	<b>9 Hour</b>
Applications as a Vital User Interface-Hidden or Restricted Access Data -Privileged, Sensitive, and Inaccessible Data Management-Proving Ownership and Integrity-Legal and Forensically Sound Acquisition - Securing the Data-Access Control and Management-Organization and File Management Techniques-Safe Storage Issues and Considerations Information Security Framework-Risk Triad-Storage Security Domains.	
T10: Analyze various monitoring parameters in secured storage environment	
T11: Creation of Linux Instance in Public Cloud Generate a private key, Access using SSH client	
T12: Usage of RSA and VMware Security Products	
<b>Unit-5 - Cloud Storage</b>	<b>9 Hour</b>
key characteristics, services, deployment models, and infrastructure components for a cloud computing-Cloud Infrastructure Mechanism-Cloud Infrastructure Mechanism: Cloud Infrastructure Mechanism-Logical Network Perimeter-Cloud Usage Monitor-Cloud Adoption Considerations-Cloud Storage Gateways	
T13: Building programs to deploy cloud applications	
T14: Usage of Cloud services with open-source cloud tools (like Eucalyptus, Openstack, Open Nebula and others)	

<b>Learning Resources</b>	1. David R Matthews, <i>Electronically Stored Information The Complete Guide to Management, Understanding, Acquisition, Storage, Search, and Retrieval</i> , Second Edition 2. EMC Corporation, <i>Information Storage and Management</i> , 2nd edition Wiley India, ISBN13: 978-1118094839	3. Thomas Erl, <i>Cloud Computing: Concepts, Technology &amp; Architecture</i> , Prentice Hall, 2013, ISBN: 9780133387568 4. UlfTroppe Rainer Wolfgang Muller, <i>Storage Networks Explained</i> , India, Wiley, 2010, ISBN13: 978-0470741436
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Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	40%	-	20%	-	40%	-		
Level 2	Understand	40%	-	20%	-	40%	-		
Level 3	Apply	10%	-	20%	-	10%	-		
Level 4	Analyze	10%	-	20%	-	10%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	10%	-	-	-		
Total		100 %		100 %		100 %			

<b>Course Designers</b>		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1. Dr.V.Masillamani	1. Dr.D.Hemavathi, DSBS

<b>Course Code</b>	21CSE360T	<b>Course Name</b>	HIGH PERFORMANCE COMPUTING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		Program Outcomes (PO)												<b>Program Specific outcomes</b>		
1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3		
CLR-1:	Understand the concepts of advanced processors															
CLR-2:	Learn the core of high-end computers, components, and their capacities															
CLR-3:	Understand the need for parallel algorithms															
CLR-4:	Build applications using parallel programming paradigm															
CLR-5:	Build solutions using programming model															
<b>Course Outcomes (CO):</b>		At the end of this course, learners will be able to:														
CO-1:	Elucidate on advanced processors															
CO-2:	Analyze the working of cluster and sky computing															
CO-3:	Apply Parallel Algorithmic concepts to solve problems															
CO-4:	Develop applications using OpenMP and MPI															
CO-5:	Describe GPU architecture and write programs using CUDA															

**Unit-1 - Fundamentals of parallel processors** 9 Hour  
 Stored Program Computer Architecture- General purpose cache- based microprocessor-Performance based metrics and benchmarks- Moore's Law- Pipelining- Superscalarity- SIMD- Memory Hierarchies Cache-mapping- prefetch- Multicore processors- Multithreaded processors- Vector Processors- Design Principles- Maximum performance estimates- Programming for vector architecture – Data flow computers and VLSI Computations – Need for Migrating to Nanoscale Processors – Design of Quantum Processors and Quantum Logic gates with Qubits Processing

**Unit-2 - Performance Enhancement Computing Cluster Computing and Sky Computing** 9 Hour  
 Introduction to Cluster Computing- Scalable Parallel Computer Architectures- Cluster Computer and its Architecture- Classifications, Components for Clusters- Cluster Middleware and Single System Image- Resource Management and Scheduling, Programming Environments and Tools, Applications, Representative Cluster Systems, Heterogeneous Clusters, Security, Resource Sharing, Locality, Dependability, Cluster Architectures, Detecting and Masking Faults, Recovering from Faults, Condor, Evolution of Metacomputing. Virtualised Architecture for Cloud Computing Storage, Hypervisor usage and Integration of Cloud Computing for Sky Computing Model

**Unit-3 - Perspective of Parallel Algorithms** 9 Hour  
 Principles of parallel algorithm design - Data Parallel, Task graph, Work pool, master- slave, pipeline, Hybrid – Non –numerical algorithms, sorting, graph algorithms, search algorithms for discrete optimization problems, Dynamic programming – Numerical algorithms, Dense matrix algorithms, fast Fourier transforms

**Unit-4 - Constructs of Parallel Programming** 9 Hour  
 Introduction to parallel computing – parallel programming platforms – Basic communication operations –Programming using message passing paradigm, MPI– Programming shared address space platforms, POSIX threads, open MP

**Unit-5 - Gpu Architecture and Programming** 9 Hour  
 Hardware Architecture – Integrated GPUs –Multi GPUs – GPU Architecture - Memory Handling with CUDA: Shared Memory, Global Memory, Constant Memory and Texture Memory. Introduction to CUDA C, parallel programming in CUDA C , Thread cooperation- Shared Memory and Synchronization

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>Georg Hager, Gerhard Wellein, <i>Introduction to High Performance Computing for Scientists and Engineers</i>, Chapman &amp; Hall / CRC Computational Science series, 2011.</li> <li>Parag K. Lala "Quantum Computing: A Beginners Introduction", Mc Graw Hill, 2020.</li> <li>R. Buyya, <i>High Performance Cluster Computing: Architectures and Systems</i>, Volume 1, Pearson Education, 2008.</li> <li><i>Introduction to Parallel Computing</i>, Ananth Grama, Anshul Gupta, George Karypis, and Vipin Kumar, 2nd edition, Addison-Wesley, 2003.</li> <li>Nicholas Wilt, —CUDA Handbook: A Comprehensive Guide to GPU Programming, Addison - Wesley, 2013.</li> <li>Jason Sanders, Edward Kandrot, —CUDA by Example: An Introduction to General Purpose GPU Programming, Addison - Wesley, 2010.</li> <li><a href="https://link.springer.com/article/10.1007/s10586-017-0727-5">https://link.springer.com/article/10.1007/s10586-017-0727-5</a></li> <li><a href="http://www.nvidia.com/object/cuda_home_new.html">http://www.nvidia.com/object/cuda_home_new.html</a></li> </ol>
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<b>Learning Assessment</b>		<b>Continuous Learning Assessment (CLA)</b>				<b>Summative Final Examination (40% weightage)</b>	
<i>Bloom's Level of Thinking</i>	<i>Formative CLA-1 Average of unit test (50%)</i>	<i>Life-Long Learning CLA-2 (10%)</i>					
		<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>
Level 1	<i>Remember</i>	15%	-	25%	-	15%	-
Level 2	<i>Understand</i>	25%	-	25%	-	25%	-
Level 3	<i>Apply</i>	30%	-	25%	-	30%	-
Level 4	<i>Analyze</i>	30%	-	25%	-	30%	-
Level 5	<i>Evaluate</i>	-	-	-	-	-	-
Level 6	<i>Create</i>	-	-	-	-	-	-
	<i>Total</i>	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Hemant Giri, NVIDIA 2. Amarendra Mohanty, AdvantagePro	1. Dr.R.S.Singh, IIT, BHU, Varanasi 2. Dr.Pradheepkumar, BITS, PILANI	1. Dr.R.S.Ponmagal 2. Dr.Sathyapriya

<b>Course Code</b>	21CSE361T	<b>Course Name</b>	DATABASE SECURITY AND PRIVACY	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Realize the fundamentals of security relates to information												<b>PSC-1</b>	<b>PSC-2</b>	<b>PSC-3</b>	
<b>CLR-2:</b>	Gain knowledge of how security is maintained in information systems															
<b>CLR-3:</b>	Comprehend the concept of security models in database															
<b>CLR-4:</b>	Study about the practices of database auditing															
<b>CLR-5:</b>	Implementation of data mining algorithms for PPDM															
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Acquire the knowledge of information system and information security												3	1	-	
<b>CO-2:</b>	Manage the security of information system as well as database												3	3	-	
<b>CO-3:</b>	Design and develop the security model in database												3	-	3	
<b>CO-4:</b>	Manage the audit database activities, users, security												3	-	-	
<b>CO-5:</b>	Apply the security mechanism in PPDM using various algorithms												3	2	2	

<b>Unit-1 - Security Architecture</b>																
<b>9 Hour</b>																

Introduction, Information Systems, Database Management Systems, Information Security Architecture, Database Security, Asset Types and Their value, Security Methods. Operating System Security Fundamentals: Introduction, Operating System Overview, The Components of an Operating System Security Environment, Authentication Methods, User Administration, Password Policies, Vulnerabilities of Operating Systems, Email Security, Internet security

<b>Unit-2 - Administration of Users</b>																
<b>9 Hour</b>																

Introduction, Documentation of User Administration, Operating System Authentication, Creating Users, creating a SQL Server user, removing users, Modifying users, Default users, Remote users, Database Links, Linked Servers, Remote Servers Practices for Administrators and Managers, Profiles, Password Policies. Privileges and Roles: Introduction, Defining and Using Profiles, Designing and Implementing Password Policies, Granting and Revoking User Privileges, Creating, Assigning and Revoking User Roles, Best practices

<b>Unit-3 - Database Application Security Models</b>																
<b>9 Hour</b>																

Types of Users, Security Models, Application Types, Application Security Models, Transparent Data Encryption, Column Encryption Full Database Encryption, Column level Security with SQL Server. Virtual Private Databases: Implementation of VPD using Views, Application Context in Oracle, Implementing Oracle VPD, Viewing VPD Policies, VPD using views, Application contexts using Data Dictionary, Policy Manager Implementing Row and Column level Security with SQL Server

<b>Unit-4 - Audits</b>																
<b>9 Hour</b>																

Ways to Audit a Database, Application API Code, Auditing with Trigger Code, Normal Audit, Unified Audit, Fine Grained Auditing, Comparing Methods Auditing Database Activities: Oracle Database Activities, Creating DLL Triggers with Oracle, Auditing Database Activities with Oracle, Auditing Server Activity with SQL Server 2022, Auditing Server Activity with Oracle21c, Case study: project security and auditing

**Unit-5 - Privacy Preserving Techniques****9 Hour**

Privacy Preserving Data Mining Techniques, Privacy Preserving Data Mining Models and Algorithms-The Randomization Method, Group Based Anonymization, Distributed Privacy-Preserving Data Mining, Privacy-Preservation of Application Results, and Applications of Privacy-Preserving Data Mining. Case study: Joseph Domingo-Ferrer, Nine Measures of Anonymity, k-Anonymous Data Mining

<b>Learning Resources</b>	1. Hassan A. Afyouni, "Database Security and Auditing Protecting Data Integrity and Accessibility", Third Edition, Cengage Learning, 2013. 2. Ron Ben-Natan, " Implementing Database Security and Auditing", Elsevier Digital Press, 2005	3. Osama Mustafa and Robert P. Lockard, " Oracle Database Application Security with Oracle Internet Directory, Oracle Access Manager, and Oracle Identity Manager", First Edition Apress Publishers, 2019 4. Charu C. Aggarwal and Philip S Yu, " Privacy Preserving Data Mining Models and Algorithms", Kluwer Academic Publishers, 2008
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**Learning Assessment**

Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1 <i>Remember</i>	15%	-	15%	-	15%	-
Level 2 <i>Understand</i>	25%	-	25%	-	25%	-
Level 3 <i>Apply</i>	30%	-	30%	-	30%	-
Level 4 <i>Analyze</i>	30%	-	30%	-	30%	-
Level 5 <i>Evaluate</i>	-	-	-	-	-	-
Level 6 <i>Create</i>	-	-	-	-	-	-
Total	100 %		100 %		100 %	

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.S.Kumarasamy, Assistant Manager - MSSQL ,Sify Technologies Limited,Chennai-600113	1. Dr.L.Jayakumar, Assistant professor, Department of computer science and engineering, National institute of technology, Agartala, Tripura. 2. Dr.K.Jayashree, Professor, Panimalar engineering college, Chennai	1. Dr.S.Gnanavel, SRMIST 2. Dr.C.Pretty Diana Cyril, SRMIST

<b>Course Code</b>	21CSE362T	<b>Course Name</b>	CLOUD COMPUTING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the cloud concepts with its features												<b>PSC-1</b>	<b>PSC-2</b>	<b>PSC-3</b>	
<b>CLR-2:</b>	Learn the cloud architecture and services															
<b>CLR-3:</b>	Comprehend Security aspects for Cloud platforms															
<b>CLR-4:</b>	Study the basic concepts of Virtualization and capacity planning															
<b>CLR-5:</b>	Gain knowledge on Cloud Applications of different service providers															
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Exhibit knowledge on basics of Cloud Computing												2	2	-	
<b>CO-2:</b>	Identify then type of services for various applications												1	1	3	1
<b>CO-3:</b>	Predict the type of security to be applied for various cloud services												1	-	2	-
<b>CO-4:</b>	Examine the concept of virtualization and capacity planning												2	1	-	2
<b>CO-5:</b>	Recommend the service provider for specific requirement												2	-	-	2

<b>Unit-1 - Fundamentals of Cloud Computing</b>	<b>9 Hour</b>
Define Cloud Computing, Cloud Types, Characteristics of Cloud Computing, Benefits and disadvantages of cloud systems, Assessing the Value Proposition, Measuring the Cloud's Value, Capital Expenditures, Total Cost of Ownership, Service Level Agreements, Licensing Models	
<b>Unit-2 - Cloud Architecture and Services</b>	<b>9 Hour</b>
Cloud Computing Stack, Composability, Infrastructure, Platforms and Virtual Appliances, Communication Protocols and Applications, Connecting to the Cloud, Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS)	
<b>Unit-3 - Cloud Security</b>	<b>9 Hour</b>
Cloud Security Challenges, Software-as-a-Service Security, End-User Access to Cloud Computing Overview, Identity Protocol Standards, Windows Azure Identity Standards	
<b>Unit-4 - Virtualization and Capacity Planning</b>	<b>9 Hour</b>
Virtualization Technologies, Abstraction versus Virtualization, Load Balancing and Virtualization, The Google Cloud, Hypervisors, Virtual Machine Imaging, Porting Applications, Capacity Planning	
<b>Unit-5 - Cloud Computing Applications</b>	<b>9 Hour</b>
Web Services: Amazon, Microsoft, Google, Case Studies:, Cloud as Infrastructure for an Internet Data Center (IDC), Cloud Computing for Software Parks, Enterprise with Multiple Data Centers	

<b>Learning Resources</b>	1. Barrie Sosinsky (2011), "Cloud Computing Bible" Wiley Publishing Inc. 2. John W. Rittinghouse and James F. Ransome (2010), "Cloud Computing, Implementation, Management, and Security", CRC Press. 3. Borko Furht, Armando Escalante (2010), "Handbook of Cloud Computing", Springer.	4. Michael Kavis, (2014) "Architecting the Cloud: Design Decisions for Cloud Computing Service Models (SaaS, PaaS, AND IaaS)", John Wiley & Sons. 5. Sunil Kumar Manvi, Gopal K. Shyam (2021) "Cloud Computing: Concepts and Technologies", CRC Press, 1st edition.
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	20%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	30%	-	30%	-		
Level 4	Analyze	30%	-	30%	-	30%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. T. Russo, Senior Project Lead, HCL Technologies, Chennai 2. Mr. Saju G Nair, Senior Development Manager Kyndryl India Pvt Ltd.	1. Dr. P. Varalakshmi, Professor, MIT, Anna University, Chennai 2. Dr. S. Gopika, Kristu Jayanti College, Bangalore.	1. Dr. D. Malathi, Professor, CTECH, SRM IST 2. Dr. J. D. Dorathi Jayaseeli, Assistant Professor, CTECH, SRM IST

<b>Course Code</b>	21CSE399T	<b>Course Name</b>	ADVANCED MOBILE COMMUNICATIONS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	understand the evolution of mobile communications												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	familiarize the basics of 5G technology															
<b>CLR-3:</b>	understand and apply the 5G networks and standards															
<b>CLR-4:</b>	understand and apply the 5G protocols, SDN and NFV															
<b>CLR-5:</b>	know the current state of the art technologies and challenges in 5G															
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Understand and analyze the evolution of mobile communications												3	-	-	
<b>CO-2:</b>	Analyze and apply 5G technology on												3	-	-	
<b>CO-3:</b>	Evaluate the 5G networks and standards												3	-	-	
<b>CO-4:</b>	Apply the 5G protocols, SDN and NFV in implementations												3	-	2	
<b>CO-5:</b>	Know the current state of the art technologies and challenges in 5G												2	-	2	

<b>Unit-1 - Evolution from 1G to 5G</b>	<b>9 Hour</b>
Analog voice systems in 1G; digital radio systems in 2G, voice and messaging services, TDMA based GSM, CDMA, 2.5G (GPRS), 2.75G (EDGE); IMT2000: 3G UMTS, W-CDMA, HSPA, HSPA+, 3G services and data rates; IMT Advanced: 4G, LTE, VoLTE, OFDM, MIMO, LTE Advanced Pro (3GPP Release 13+); IMT2020: 5G, enhancements in comparison to IMT Advanced.	
<b>Unit-2 - Basics of 5G</b>	<b>9 Hour</b>
5G potential and applications; Usage scenarios: enhanced mobile broadband (eMBB), ultra-reliable low latency communications (URLLC), massive machine type communications (MMTC), D2D communications, V2X communications; Spectrum for 5G, spectrum access/sharing; millimeter Wave communication, channels and signals/waveforms in 5G, carrier aggregation, small cells, dual connectivity.	
<b>Unit-3 - 5G Network and Standards</b>	<b>9 Hour</b>
New Radio (NR), Standalone and non-standalone mode; non-orthogonal multiple access (NOMA); massive MIMO, beam formation, FAPI: PHY API Specification, flexible frame structure,	
<b>Unit-4 - 5G Network protocols, SDN and NFV</b>	<b>9 Hour</b>
Service Data Adaptation Protocol (SDAP); centralized RAN, open RAN; multi-access edge computing (MEC); software defined networking (SDN), network function virtualization (NFV); network slicing; restful API for service-based interface; private networks.	
<b>Unit-5 - Current State and Challenges Ahead</b>	<b>9 Hour</b>
5G penetration in developed countries; deployment challenges in low-middle income countries, stronger backhaul requirements, dynamic spectrum access and usage of unlicensed spectrum, contrasting radio resource requirements; large cell usage: LMLC; possible solutions for connectivity in rural areas (BharatNet, TVWS, Long-range WiFi, FSO); non-terrestrial fronthaul/backhaul solutions: LEOs, HAP/UAV.	

<b>Learning Resources</b>	1. 4G, LTE-Advanced Pro and The Road to 5G by Erik Dahlman 2. 5G NR: Architecture, Technology, Implementation, and Operation of 3GPP New Radio	3. Standards Hardcover – 1 June 2019 by Sasan Ahmadi Dr. (Author)
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)	Life-Long Learning CLA-2 (10%)							
		Theory	Practice	Theory	Practice				
Level 1	Remember	20%	-	20%	-	20%	-		
Level 2	Understand	30%	-	30%	-	30%	-		
Level 3	Apply	30%	-	30%	-	30%	-		
Level 4	Analyze	20%	-	20%	-	20%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	Suggested by AICTE	

<b>Course Code</b>	21CSE451T	<b>Course Name</b>	PATTERN RECOGNITION TECHNIQUES	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Know about various techniques in pattern recognition												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Develop good knowledge of Bayesian Theory															
<b>CLR-3:</b>	Explore the various non-Parametric techniques															
<b>CLR-4:</b>	Understand the Linear Discriminant functions															
<b>CLR-5:</b>	Utilize Artificial Neural networks for classification problems															
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Identify the various techniques involved in pattern recognition												3	1	-	
<b>CO-2:</b>	Summarize Bayesian decision theory and Bayesian learning												3	2	-	
<b>CO-3:</b>	Categorize the various non-Parametric techniques												2	2	-	
<b>CO-4:</b>	Formulate appropriate Linear Discriminant Function, Nearest neighbor rule, Neural Network and SVM for the problem statement												3	2	-	
<b>CO-5:</b>	Demonstrate the Artificial Neural Network based Pattern recognition												3	-	2	

<b>Unit-1 - Introduction to Pattern recognition Systems</b>	<b>9 Hour</b>
Basics of Probability, Independence of events, Conditional and Joint probability, Machine perception, Pattern Recognition Systems, The Design cycle, Learning and Adaptation, Minimum-error-rate classification, Classifiers, Discriminant functions, Decision surfaces, Normal density, and discriminant functions	
<b>Unit-2 - Parameter Estimation Methods</b>	<b>9 Hour</b>
Maximum Likelihood Estimation, Bayesian Estimation, Bayesian Parameter Estimation: Gaussian case, Bayesian Parameter Estimation: General Theory, Problems of Dimensionality, Component Analysis and Discriminants, Expectation-Maximization, Hidden Markov Model	
<b>Unit-3 - Non-Parametric Techniques</b>	
Density Estimation, Parzen Windows, K- Nearest Neighbor Estimation, The Nearest Neighbor Rule, Metrics and Nearest Neighbor classification, Fuzzy classification, reduced coulomb energy networks, Approximations by series expansions	
<b>Unit-4 - Linear Discriminant Functions</b>	
Linear Discriminant Functions and Decision Surfaces, Generalized Linear Discriminant Functions, Two-category linearly separable case, Perceptron criterion functions, Relaxation procedures, Nonseparable Behavior, Minimum Squared Error procedures, Linear Programming Algorithms, Support Vector Machines	
<b>Unit-5: Multilayer Neural Networks and Nonmetric Methods</b>	
Introduction to Neural Networks. Multilayer Neural Networks: Feedforward operations and classification, Backpropagation algorithms, Nonmetric methods: Decision Trees, CART, Applications: Face recognition System	

<b>Learning Resources</b>	1. R.O. Duda, P.E.Hart and D.G.Stork, <i>Pattern Classification</i> , John Wiley 2001 2. S. Theodoridis and K.Koutroumbas, <i>Pattern Recognition</i> , 4th Ed., Academic Press, 2009 3. C.M. Bishop, <i>Pattern Recognition and Machine Learning</i> , Springer, 2006 4. P.A Devijver and J. Kittler, <i>Pattern Recognition: A Statistical Approach</i> , Prentice-Hall International, Englewood Cliffs, NJ, 1980	5. K. Fukunaga, <i>Introduction to Statistical Pattern Recognition</i> , 2nd Ed. Academic Press, New York, 1990. 6. Wu, Jianxin. <i>Essentials of Pattern Recognition: An Accessible Approach</i> . United Kingdom, Cambridge University Press, 2020. 7. Bengio, Y., Goodfellow, I., Courville, A. (2016). <i>Deep Learning</i> . United Kingdom: MIT Press.
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	30%	-	30%	-		
Level 4	Analyze	30%	-	30%	-	30%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

#### Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.Peter PethuruRaj, Jio Cloud, Bengaluru 2. Mr. Srivaths Pasumarthi, Senior Research Scientist Subtle Medical, Menlo Park, California, USA	1. Dr.S.Chithra, Associate Professor, SSN College of Engineering, Chennai	1. Dr.B.Baranidharan, Associate Professor, Dept of C.Tech, SRMIST

<b>Course Code</b>	21CSE452T	<b>Course Name</b>	SEMANTIC WEB	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>			
<b>CLR-1:</b>	Understand the basic concepts of semantic web												<b>PSC-1</b>	<b>PSC-2</b>	<b>PSC-3</b>		
<b>CLR-2:</b>	Analyze the Ontology terminologies												-	-	3	-	
<b>CLR-3:</b>	Investigate the concepts of semantic web services												-	-	3	-	
<b>CLR-4:</b>	Construct and map Ontologies												-	-	3	-	
<b>CLR-5:</b>	Apply semantic web knowledge using XML												2	-	3	3	-
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>																
<b>CO-1:</b>	Acquire knowledge about Semantic Web																
<b>CO-2:</b>	Recognize Ontology Terminologies																
<b>CO-3:</b>	Analyze the XML web services																
<b>CO-4:</b>	Apply Ontology concepts																
<b>CO-5:</b>	Design XML documents																

**Unit-1 - The Semantic Web** 9 Hour

The Semantic Web: Introduction - Scenario - Layer Cake. Describing Data with RDF- properties - visualization, RDF Applications. Topic Maps - Introduction - Examples- Comparison with Web and RDF. Annotations - Searching - Strategies. Logic - order – pitfalls

**Unit-2 - Understanding Ontologies** 9 Hour

Graphical ontology example: Human resources., Definitions-Syntax, Structure, Semantics, and Pragmatics- Ontology and Semantic Mapping Problem-Knowledge Representation: Languages, Formalisms, Logics- Levels of Ontologies- OWL-Ontologies Today

**Unit-3 - Semantic Web Services** 9 Hour

Web Services-Invoking-Describing-finding services. Intelligent agents-Types-Interactions-Frameworks-Standards. Distributed trust and belief-tools of trust-

**Unit-4 - Ontology Engineering** 9 Hour

Constructing Ontologies Manually-Reusing Existing Ontologies-Semiautomatic Ontology Acquisition-Ontology Mapping-Exposing Relational Databases-Semantic Web Application Architecture

**Unit-5 - Case Studies with XML** 9 Hour

The XML Language-Structuring-Namespace-Addressing and Querying XML Documents-Processing-Case Studies: Friend of a Friend-Browser Bookmarks-Crafting Your Company's Roadmap to the Semantic Web

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>Thomas.B.Passin: <i>Explorer's guide to the semantic web</i>. Manning Publications Company 2004, ISBN 978-1-932394-20-7, pp. I-XXII, 1-281</li> <li>Michael C. Daconta, Leo J. Obrst and Kevin T. Smith, "The semantic Web: A guide to the future of XML, web services, and knowledge management", ohn wiley &amp; sons, 2003.</li> <li>Grigoris Antoniou and Frank Van Harmelen, "A Semantic Web Primer", the MIT Press, Cambridge, Massachusetts London, England, 2004.</li> <li><a href="http://www.semanticweb.org">www.semanticweb.org</a></li> </ol>		
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<b>Learning Assessment</b>		<b>Continuous Learning Assessment (CLA)</b>				<b>Summative Final Examination (40% weightage)</b>			
	<i>Bloom's Level of Thinking</i>	<i>Formative CLA-1 Average of unit test (50%)</i>		<i>Life-Long Learning CLA-2 (10%)</i>					
		<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>				
Level 1	<i>Remember</i>	15%	-	25%	-	15%	-		
Level 2	<i>Understand</i>	25%	-	25%	-	25%	-		
Level 3	<i>Apply</i>	30%	-	25%	-	30%	-		
Level 4	<i>Analyze</i>	30%	-	25%	-	30%	-		
Level 5	<i>Evaluate</i>	-	-	-	-	-	-		
Level 6	<i>Create</i>	-	-	-	-	-	-		
	<i>Total</i>	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. R Velmurugan Manager, Cognizant	1. Prof. Dr. J. I. Sheeba, Department of CSE, Puducherry Technological University, Pondicherry, India 2. Prof. Dr. K. Prasanth, Dept of IT, KSRCT, Tiruchengode, India	1. Dr. Sindhu C, Computing Technologies 2. Mrs. R. Lavanya, Computing Technologies

<b>Course Code</b>	21CSE453T	<b>Course Name</b>	SPEECH RECOGNITION	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the basics of Acoustics and Phonetics												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Illustrate the concepts of Chatbots and Dialogue systems															
<b>CLR-3:</b>	Demonstrate the feature extraction process of speech recognition task															
<b>CLR-4:</b>	Apply the deep learning architecture for speech recognition task															
<b>CLR-5:</b>	Analyzing and applying the transfer learning models for machine translation task															
<b>Course Outcomes (CO):</b>		<b>At the end of this course, learners will be able to:</b>														
<b>CO-1:</b>	Familiarize the concepts of acoustics and phonetics												3	2	Problem Analysis	
<b>CO-2:</b>	Understand the applications of speech recognition												1	2	Design/development of solutions	
<b>CO-3:</b>	Identify the feature extraction process involved in speech recognition												3	-	Conduct investigations of complex problems	
<b>CO-4:</b>	Design and Develop the deep learning architecture												3	2	Modern Tool Usage	
<b>CO-5:</b>	Understand the recent technologies in machine translation process												2	-	The engineer and society	
															Environment & Sustainability	
															Ethics	
															Individual & Team Work	
															Communication	
															Project Mgt. & Finance	
															Life Long Learning	

<b>Unit-1 - Introduction to Acoustic Phonetics</b>	9 Hour
Speech Sounds and Phonetic Transcription, Articulatory phonetics, Prosody, Acoustic Phonetics and Signals, Phonetic Resources	
<b>Unit-2 - Chatbots &amp; Dialogue Systems</b>	9 Hour
Properties of Human Conversation, Chatbots, GUS: Simple Frame-based Dialogue Systems, The Dialogue-State Architecture, Evaluating Dialogue Systems, Dialogue System Design	
<b>Unit-3 - Automatic Speech Recognition and Text-to-Speech</b>	9 Hour
The Automatic Speech Recognition Task, Feature Extraction for ASR: Log Mel Spectrum, Speech Recognition Architecture, CTC, ASR Evaluation: Word Error Rate, TTS	
<b>Unit-4 - Deep Learning Architectures for Sequence Processing</b>	9 Hour
Language Models Revisited, Recurrent Neural Networks, RNNs as Language Models, RNNs for other NLP tasks, Stacked and Bidirectional RNN architectures, The LSTM, Self-Attention Networks: Transformers, Transformers as Language Models, Contextual Generation and Summarization	
<b>Unit-5 - Machine Translation and Encoder-Decoder Models</b>	9 Hour
Language Divergences and Typology, The Encoder-Decoder Model, Encoder-Decoder with RNNs, Attention, Beam Search, Encoder-Decoder with Transformers, Some practical details on building MT systems, MT Evaluation	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Daniel Jurafsky and James H Martin, "Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", Prentice Hall, 2nd Edition, 2018.</li> <li>2. L. Rabiner and B. H. Juang, Fundamentals of Speech Recognition, Prentice Hall, 1993</li> <li>3. Wang, Y., Skerry-Ryan, R.J., Stanton, D., Wu, Y., Weiss, R.J., Jaitly, N., Yang, Z., Xiao, Y., Chen, Z., Bengio, S. and Le, Q., Tacotron: Towards end-to-end speech synthesis. arXiv. 2017.</li> <li>4. Ren, Y., Ruan, Y., Tan, X., Qin, T., Zhao, S., Zhao, Z., and Liu, T. Y. Fastspeech: Fast, robust and controllable text to speech. Advances in Neural Information Processing Systems 32. 2019.</li> <li>5. Sutskever, Ilya, Oriol Vinyals, and Quoc V. Le. Sequence to sequence learning with neural networks arXiv 2014</li> <li>6. The Illustrated Transformer – Jay Alammar – Visualizing machine learning one concept at a time arXiv. 2017.</li> </ol>
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. J.Balaji, Associate Manager,Allstate Solutions Pvt Ltd, jagank.balaji@gmail.com	1. Dr Gautam Srivatsava, Brandon University, Cananda 2. Mr Tamilanaban, IBM Software Labs, Bangalore	1. Dr. R. Srinivasan, Assistant Professor, SRMIST,KTR. 2. Dr.Subalalitha C.N, Associate professor, SRMIST, KTR.

<b>Course Code</b>	21CSE454T	<b>Course Name</b>	COMPUTER VISION	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>											<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	The purpose of learning this course is to:											<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-1:</b>	Introduce students the foundations of Image Processing Techniques.	1	2	3	4	5	6	7	8	9	10	11	12		
<b>CLR-2:</b>	Understand the shape and region analysis.	3	-	-	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CLR-3:</b>	Understand the Hough Transform and its applications to detect lines, circles, ellipses.	2	2	1	-	-	-	-	-	-	-	-	-	3	-
<b>CLR-4:</b>	Understand the Three-dimensional image analysis techniques and Motion Analysis.	3	2	1	-	1	-	-	-	-	-	-	-	3	-
<b>CLR-5:</b>	Study some applications of computer vision algorithms.	2	-	-	-	-	-	-	-	-	-	-	-	3	2
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>	2	-	1	-	1	-	-	-	-	-	-	-	3	-
<b>CO-1:</b>	Perform basic Point detection and Morphology.	3	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>CO-2:</b>	Perform shape analysis, implement boundary tracking techniques and apply chain codes and other region descriptors	2	2	1	-	-	-	-	-	-	-	-	-	3	-
<b>CO-3:</b>	Apply Hough Transform for line, circle, and ellipse detections.	3	2	1	-	1	-	-	-	-	-	-	-	3	-
<b>CO-4:</b>	Apply 3D vision techniques. Implement motion related techniques.	2	-	-	-	-	-	-	-	-	-	-	-	3	2
<b>CO-5:</b>	Develop applications using computer vision techniques.	2	-	1	1	1	-	-	-	-	-	-	-	3	2

<b>Unit-1 - Image Processing Foundations</b>	9 Hour
Image processing techniques - classical filtering operations - thresholding techniques - edge detection techniques - corner and interest point detection - mathematical morphology - texture.	
<b>Unit-2 - Shapes and Regions</b>	9 Hour
Binary shape analysis – connectedness – object labeling and counting – size filtering – distance functions – skeletons and thinning – deformable shape analysis – boundary tracking procedures – active contours – shape models and shape recognition – centroidal profiles – handling occlusion – boundary length measures – boundary descriptors – chain codes – Fourier descriptors – region descriptors – moment.	
<b>Unit-3 - Hough Transform</b>	9 Hour
Line detection – Hough Transform (HT) for line detection – foot-of-normal method – line localization – line fitting – RANSAC for straight line detection – HT based circular object detection – accurate center location – speed problem – ellipse detection – Case study: Human Iris location – hole detection – generalized Hough Transform (GHT) – spatial matched filtering – GHT for ellipse detection – object location – GHT for feature collation.	
<b>Unit-4 - Vision and Motion</b>	9 Hour
Methods for 3D vision – projection schemes – shape from shading – photometric stereo – shape from texture – shape from focus – active range finding – surface representations – point-based representation – volumetric representations – 3D object recognition – 3D reconstruction – introduction to motion – triangulation – bundle adjustment – translational alignment – parametric motion – spline-based motion – optical flow – layered motion.	
<b>Unit-5 - Applications</b>	9 Hour
Application: Photo album – Face detection – Face recognition – Eigen faces – Active appearance and 3D shape models of faces Application: Surveillance – foreground-background separation – particle filters – Chamfer matching, tracking, and occlusion – combining views from multiple cameras – human gait analysis Application: In-vehicle vision system: locating roadway – road markings – identifying road signs – locating pedestrians.	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Computer Vision: Algorithms and Applications,</li> <li>2. Richard Szeliski, Springer-Verlag London Limited 2011</li> <li>3. E. R. Davies, –Computer &amp; Machine Visionll, Fourth Edition, Academic Press, 2012</li> <li>4. D. L. Baggio et al., –Mastering OpenCV with Practical Computer Vision Projectsll, Packt Publishing, 2012</li> <li>5. Computer Vision: A Modern Approach, Forsyth, J. Ponce, Pearson Education, 2003.</li> <li>6. Jan Erik Solem, –Programming Computer Vision with Python: Tools and algorithms for analyzing imagesll, O'Reilly Media, 2012.</li> <li>7. Mark Nixon and Alberto S. Aquado, –Feature Extraction &amp; Image Processing for Computer Visionll, Third Edition, Academic Press, 2012.]</li> <li>8. Davies, E. R. (2017). Computer Vision: Principles, Algorithms, Applications, Learning. Netherlands: Elsevier Science.</li> <li>8. Bhuyan, M. K. (2019). Computer Vision and Image Processing: Fundamentals and Applications. United States: CRC Press.</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>			
	<i>Bloom's Level of Thinking</i>	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	20%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	30%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. BharathKumar, Senior Software Developer, MalwareBytes, Estonia, sadanandam@malwarebytes.com	1. Dr. K. Vivekanandan , Ph.D., Professor in Computer Science and Engineering , Pondicherry Engineering College, Puducherry-605014, k.vivekanandan@pec.edu	1. Dr M Suchithra, Associate Professor, Dept. of Computing Technologies.

<b>Course Code</b>	21CSE455T	<b>Course Name</b>	SOCIAL NETWORK ANALYSIS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
1	2	3	4	5	6	7	8	9	10	11	12					
<b>CLR-1:</b>	Familiarize the Concept of semantic web and the introduction to social network analysis															
<b>CLR-2:</b>	Get familiar with the modeling and aggregating of data from social networks.															
<b>CLR-3:</b>	Explore the method of extracting and mining data from social network communities															
<b>CLR-4:</b>	Understanding and predicting human behavior for social communities															
<b>CLR-5:</b>	Acquire the ability to implement social networks and visualize its applications															
<b>Course Outcomes (CO):</b>		<b>At the end of this course, learners will be able to:</b>														
<b>CO-1:</b>	understand the concepts of semantic web and introduction of social network analysis	2	-	2	3	-	-	-	-	-	-	-	-	-	-	2
<b>CO-2:</b>	Understand and design the roles of ontology in the semantic web	2	-	2	3	-	-	-	-	-	-	-	-	-	-	2
<b>CO-3:</b>	learn about the social network communities	-	3	2	-	3	-	-	-	-	-	-	-	-	-	2
<b>CO-4:</b>	understand and predict the human behavior for social communities	2	-	3	-	3	-	-	-	-	-	-	-	-	-	2
<b>CO-5:</b>	Design and implement the social network representations and visualize its applications	2	-	3	-	2	-	-	-	-	-	-	-	-	-	2

**Unit-1 - Introduction** 9 Hour  
 Introduction to Semantic web: Limitations of current web, Development of Semantic web, Emergence of the Social Web, Social Network analysis, Components, Development of Social Network Analysis, Key concepts and measures in network analysis, electronic sources for network analysis, Examples, Web-based networks, Examples with diagrams, Applications of Social Network Analysis, Examples

**Unit-2 - Ontology and their role in the Semantic Web** 9 Hour  
 Roles of Ontology, Ontology-based knowledge Representation, Explanation of Diagram, Ontology languages for the Semantic Web, Resource Description Framework, Web Ontology Language, Examples, Modeling and aggregating social network data, State-of-the-art in network data Representation, Aggregating, Advanced representations, Examples for Representations

**Unit-3 - Extraction and Mining communities in web social networks** 9 Hour  
 Extracting evolution of Web Community from a Series of Web Archive, Definition of Community, Examples for Community, detecting communities in social Networks, Examples for Detection of Communities, Algorithms, Tools for detecting communities social network infrastructures and communities, Examples for various tools

**Unit-4 - Predicting Human behavior and Privacy issues** 9 Hour  
 User data management, Inference and Distribution, Enabling new human experiences, Reality mining, Context, Privacy in online social networks, Trust model example, Trust network analysis, Trust transitivity Analysis

**Unit-5 - Visualization and Applications** 9 Hour  
 Graph theory, Centrality, Clustering, Node, Edge diagrams, Matrix representation, visualizing social networks with matrix-based representation, Matrix, Node, Link diagrams, Hybrid representations, Applications: Cover networks, Community welfare, Collaboration networks, Co-Citation networks

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>Peter Mika, "Social Networks and the Semantic Web", First Edition, Springer 2007.</li> <li>Borko Furht, "Handbook of Social Network Technologies and Applications", 1st Edition, Springer, 2010.</li> <li>Guandong Xu, Yanchun Zhang and Lin Li, "Web Mining and Social Networking – Techniques and applications", First Edition Springer, 2011.</li> <li>Dion Goh and Schubert Foo, "Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively", IGI Global Snippet, 2008.</li> <li>Ian McCulloh, Helen Armstrong, and Anthony Johnson, "Social Network Analysis with Applications", Wiley Publications, 2013.</li> <li>Borgatti, S. P., Everett, M. G., &amp; Johnson, J. C., "Analyzing social networks", SAGE Publications Ltd; 1 edition, 2013.</li> </ol>
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	25%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Muthukumarasamy S, Capgemini India Pvt Ltd,Chennai	1. Prof.Dr. Deivamani Mallaya, College of Engineering, Guindy, Chennai.	1. Ms.Briskilal J, Computing Technologies, SRMIST, KTR, Chennai.
		2. Ms.Vijayalakshmi M, Computing Technologies, SRMIST, KTR, Chennai.

<b>Course Code</b>	21CSE456T	<b>Course Name</b>	SOFTWARE DEFINED NETWORKS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>			
<b>CLR-1:</b>	The purpose of learning this course is to:												<b>PSC-1</b>	<b>PSC-2</b>	<b>PSC-3</b>		
<b>CLR-1:</b>	Learn the fundamentals of software defined networks.	1	Problem Analysis	2	Design/development of solutions	3	Conduct investigations of complex problems	4	Modern Tool Usage	5	The engineer and society	6	Environment & Sustainability	7	Ethics	8	Individual & Team Work
<b>CLR-2:</b>	Explore different controllers of SDN.	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	Project Mgt. & Finance
<b>CLR-3:</b>	Study about the SDN Programming.	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	Life Long Learning
<b>CLR-4:</b>	Analyze the various applications of SDN	-	3	-	-	1	-	-	-	-	-	-	-	-	-	-	2
<b>CLR-5:</b>	Express the various components of SDN and their uses	-	1		3	-	-	-	-	-	-	-	-	-	-	-	2

<b>Course Outcomes (CO):</b>		<b>At the end of this course, learners will be able to:</b>
<b>CO-1:</b>		Differentiate between traditional and software defined networks
<b>CO-2:</b>		Associate appropriate Controllers for different applications
<b>CO-3:</b>		Obtain skills to do advanced networking research and programming
<b>CO-4:</b>		Learn how to use software programs to perform varying and complex networking tasks
<b>CO-5:</b>		Explore the knowledge learned and apply it to solve real time problems

<b>Unit-1 - Introduction to SDN</b>	<b>9 Hour</b>
Introduction - Evolution of SDN – Need for SDN - Centralized and Distributed Control and Data Planes - The Genesis of SDN Introducing Mininet - Setting up the Environment and Implementation of SDN Aspects in Mininet	
<b>Unit-2 - SDN Abstractions</b>	<b>9 Hour</b>
Working principle of SDN - Openflow Protocol, SDN Controllers: Introduction - General Concepts - VMware - Nicira - OpenFlow-Related - Mininet - NOX/POX - Trema - Ryu , Floodlight - Layer 3 Centric - Plexxi - Cisco One PK ,Implementation of Custom Topologies in POX, ODL, Floodlight 3 Click, ONOS,Interfacing: Northbound – Southbound and East bound -West bound.	
<b>Unit-3 - Programming of SDN</b>	<b>9 Hour</b>
Network Programmability - Network Function Virtualization - NetApp Development, Network Slicing, ONOS deployment ONOS – OPNFV	
<b>Unit-4 - SDN Applications and Use Cases</b>	<b>9 Hour</b>
SDN in the Data Center - SDN in Other Environments - SDN Applications - SDN Use Cases - The Open Network Operating System 3	
<b>Unit-5 - SDN's Future and Perspectives</b>	<b>9 Hour</b>
SDN Open Source - SDN Futures – SDN SECURITY- Switching and Load Balancers, Firewall and Access Control, Use cases in Legacy Networks security.	

<b>Learning Resources</b>	1. Software Defined Networks: A Comprehensive Approach by Paul Goransson and Chuck Black, Morgan Kaufmann Publications, 2016 Reprint 2. SDN - Software Defined Networks by Thomas D. Nadeau & Ken Gray, O'Reilly, 2013 3. Software Defined Networking with OpenFlow By Siamak Azodolmolky, Packt Publishing, 2013 4. Feamster, Nick, Jennifer Rexford, and Ellen Zegura. "The road to SDN: an intellectual history of programmable networks." ACM SIGCOMM Computer Communication Review 44.2 (2014): 87-98
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Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1 Remember	15%	-	15%	-	15%	-
Level 2 Understand	25%	-	25%	-	25%	-
Level 3 Apply	30%	-	30%	-	30%	-
Level 4 Analyze	30%	-	30%	-	30%	-
Level 5 Evaluate	-	-	-	-	-	-
Level 6 Create	-	-	-	-	-	-
Total	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. P.Kumaran,Senior Engineer,CSS Corp , Navalur,Chennai 2. D.Dinesh Babu,Servion global solution private limited,Software Engineer,Chennai	1. Dr. M. Sridevi, Associate Professor, Dept. of CSE, NIT, Trichy	1. Dr.B.Amutha, Prof./CTech/SRMIST 2. D.Vanusha,Assistant Assistant Prof./CTech/SRMIST 3. Dr.R.Thamizhamuthu Assistant Prof./CTech/SRMIST

<b>Course Code</b>	21CSE457T	<b>Course Name</b>	SERVICE ORIENTED ARCHITECTURE	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the main concepts, principles, needs and evolution of SOA												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Understand and apply patterns for service design from the provider and requester perspectives															
<b>CLR-3:</b>	Understand SOA challenges mainly regarding governance, testing and maintenance															
<b>CLR-4:</b>	Understand the business case for SOA															
<b>CLR-5:</b>	Understand the best strategies and practices of SOA															
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Comprehend the need for SOA and its systematic evolution.												2	-	-	
<b>CO-2:</b>	Design and analyze various SOA patterns and techniques.												2	-	-	
<b>CO-3:</b>	Create a best implementation model												3	-	-	
<b>CO-4:</b>	Apply SOA technologies to enterprise domain												2	-	-	
<b>CO-5:</b>	Implement the best strategies and practices of SOA												3	-	-	

<b>Unit-1 - Introduction</b>	<b>9 Hour</b>
Introduction: SOA and MSA Basics: Service Orientation in Daily Life, Evolution of SOA and MSA. Service oriented Architecture and Microservices architecture – Drivers for SOA, Dimensions of SOA, Conceptual Model of SOA, Standards and Guidelines for SOA, Emergence of MSA Enterprise-Wide SOA: Considerations for Enterprise-wide SOA, Strawman Architecture for Enterprise-wide SOA, Enterprise SOA Reference Architecture, Object-oriented Analysis and Design (OOAD) Process, Service-oriented Analysis and Design (SOAD) Process, SOA Methodology for Enterprise	
<b>Unit-2 - Analysis and Design</b>	<b>9 Hour</b>
Service-Oriented Applications: Considerations for Service-oriented Applications, Patterns for SOA, Pattern-based Architecture for Service-oriented Applications, Composite Applications, Composite Application Programming Model. Service-Oriented Analysis and Design: Need for Models, Principles of Service Design, Nonfunctional Properties for Services, Design of Activity Services (or Business Services), Design of Data Services, Design of Client Services, Design of Business Process Services	
<b>Unit-3 - Technologies for SOA</b>	<b>9 Hour</b>
Technologies for SOA: Technologies for Service Enablement, Technologies for Service Integration, Technologies for Service Orchestration. SOA Governance and Implementation: Strategic Architecture Governance, Service Design-time Governance, Service Run-time Governance, Approach for Enterprise-wide SOA Implementation	
<b>Unit-4 - Big Data and SOA</b>	<b>9 Hour</b>
Big Data and SOA: Concepts, Big Data and its characteristics, Technologies for Big Data, Service-orientation for Big Data Solutions. Business Case for SOA: Stakeholder Objectives, Benefits of SOA, Cost Savings, Return on Investment (ROI), Build a Case for SOA	
<b>Unit-5 - SOA Best Practices</b>	<b>9 Hour</b>
SOA Best Practices: SOA Strategy – Best Practices, SOA Development – Best Practices, SOA Governance – Best Practices. EA and SOA for Business and IT Alignment: Enterprise Architecture, Need for Business and It Alignment, EA and SOA for Business and It Alignment	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>Shankar Kambhampaty; Service - Oriented Architecture &amp; Microservices Architecture: For Enterprise, Cloud, Big Data and Mobile; Wiley; 3rd Edition; 2018; ISBN: 9788126564064.</li> <li>Icon Group International; The 2018-2023 World Outlook for Service-Oriented Architecture (SOA) Software and Services; ICON Group International; 1st Edition, 2017; ASIN: B06WGPN8YD.</li> <li>Thomas Erl; Service Oriented Architecture Concepts Technology &amp; Design; Pearson Education Limited; 2015; ISBN-13: 9788131714904.</li> <li>Guido Schmutz, Peter Welkenbach, Daniel Liebhart; Service Oriented Architecture An Integration Blueprint; Shroff Publishers &amp; Distributors; 2010; ISBN-13: 9789350231081</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>	
<i>Bloom's Level of Thinking</i>	<i>Formative CLA-1 Average of unit test (50%)</i>	<i>Life-Long Learning CLA-2 (10%)</i>					
		<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Umesh Goyal Senior Manager System Engineering - End User Computing at VMware		1. Dr J Selvin Paul Peter

<b>Course Code</b>	21CSE458T	<b>Course Name</b>	WIRELESS AND MOBILE COMMUNICATION	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Analyze the fundamental of transmission and cellular systems												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Apply skills in real time engineering problems and can have capability to evaluate the transmission errors															
<b>CLR-3:</b>	Comprehend the concept of mobile network, transport layer and wireless technologies															
<b>CLR-4:</b>	Differentiate the various types of cellular standard by their unique services															
<b>CLR-5:</b>	Grasp GSM, GPRS, Handover and Localization techniques, Apply skills in various Routing protocols															
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>															
<b>CO-1:</b>	Apply Wireless Technology concepts to Engineering problems related to communication												1	PSO-1	-	
<b>CO-2:</b>	Improve their knowledge on Digital and analog Modulation techniques.												1	-	-	
<b>CO-3:</b>	Equip themselves familiar with principle of Mobile Communication												1	-	-	
<b>CO-4:</b>	Familiarize with Digital Cellular Standards												1	-	-	
<b>CO-5:</b>	Acquaint with routing protocols, Expose to the emerging wireless technologies												1	-	-	

**Unit-1 - Introduction to wireless communication** 9 Hour  
Elements of wireless communication system- Frequencies for radio communication- Signals, Noise – Types of Noise- Introduction to modulation and demodulation- Signals in the modulation- Introduction to Analog modulation schemes- Amplitude Modulation Frequency modulation- Phase Modulation Introduction to Analog modulation schemes- Amplitude Shift Keying Frequency Shift Keying Phase Shift Keying- BPSK, QPSK- Multiplexing and multiple access techniques- Frequency-division multiplexing- Time-division multiplexing- Code-division multiplexing- Spread spectrum modulation- frequency hopping Spread spectrum- Direct Sequence Spread spectrum

**Unit-2 - Cellular Concept** 9 Hour  
Cell area- Signal strength- Cell parameter- Capacity of Cell- Co channel interference- Frequency reuse- Frequency reuse- Multiple Radio access protocols Frequency division Multiple Access- Multiple Radio access protocols Frequency division Multiple Access- Multiple Access with Collision Avoidance- Space division Multiple Access Code division Multiple Access- Space division Multiple Access Code division Multiple Access- OFDM- Variants of OFDM- Comparison of Multiple Access Technique

**Unit-3 – Generation of Cellular Systems** 9 Hour  
Introduction to GSM- Frequency Bands and Channels- Frames in GSM- Planes and layers of GSM- Protocols- Localization and calling- Handoff – Short messaging system- GPRS EDGE- 3G CELLULAR Systems MMS- 3G CELLULAR Systems MMS- Handover- Satellite System Infrastructure- GEO, LEO, MEO- Limitations of GPS- GPS Beneficiaries of GPS- 4G Cellular systems- 4G Standards (LTE/WiMax)

**Unit-4 – Communication Protocols** 9 Hour  
Mobile IP- IP packet delivery- Tunneling – Reverse Tunneling- IPv6- DHCP- Tradition TCP- Congestion control- Classical TCP Snooping- Mobile TCPFast retransmit / Fast recovery- Transaction oriented TCP TCP over 2.5/3G wireless Networks- Introduction to WAP WAP Architecture- Wireless Datagram Protocol Wireless Transaction Protocol- Wireless Session Protocol- Wireless Transport Layer Security- Wireless Markup Language- Push Architecture

**Unit-5 – Protocol Architectures and Standards** **9 Hour**

System Architecture- Protocol Architecture- MAC Layer and Management- 802.11a, 802.11b- HIPERLAN- Bluetooth Architecture- IEEE 802.15 IEEE 802.15.4-MANET characteristics ROUTING- AODV Routing VANET Communications in VANET- Wireless Sensor Networks- RFID Technology Two tags of RFID- Wi-Fi Standards- WiMax Standards- Fem-to-Cell Network- Push-to-talk technology for SMS

<b>Learning Resources</b>	1. Roy Blake, "Wireless Communication Technology" CENGAGE learning, Sixth Indian reprint 2013.	6. G.I. Papadimitriou, A.S. Pomportsis, P. Nicopolitidis, M.S. Obaidat, "Wireless Networks", John Wiley and Sons, 2003
	2. Dharma Prakash Agarwal, Qing-An Zeng, "Introduction to Wireless and Mobile Systems" CENGAGE learning, First edition 2014	7. Upena Dalal, "Wireless Communication" Oxford University Press, First edition 2009. Kaveh Pahlavan & Prashant Krishnamurthy, "Wireless Networks" PHI 2002.
	3. Jochen Schiller, "Mobile Communications", Addison Wesley, 2nd edition 2011.	8. Martyn Mallick, "Mobile and Wireless Design Essentials", Wiley Dreamtech India Pvt.Ltd., 2014.
	4. Singal TL, "Wireless Communication", Tata McGraw Hill Education Private Limited	
	5. G.I. Papadimitriou, A.S. Pomportsis, P. Nicopolitidis, M.S. Obaidat, "Wireless Networks", John Wiley and Sons, 2003	

Learning Assessment						
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)		
		Theory	Practice	Theory	Practice	Theory
Level 1	Remember	15%	-	15%	-	15%
Level 2	Understand	25%	-	20%	-	25%
Level 3	Apply	30%	-	25%	-	30%
Level 4	Analyze	30%	-	25%	-	30%
Level 5	Evaluate	-	-	10%	-	-
Level 6	Create	-	-	5%	-	-
	Total	100 %		100 %		100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1. Dr.V.Kavitha Associate professor,Kings Engineering college.Anna University.chennai 2. Dr.Kadiyala Ramana,Associate professor,Chaitanya bharathi Institute of Technology,Osmania University.Hyderabad.	1. Dr.V.Deeban Chakravarthy 2. Dr.P.Kirubanantham

<b>Course Code</b>	21CSE459T	<b>Course Name</b>	WIRELESS SENSOR NETWORKS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the basic sensor network concepts												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Learn about various Medium Access Control Protocols															
<b>CLR-3:</b>	Comprehend the strategies of various routing Protocols															
<b>CLR-4:</b>	Gain the knowledge on Localization and Time Synchronization															
<b>CLR-5:</b>	Understand the concept of Middleware Services and Network Security															
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>															
<b>CO-1:</b>	Understand the challenges of WSN												1	-	-	
<b>CO-2:</b>	Analyze the variation in different protocols and apply in real time scenario												1	-	-	
<b>CO-3:</b>	Identify the best Routing Strategies												1	-	-	
<b>CO-4:</b>	Apply and Analyze the importance of various Localization and Time Synchronization												1	-	-	
<b>CO-5:</b>	Implement an application using middleware architecture with advanced security features												1	-	-	

<b>Unit-1 - Introduction to Wireless Sensor Networks</b>	<b>9 Hour</b>
Motivation for a network of Wireless Sensor nodes - Sensing and sensors- Challenges and constraints- Node architecture- Sensing sub system- Processor sub system- Communication interfaces-- prototypes- Application of Wireless sensors- WSN Tools- Overview and Limitations- Contiki -Introduction- Characteristics of Contiki WSN simulator- Sensor Network Programming- Challenges in Sensor Network Programming- Node-Centric Programming	
<b>Unit-2 - MAC Protocols for WSN</b>	<b>9 Hour</b>
Characteristics of MAC protocols in Sensor networks- Contention free MAC Protocols- MAC Protocols –Characteristics- Traffic Adaptive Medium Access- Y-MAC- Low energy Adaptive Clustering- Contention based MAC Protocols- Sensor MAC- Timeout MAC and pattern MAC- Hybrid MAC Protocol- MAC protocols in ContikiOS simulator- Nullmac in Contiki simulator	
<b>Unit-3 - Routing Strategies</b>	<b>9 Hour</b>
Routing Metrics- Flooding and Gossiping- Data-Centric Routing- Proactive Routing- On-Demand Routing- Hierarchical Routing- Location-Based Routing- QoS-Based Routing Protocols- Local Power Management Aspects- Dynamic Power Management	
<b>Unit-4 - Localization and Time Synchronization</b>	<b>9 Hour</b>
Clocks and the Synchronization Problem- Time Synchronization in Wireless Sensor Networks- Basics of Time Synchronization- Time Synchronization Protocols- Ranging Techniques- Range-Based Localization- Range-Free Localization- Event-Driven Localization	
<b>Unit-5 - WSN Security and Middleware Services</b>	<b>9 Hour</b>
Fundamentals of Network Security- Challenges of Security in Wireless Sensor Networks- Security Attacks in Sensor Networks- Protocols and Mechanisms for Security- Middleware Architecture- Data related functions, Architecture- Existing middleware- MILAN,IrisNet- AMF,DSWare- CLMF	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>Waltenegus Dargie, Christian Poellabauer, —Fundamentals of Wireless Sensor Networks, Theory and Practicell, Wiley Series on wireless Communication and Mobile Computing, 2011</li> <li>Kazem Sohraby, Daniel manoli, —Wireless Sensor networks- Technology, Protocols and Applicationsll, Wiley InterScience Publications 2013.</li> <li>S. Swapna Kumar, "A Guide to Wireless Sensor Networks", kindle Edition, USP publications,2017</li> <li>C.S Raghavendra, Krishna M. Sivalingam, Taieb znati, —Wireless Sensor Networksll, Springer Science 2010.</li> <li>Bhaskar Krishnamachari, — Networking Wireless Sensorsll, Cambridge University Press, 2005</li> <li><a href="https://www.amazon.in/Guide-Wireless-Sensor-Networks-ebook/dp/B072R53JJM">https://www.amazon.in/Guide-Wireless-Sensor-Networks-ebook/dp/B072R53JJM</a></li> <li><a href="https://anrg.usc.edu/contiki/index.php/Contiki_tutorials">https://anrg.usc.edu/contiki/index.php/Contiki_tutorials</a></li> <li>file:///C:/Users/Administrator.RD27/Downloads/Fundamentals-of-Wireless-Sensor-Networks-Waltenegus-Dargie.pdf</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>			
<i>Bloom's Level of Thinking</i>	<i>Formative CLA-1 Average of unit test (50%)</i>	<i>Life-Long Learning CLA-2 (10%)</i>							
		<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr.J.Shelton Samson Vedharaj Head of Global Software Application Support Digital and Technology Coats	1. Dr. N. Radha, SSN College of Engineering,	1. P.Renukadevi AP/CTech ,SRMIST,KTR
	2. Dr.N.Poongavanam Veltech Rangarajan Dr.Sagunthala R & D Institute of Science and Technology,	2. R.Brindha AP/Ctech SRMIST,KTR

<b>Course Code</b>	21CSE460T	<b>Course Name</b>	NETWORK PROTOCOLS AND ALGORITHMS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the layered architecture for communication networks and the specific functionality of the network layer.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Gain knowledge on the need for network protocols, its functionality, and different architectures.															
<b>CLR-3:</b>	Understand fundamental basis of various algorithms in centralized and distributed point of view.															
<b>CLR-4:</b>	Understand the various types of key routing protocols used in wireless networks.															
<b>CLR-5:</b>	Gain knowledge on past experiences and prepare for next generation networks and routing															

<b>Course Outcomes (CO):</b>		<b>At the end of this course, learners will be able to:</b>														
<b>CO-1:</b>	Acquire the knowledge of conventional networks routing operations	1	2	-	-	-	-	-	-	-	-	-	-	1	-	-
<b>CO-2:</b>	Comprehend Router Architectures and IP Address Lookup Algorithms	2	1	-	-	-	-	-	-	-	-	-	-	1	-	-
<b>CO-3:</b>	Model and evaluate various routing techniques and protocols	-	2	1	-	-	-	-	-	-	-	-	-	1	-	-
<b>CO-4:</b>	Examine how different dimensions of routing differ for different types of networks	-	2	1	-	-	-	-	-	-	-	-	-	1	-	-
<b>CO-5:</b>	Analyze and evaluate various routing paradigms in next generation	-	1	2	-	-	-	-	-	-	-	-	-	1	-	-

**Unit-1 - Introduction** 9 Hour  
ISO OSI Layer Architecture, TCP/IP Layer Architecture, Functions of Network layer, General Classification of routing, Routing in telephone networks, Dynamic Nonhierarchical Routing (DNHR), Trunk status map routing (TSMR), real-time network routing (RTNR), Distance vector routing, Link state routing, Hierarchical routing

**Unit-2 - TCP/IP protocols** 9 Hour  
BOOTP, DHCP, DNS, Finger, FTP, HTTP, S-HTTP, IMAP and IMAP4, MIME (S-MIME), NAT, NNTP, POP and POP3, rlogin, RMON, SLP, SMTP, SNMP, SNMPv1, SNMPv2, SNMPv3, SNTP, TELNET, URL, Whois (and RWhois), XMPP, X Window/X Protocol, RPC, ITOT, RDP, RUDP, TCP, UDP, BGP (BGP4).

**Unit-3 - LAN Protocols** 9 Hour  
LAN Protocols: Ethernet: IEEE 802.3 Local Area Network protocols – Fast Ethernet: 100Mbps Ethernet (IEEE 802.3u)- Gigabit (1000 Mbps) Ethernet: IEEE 802.3z (1000Base-X) and 802.3ab (1000Base-T)- 10-Gigabit Ethernet: IEEE 802.3ae and 802.3an – WLAN: Wireless LAN by IEEE 802.11 protocols – IEEE 802.11i: WLAN Security Standard – IEEE 802.1X: EAP over LAN(EAPOL) for LAN/WLAN Authentication and Key Management – WPAN: Wireless Personal Area Network Communication Protocols – IEEE 802.15.1 and the Bluetooth for WPAN Communications – FDDI: Fiber Distributed Data Interface – Token Ring: IEEE 802.5 LAN Protocol – LLC: Logic Link Control (IEEE 802.2)- SNAP: SubNetwork Access Protocol – STP: Spanning Tree Protocol (IEEE 802.1D).

**Unit-4 - WAN Protocols** 9 Hour  
WAN Protocols: ATM: Asynchronous Transfer Mode Reference Model and Protocols -SONET/SDH: Synchronous Optical Network and Synchronous Digital Hierarchy – EoS: Ethernet over SONET/SDH – BISDN: Broadband Integrated Services Digital Network (Broadband ISDN) -ISDN: Integrated Services Digital Network – PPP: Point-to-Point Protocols – FTP: File Transfer Protocol – PAP: Password Authentication Protocol – PoS:

<b>Unit-5 - Network Security Technologies and Protocols</b>	<b>9 Hour</b>
Kerberos: Network Authentication Protocol – RADIUS: Remote Authentication Dial In User Service – SSH: Secure Shell Protocol – L2F: Layer 2 Forwarding Protocol – L2TP: Layer 2 Tunneling Protocol – PPTP: Point-to-Point Tunneling Protocol – DiffServ: Differentiated Service Architecture – GRE: Generic Routing Encapsulation – IPsec: Internet Protocol Security Architecture – IPsec AH: IPsec Authentication Header – IPsec ESP: IPsec Encapsulating Security Payload – IPsec IKE: Internet Key Exchange Protocol – IPsec ISAKMP:	

<b>Learning Resources</b>	1. Jielin Dong, <i>Network Protocols Handbook</i> , 4th Edition, Javvin Press, 2007 2. Bruce Hartpence, <i>Packet Guide to Core Network Protocols</i> , O'Reilly Media, Inc., 2011. 3. Walter Y. Chen, <i>Home Network Basis: Transmission Environments and Wired/Wireless Protocols</i> , Prentice Hall, 2003.	4. Ana Minaburo, Laurent Toutain, <i>Local Networks, and the Internet: From Protocols to Interconnection</i> , John Wiley, and Sons, 2011
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Amarendra Mohanty, AdvantagePro 2. Mr. Saju G Nair, Senior Development Manager Kyndryl India Pvt Ltd.	1. Dr. Pradeepkumar, BITS, PILANI 2. Dr. P. Varalakshmi, Professor, MIT, Anna University, Chennai	1. Dr. S. Nagadevi, Assistant Professor, CTECH, SRM IST 2. Dr. R. Vidhya, Assistant Professor, CTECH, SRM IST

# **ACADEMIC CURRICULA**

## **UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES**

**(With exit option of Diploma)**

**(Choice Based Flexible Credit System)**

**Regulations 2021**

**Volume - 11B**

**(Syllabi for Computer Science and Engineering w/s in  
Artificial Intelligence and Machine Learning Programme  
Courses)**



**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

**(Deemed to be University u/s 3 of UGC Act, 1956)**

**Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India**

# ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021



**SRM**

INSTITUTE OF SCIENCE & TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

<b>Course Code</b>	21CSC401J	<b>Course Name</b>	DEEP LEARNING TECHNIQUES	<b>Course Category</b>	C	PROFESSIONAL CORE	L 3	T 0	P 2	C 4
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>			
<b>CLR-1:</b>	The purpose of learning this course is to:												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>		
<b>CLR-1:</b>	Illustrate the basic concepts of deep learning	1	Problem Analysis	2	Design/development of solutions	3	Conduct investigations of complex problems	4	Modern Tool Usage	5	The engineer and society	6	Environment & Sustainability	7	Ethics	8	Individual & Team Work
<b>CLR-2:</b>	Gain knowledge in Optimization algorithms and dimensionality reduction	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	
<b>CLR-3:</b>	Develop a broad understanding of word2vec models and Convolution Neural Network models	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	
<b>CLR-4:</b>	Acquire knowledge in Transfer learning and Sequential Models	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	
<b>CLR-5:</b>	Implement the attention mechanism and advanced deep learning models	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>																
<b>CO-1:</b>	Understand the basic concepts of deep learning	-	3	-	-	-	-	-	-	-	-	-	2	-	-	-	2
<b>CO-2:</b>	Compare the optimization algorithms and high dimensional data using reduction techniques	-	2	-	-	-	-	-	-	-	-	-	2	-	-	-	2
<b>CO-3:</b>	Implement word2vec models and Convolution Neural Network models	-	3	-	2	-	-	-	-	-	-	-	3	-	-	-	2
<b>CO-4:</b>	Apply RNN and transfer learning to real world scenarios	-	3	-	2	-	-	-	-	-	-	-	3	-	-	-	3
<b>CO-5:</b>	Use deep learning models to solve real-world applications	-	3	-	2	-	-	-	-	-	-	-	3	-	-	2	3

**Unit-1 - Introduction to Neural Networks** 15 Hour  
 Biological neuron, Motivation from biological neuron, McCulloch Pitts Neuron, Perceptron, Perceptron learning Algorithm, Representation power of a network of perceptrons, Activation functions-Sigmoid, tanh, ReLU, leaky ReLU, Sigmoid neuron, Gradient descent learning Algorithm, Representation power of multilayer Network of Sigmoid Neurons, Representation power of function: Complex functions in real world examples, Feedforward Neural Networks, Learning parameters, output and loss functions of FFN Networks, Backpropagation learning Algorithm, Applying chain rule across in a neural network, Computing partial derivatives w.r.t a weight

**Unit-2 - Optimization** 15 Hour  
 Limitations of gradient descent learning algorithm, Momentum based gradient descent, Nesterov accelerated gradient descent, AdaGrad, RMSProp, Adam learning algorithm, Stochastic gradient descent, Mini-batch gradient descent, Bias Variance tradeoff, Overfitting in deep neural networks, Hyperparameter tuning, Regularization: L2 regularization, Dataset Augmentation and Early Stopping, Dimensionality reduction, Principal Component Analysis, Autoencoders, Relation between PCA and Autoencoders, Regularization in Autoencoders

**Unit-3 - Word2vec and Convolutional Neural Networks** 15 Hour  
 One hot representation of words, Distributed representation of words, SVD for learning word Representations, Continuous bag of words model, Skip-gram model, Introduction to Convolution Neural Networks, Kernel filters, the convolution operation with Filters, padding and stride, Max pooling and non-linearities, Classic CNNs architecture- The ImageNet challenge, Alex Net architecture, ZFNet, The intuition behind GoogleNet, Residual CNN-ResNet architecture, DenseNet Architecture.

**Unit-4 - Recurrent Neural Networks** 15 Hour  
 Transfer Learning, Need for Transfer Learning, Applications of Transfer learning, Sequence Learning Problems, Recurrent Neural Networks, Backpropagation through time, Unfolded RNN, problem of exploding and vanishing Gradients, Seq to Seq Models, how gates help to solve the problem of vanishing gradients, Long-Short Term Memory architectures, dealing with exploding gradients, Gated Recurrent Units, Encoder-Decoder Models, and its applications.

<b>Unit-5 - Attention models &amp; Generative Adversarial Networks</b>		<b>15 Hour</b>
Language Modeling, Image Captioning, Machine Translation, Attention Mechanism, Attention over images, Hierarchical Attention, Monte Carlo Methods, Local Independencies in a Markov Network, Joint Distributions, the concept of a latent variable, Restricted Boltzmann Machines, RBMs as Stochastic Neural Networks, Unsupervised Learning with RBMs, Setting up a Markov Chain for RBMs, Generative Adversarial Networks-Architecture, Generative Adversarial Networks- Applications		
<b>Lab Experiments</b>		
Lab1: Apply MP Neuron and perceptron to solve a binary classification problem Lab2: Apply sigmoid neuron to solve a real-world classification / regression problem Lab3: Build a FFN Network to solve a multi-class classification problem Lab4: Implement linear regression with stochastic gradient descent. Lab5: Implement linear regression with stochastic mini-batch gradient descent and compare the results with previous exercise. Lab6: Optimizing neural networks using L2 regularization, Dropout, data augmentation and early stopping Lab7: Implement skip gram model to predict words within a certain range before and after the current word.		
Lab 8: Implement LeNet for image classification Lab 9: Implement ResNet for detecting objects. Lab 10: Transfer learning implementation using VGG16 model to classify images. Lab 11: Building a RNN to perform Character level language modeling Lab 12: Build a LSTM network for Named Entity recognition. Lab 13: Neural Machine Translation with attention. Lab 14: Case study on Scene Understanding using RBMs Lab 15: Case study on generating examples for Image dataset using Generative Adversial Networks		

<b>Learning Resources</b>	1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, <i>Deep Learning</i> , MIT Press, 2016. 2. Stevens, Eli, Luca Antiga, and Thomas Viehmann. <i>Deep learning with PyTorch</i> . Manning Publications, 2020. 3. Eugene Charniak, <i>Introduction to Deep Learning</i> , MIT Press, 2018. 4. Charu C. Aggarwal, <i>Neural Networks and Deep Learning</i> , Springer, 2018. 5. Francois Chollet, <i>Deep Learning with Python</i> , Manning Publications, 2017	6. NPTEL course: Deep Learning, Prof. Mitesh Khapra <a href="https://archive.nptel.ac.in/noc/courses/noc18/SEM2/noc18-cs41/">https://archive.nptel.ac.in/noc/courses/noc18/SEM2/noc18-cs41/</a> 7. MIT Deep Learning and Artificial Intelligence Lectures: <a href="https://deeplearning.mit.edu">https://deeplearning.mit.edu</a> 8. Stanford course CS231n: Deep Learning for Computer Vision: <a href="http://cs231n.stanford.edu">http://cs231n.stanford.edu</a> 9. MIT's introductory course on deep learning methods: <a href="http://introtodeeplearning.com">http://introtodeeplearning.com</a>
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	-	15%	15%	-		
Level 2	Understand	25%	-	-	20%	25%	-		
Level 3	Apply	30%	-	-	25%	30%	-		
Level 4	Analyze	30%	-	-	25%	30%	-		
Level 5	Evaluate	-	-	-	10%	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Dr. Marriappan Vaithilingam, Senior Director of Engineering, Fresh works	1. Dr. Lathaparthiban, Pondicherry University	1. Dr. Athira M Nambiar SRMIST

<b>Course Code</b>	21CSC402P	<b>Course Name</b>	REPORT WRITING	<b>Course Category</b>	C	PROFESSIONAL CORE	L 2	T 0	P 0	C 2
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>													
<b>CLR-1:</b>	Employ an efficient process for planning and organizing information.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>												
<b>CLR-2:</b>	Communicate the information to those who need it.																										
<b>CLR-3:</b>	Demonstrate an understanding of the ethical implications of decisions and actions.																										
<b>CLR-4:</b>	Express themselves effectively, professionally, and persuasively both orally and in writing.																										
<b>CLR-5:</b>	Provide facts and results of an enquiry.																										
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>												<b>Engineering Knowledge</b>	<b>Problem Analysis</b>	<b>Design/development of solutions</b>	<b>Conduct investigations of complex problems</b>	<b>Modern Tool Usage</b>	<b>The engineer and society</b>	<b>Environment &amp; Sustainability</b>	<b>Ethics</b>	<b>Individual &amp; Team Work</b>	<b>Communication</b>	<b>Project Mgt. &amp; Finance</b>	<b>Life Long Learning</b>	<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>
<b>CO-1:</b>	Illustrates the current professional practices and concepts of writing reports.												-	-	-	3	-	-	-	-	-	-	-	-	1		
<b>CO-2:</b>	Discover sensible decisions by employing logical and critical thinking.												-	2	-	-	-	-	-	-	-	-	-	-	1		
<b>CO-3:</b>	Demonstrate the effective way of communications.												-	-	-	-	-	-	3	-	-	-	-	-	2		
<b>CO-4:</b>	Discuss about the competent in applying relevant techniques to commercial problems.												-	2	-	2	-	-	-	-	-	-	-	-	2		
<b>CO-5:</b>	Apply knowledge in ethical report writing.												-	-	-	2	-	-	-	-	-	-	-	-	2		

<b>Unit-1 - Introduction</b>	<b>6 Hour</b>
Preparing to Write, Define the audience for report writing, Types of Reports, Planning -brainstorming and mind mapping, Formatting guidelines, Components of a report, Text of report.	
Assignment1: Define the problem of the proposal, learn the report types, and submit an assignment with all components of a report.	
<b>Unit-2 - Research Methodology</b>	
Defining the problem, Literature Review, Methodologies, and Findings Decision-Making Techniques, Collecting Appropriate Data, Analyzing Information and Interpreting Results, Effective Collaborative Writing, Problem-Solving Skills, Oral Report Assignments.	
Assignment 2: Do the survey on existing system of the proposal, Identify the data collections, and submit an assignment	
<b>Unit-3 - Communication</b>	
Communication Skills - Written Assignments, Oral Communication Activities: Class Discussions, Group Analysis of Problem Situations and Formal Oral Presentation, communication tools-Cloud-Based Collaboration Apps	
Assignment 3: Conduct an oral presentation to evaluate the communication skills	
<b>Unit-4 - Layouts</b>	
Technical knowledge: Logical sections, Cohesive subsections, Analyze and visual software packages, Data Storage and Retrieval, Layout and Proof-reading.	
Assignment 4: Find the technologies to implement the problem defined	
<b>Unit-5 - Documentation</b>	
Scope of the work, Literature review, computational details, Results and Discussions, Figures and Tables preparation, Conclusions and future works, Bibliography, Appendices. Uses of plagiarism detection tools.	
Case Study: Reports Writing for research proposals.	
Assignment 5: Submit the complete project report with all components	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>Phillip A. Laplante <i>Technical Writing: A Practical Guide for Engineers, Scientists, and Nontechnical Professionals</i>, Second Edition (What Every Engineer Should Know), July 2019</li> <li>Edith Cowan University. (n.d.). <i>Report writing: Academic tip sheet [Fact sheet]</i>. Retrieved from <a href="https://intranet.ecu.edu.au/data/assets/pdffile/0018/20628/reportwriting.pdf">https://intranet.ecu.edu.au/data/assets/pdffile/0018/20628/reportwriting.pdf</a></li> <li>McKeown, J. Newcastle Business School: <i>Postgraduate students manual 2016</i> (5th Ed.). Retrieved from GSBS6001 Blackboard course.</li> <li>Anne Winckel and Bonnie Hart "Report Writing Style Guide for Engineering Students" School of Natural and Built Environments, University of South Australia, July 2002.</li> <li><a href="https://canvas.bham.ac.uk/courses/11845/pages/what-is-a-report?module_item_id=355522">https://canvas.bham.ac.uk/courses/11845/pages/what-is-a-report?module_item_id=355522</a></li> </ol>
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<b>Learning Assessment</b>									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20%)			
		Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	15%	-	--	15%	-	15%	-	
Level 2	Understand	25%	-	-	20%	-	20%	-	
Level 3	Apply	30%	-	-	25%	-	25%	-	
Level 4	Analyze	30%	-	-	25%	-	25%	-	
Level 5	Evaluate	-	-	-	10%	-	10%	-	
Level 6	Create	-	-	-	5%	-	5%	-	
	Total	100 %		100 %		100 %		-	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Gowtham R, Senior Data Engineer, Mercedes Benz Research Development of India, <a href="mailto:gowtham.rajkodeesvaran@mercedes-benz.com">gowtham.rajkodeesvaran@mercedes-benz.com</a>	1. Dr. Sindia, AP, NIT – Trichy, <a href="mailto:sindhia@nitt.edu">sindhia@nitt.edu</a> 2. Dr. Vidhyavathi Prasath, AP, Government arts college for men, <a href="mailto:pravith_vidhu@yahoo.co.in">pravith_vidhu@yahoo.co.in</a>	1. Dr. Sudha Rajesh, SRMIST

# ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021



**SRM**

INSTITUTE OF SCIENCE & TECHNOLOGY

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**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

<b>Course Code</b>	21CSE271T	<b>Course Name</b>	PROGRAMMING IN JAVA	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Introduce the fundamental concepts and programming environment.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	Outline the Concepts of classes and IO streams																								
<b>CLR-3:</b>	Acquire Object oriented concepts like inheritance, reusability, and encapsulation																								
<b>CLR-4:</b>	Learn the custom exceptions and employ concurrency concepts																								
<b>CLR-5:</b>	Exploit the power of advanced data structures and basic GUI design.																								
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>																								
<b>CO-1:</b>	Summarize the knowledge of fundamentals of Java Programming												3	-	1	2	-	-	-	-	-	1	1	-	
<b>CO-2:</b>	Determine the type of constructor and class concepts used in OOPS based programming paradigms.												3	2	-	2	-	-	-	-	-	-	2	-	-
<b>CO-3:</b>	Articulate the different concepts involved in information hiding and reusability techniques.												3	2	1	-	-	-	-	-	-	-	3	2	-
<b>CO-4:</b>	Understand the different concepts of Exception Handling and Concurrency topics.												3	2	1	-	-	-	-	-	-	-	-	-	-
<b>CO-5:</b>	Acquire the integration of Collection Frameworks and GUI programming to product development.												3	2	-	1	-	-	-	-	-	-	1	-	-

#### **Unit-1 - Fundamentals of Java Technology and Programming** 9 Hour

Java platform features, Java technologies-JSR, JCP, Data types, Key words, and Scoping rules, Automatic Type Conversion, Type Casting and Arrays, Operators Precedence & Associativity, Expression, Flow control, enhanced for loop, switch statements, String handling

#### **Unit-2 - Classes, Objects and Streams** 9 Hour

Class fundamentals: Declaring objects, Assigning object reference variable, Methods & Method Signatures, Method with parameters, Variable arguments, I/O Basics: Byte stream& Character Stream, Getting user input: Reading console input & Writing console output, Reading and Writing files, Command Line arguments, Constructors and its Types, this keyword, Garbage Collector, finalize() method, Overloading methods and constructors, Using object as parameters, returning object in methods, recursion, Access control, static and final keyword, Nested and Inner classes.

#### **Unit-3 - Information Hiding & Reusability** 9 Hour

Inheritance basics, Using super, Method Overriding, Dynamic method dispatch, Abstract class, Using final with inheritance, Default Package, Path & Class Path Environment Variables, Package level access, Importing Packages, Interface: Multiple Inheritance, Extending interface, Wrapper Class, Auto Boxing.

#### **Unit-4 - Exception, Concurrency, Enumeration and Annotations** 9 Hour

Exception handling mechanism, try/catch mechanism, Thread class & Runnable Interface, Inter Thread Communication, Synchronization of threads using Synchronized keyword and lock method, Thread pool and Executors framework, Futures and callable, Fork-Join, Deadlock conditions, Enumeration, Annotations: basics of annotation.

#### **Unit-5 - Generics, Collections Framework and GUI Programming** 9 Hour

Generics: Basics, Collections Interfaces – Set, List, Queue, Collections Classes – Array List, Hash Set, Tree Set. Abstract Map, Hash Map, Tree Map, Introduction to GUI and its component basics

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>Herbert Schildt, "The Complete Reference (Fully updated for jdk7)", Oracle press Ninth Edition, 2014.</li> <li>Cay S. Horstmann, "Core Java Volume –I Fundamentals", Prentice Hall, 11th Edition, 2018.</li> <li>Deitel&amp;Deitel, "Java How to Program", Prentice Hall, 10th Edition, 2016.</li> <li>Herbert Schildt, "Java: A Beginner's Guide", Eighth Edition, Oracle Press, 2018.</li> <li><a href="https://docs.oracle.com/javase/tutorial">https://docs.oracle.com/javase/tutorial</a></li> <li>NPTEL Course: <a href="https://onlinecourses.nptel.ac.in/noc22_cs47/preview">https://onlinecourses.nptel.ac.in/noc22_cs47/preview</a></li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	35%	-	30%	-	30%	-		
Level 2	Understand	40%	-	40%	-	40%	-		
Level 3	Apply	25%	-	30%	-	30%	-		
Level 4	Analyze	-	-	-	-	-	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr.Jero Terrence, Assistant Consultant in Tata Consultancy Services, United Kingdom	1. Dr.R.Ganeshan, VIT Bhopal, Madhya Pradesh.	1. Dr.S.Amudha, SRMIST

Course Code	21CSE272T	Course Name	GENETIC ALGORITHM AND ITS APPLICATIONS	Course Category	E	PROFESSIONAL ELECTIVE	L 3	T 0	P 0	C 3
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Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards			Nil

Course Learning Rationale (CLR):		Program Outcomes (PO)											Program Specific outcomes										
CLR-1:	The purpose of learning this course is to:											PSO-1	PSO-2	PSO-3									
CLR-1:	Understand evolutionary computation and Genetic Algorithms	1	Problem Analysis	2	Design/development of solutions	3	Conduct investigations of complex problems	4	Modern Tool Usage	5	The engineer and society	6	Environment & Sustainability	7	Ethics	8	Individual & Team Work	9	Communication	10	Project Mgt. & Finance	11	Life Long Learning
CLR-2:	Learn terminologies and operators of GA	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
CLR-3:	Gain knowledge on advanced operators and techniques in GA and classification of Genetic Algorithms	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
CLR-4:	Acquire knowledge in Genetic Programming and Genetic Algorithm Optimization problems	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
CLR-5:	Build the applications of Genetic Algorithms	1	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		

Course Outcomes (CO):		At the end of this course, learners will be able to:											Engineering Knowledge	Program Specific outcomes	
CO-1:	Gain knowledge on the basics of evolutionary computing and genetic algorithms	1	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-2:	Acquire knowledge on the GA terminologies and operators	1	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-3:	Understand the advanced operators in Genetic Algorithm optimization problems	1	2	-	-	-	-	-	-	-	-	-	2	-	-
CO-4:	Apply the knowledge of Genetic algorithms using optimization problems on wireless networks	1	1	3	-	-	-	-	-	-	-	-	3	-	-
CO-5:	Design and develop the GA-based application in different engineering fields	1	2	3	-	-	-	-	-	-	-	-	1	-	-

**Unit-1 - Evolutionary Computation and Genetic Algorithms** 9 Hour  
 Introduction to genetic algorithms-The Historical Development of Evolutionary Computing, Genetic Algorithms and Genetic Programming, Features of Evolutionary Computation, Advantages of Evolutionary computation, Genetic Algorithms-Biological background. Cell, Chromosomes, Genetics, Reproduction, and Natural selection, Search space, GA world, Evolution and optimization, Evolution and genetic algorithms, Limitations of GA.

**Unit-2 - GA Terminologies and Operators** 9 Hour  
 Terminologies and operators of GA, Key elements, Individuals, Genes, Fitness, Populations, Data Structures, Breeding, Selection, Crossover, Mutation, and Replacement, Search Termination or Convergence criteria, Best individual, Worst individual, Sum of fitness and Medium fitness, Genetic algorithms working mechanism: Building block hypothesis, A Macro mutation hypothesis, An adaptive mutation hypothesis, The Schema theorem, Optimal allocation of Trials Implicit Parallelism, Advanced operators and techniques in GA, Convergence problems in GA

**Unit-3 - Advanced Operators and Techniques in Genetic Algorithm** 9 Hour  
 Introduction of advanced operators-Diploidy, Dominance and Abeyance, Multiploid, Inversion and Reordering, Order Crossover and Cycle crossover, Micro operators: Segregation and translocation, Duplications and Deletion, Sexual determination, non-binary representation, multi-objective optimization, combined optimization and Knowledge-based techniques, Classification of GAs. Simple Genetic algorithms (SGA). Parallel and distributed GAs, Master-slave, Fine-grained parallel GAs. Multiple-Deme Parallel GAs, Hierarchical Parallel algorithms. Hierarchical Genetic Algorithms: Crossover, Initialization heuristics, Remove sharp algorithms, Adaptive GA, Initialization, Evaluation function, Selection operators, Crossover operators, and mutation operators, Independent sampling GA and Breeding Phase, Niched pareto genetic algorithm.

**Unit-4 - Genetic Programming and Optimization Problems** 9 Hour  
 Introduction to Genetic programming, Comparison of GP, and other algorithms. Genetic operators, Tree-based GP, Representation of GP, Attributes in GP, Steps and Characteristics of GP, Applications of Genetic Programming, GA Optimization problems, Fuzzy optimization problems, Multi-objective Reliability Design Problem. Network and bicriteria reliability design, Combinatorial Optimization problems. Linear integer model, Applications of combinatorial optimization methods, Network design and Routing problems, planning of passive optical networks, Packet switched networks, Optimal topological design of all terminal networks

<b>Unit-5 - Applications of Genetic Algorithms</b>	<b>9 Hour</b>
Applications of Genetic Algorithms, GA in network synthesis, Control systems engineering and Fuzzy based speed control of Brushless DC motor, Feature Selection in Machine learning using GA, Designing texture filters with GA, GA based knowledge acquisition in Image Processing. Object localization in image using GA, Data mining applications such as feature selection in data mining, GA in intrusion detection, Applications in wireless networks for topology planning. GA application in ATM network, VLSI design applications, Genetic Layout optimization using GA, Introduction to Particle Swarm Optimization (PSO) and Ant Colony Optimization (ACO), Examples on PSO and ACO, Comparison of GA with PSO and ACO, Comparison of GA with PSO and ACO	

<b>Learning Resources</b>	1. S.N. Sivanandam and S.N. Deepa, "Introduction to Genetic Algorithms", Springer, 2nd edition (2008) 2. Mitsuo Gen and Runwei Cheng, "Genetic Algorithms and Engineering Optimization", John Wiley, Fourth edition (2010).	3. Michael Negnevitsky, "Artificial Intelligence, A Guide to Intelligent Systems", Second edition ((2005)) 4. David E.Goldberg , "Genetic Algorithms in search, Optimization & Machine Learning", Pearson Education,2001
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<b>Learning Assessment</b>						
Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1 <i>Remember</i>	40%	-	30%	-	20%	-
Level 2 <i>Understand</i>	40%	-	40%	-	40%	-
Level 3 <i>Apply</i>	20%	-	30%	-	40%	-
Level 4 <i>Analyze</i>	-	-	-	-	-	-
Level 5 <i>Evaluate</i>	-	-	-	-	-	-
Level 6 <i>Create</i>	-	-	-	-	-	-
Total	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. K. Selvaraj, Caterpillar, Bangalore	1. Dr. A.P. Shanthi, CSE, Anna University, Chennai	1. Dr.R. Athilakshmi, SRMIST

<b>Course Code</b>	21CSE291T	<b>Course Name</b>	INTRODUCTION TO COGNITIVE NEUROSCIENCE	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Outline the fundamental framework of brain and its function												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	Explain the importance of neurons and their interconnections																								
<b>CLR-3:</b>	Illustrate the geography of living brain																								
<b>CLR-4:</b>	Introduce the functional overview of learning and memory, thinking and problem solving																								
<b>CLR-5:</b>	Provide the insight of executing goals and social cognition																								
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Acquire knowledge on mind-brain science and working memory													1	2	-	-								
<b>CO-2:</b>	Understand the adaptation of neural arrays and coordinating neural sets													1	2	-	-								
<b>CO-3:</b>	Comprehend the usage of functional neuroimaging and the roles of brain regions													1	-	-	-	-	-	-	-	-	1	1	
<b>CO-4:</b>	Apply the varieties of memories and find ways to use existing knowledge													-	3	-	2	-	-	-	-	-	1	-	
<b>CO-5:</b>	Analyze and perceive the mental state of others													-	3	2	-	-	-	-	-	-	1	-	

**Unit-1 - Mind and Brain Frameworks** 9 Hour  
An invitation to mind-brain science - Distance: seven orders of magnitude - Time: ten orders of magnitude - The need to make inferences - going beyond the raw observations - The importance of convergent measures - The mind and the brain - Biology shapes cognition and Emotion - Cajal's neuron doctrine: the working assumption of brain science - Pierre-Paul Broca and the localization of speech production - The conscious and unconscious mind - The return of consciousness in the sciences - Classical working memory - Limited and large-capacity functions - The inner and outer senses - The central executive - Action - Consolidation of short-term events into long-term memory.

**Unit-2 - Neurons and their Interconnections** 9 Hour  
Real and idealized neurons - Excitation and inhibition - Neural computation - Working assumptions - Arrays and maps - Maps flow into other maps - Temporal codes: spiking patterns and brain rhythms - Choice-points in the flow of information - Top-down or expectation-driven processing - Hebbian learning - Neural Darwinism: survival of the fittest cells and synapses - Symbolic processing and neural nets - Coordinating neural nets - Functional redundancy.

**Unit-3 - Imaging the Living Brain** 9 Hour  
Imaging the living brain - Brain recording: more and less direct measurements - The time-space tradeoff - Measuring electric and magnetic signals - Functional neuroimaging: a bold new world - New ways to measure brain connectivity: diffusion tensor imaging - Conscious versus unconscious brain events - Correlation and causation.

**Unit-4 - Learning and Memory, Thinking and Problem solving****9 Hour**

Learning and memory - A functional overview - Implicit and explicit memory - Electrically evoked autobiographical memories - Long-term potentiation and long-term depression: excitatory and inhibitory memory traces - Consolidation: from temporary to permanent storage - Rapid consolidation: synaptic mechanisms, gene transcription, and protein synthesis - System consolidation: interaction between the medial temporal lobes and neocortex - Varieties of memory - MTL in explicit learning and memory - Prefrontal cortex, consciousness, and working memory - Retrieval and metacognition - Thinking and problem solving - Explicit problem solving - Mental workload and cortical activity - Using existing knowledge - Implicit thinking.

**Unit-5 - Goals, Executive control, action, and Social Cognition****9 Hour**

Goals, executive control, and action - Phylogeny and ontogeny - Function overview - Closer look at frontal lobes - Neuroimaging the executive brain - Frontal lobe dysfunction - A current view of organizing principles of the frontal lobes - Social cognition: Perceiving the mental states of others - An organizing framework for social cognition - Mirror neurons and intention detection.

<b>Learning Resources</b>	1. Cognition, Brain, and Consciousness: Introduction to Cognitive Neuroscience (2010), Bernard J. Bear, Nicole M. Gage, Academic Press (2010) 2. Quantum Models of Cognition and Decision, Jerome R. Busemeyer, Peter D. Bruza, Cambridge University Press (2014) 3. Cognitive Science. B M Bly & D E Rumelhart (Ed) (1999) the new cognitive neurosciences. M S Gazzaniga (ed) (2000)	4. Sternberg, Robert J., Cognitive Psychology, 4th ed., Cengage Learning India, 2008 5. MIND, An Introduction to Cognitive Science, Paul Thagard, MIT Press, 2 <sup>nd</sup> edition, 2005 6. Cognitive Science, Jay Freidenberg and Gordon Silverman, SAGE, 2016.
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**Learning Assessment**

Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	25%	-	25%
Level 2	Understand	40%	-	40%	-	40%
Level 3	Apply	20%	-	25%	-	25%
Level 4	Analyze	10%	-	10%	-	10%
Level 5	Evaluate	-	-	-	-	-
Level 6	Create	-	-	-	-	-
	Total	100 %		100 %		100 %

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.V.Anbarasan, Senior Engineer, Nielsen IQ India Pvt. Ltd.	1. Dr.K.Jayashree, Professor, Department of Artificial Intelligence and Data Science, Panimalar Engineering College, Chennai	1. Dr. R. Babu, SRMIST
2. Ms.A.Saranya, Application Development Team Lead, Accenture India		

<b>Course Code</b>	21CSE311P	<b>Course Name</b>	ROBOT PROGRAMMING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	The purpose of learning this course is to:												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-1:</b>	Introduce the fundamentals of robot programming.	1	2	3	4	5	6	7	8	9	10	11	12			
<b>CLR-2:</b>	Explain the fundamentals of Embedded programming.	2	2	-	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance			
<b>CLR-3:</b>	Acquire knowledge for selection and calibration of sensors, actuator and how to interface with Robot.	-	2	-	3	-	-	-	-	-	-	-	-	1	-	-
<b>CLR-4:</b>	Understand the Robot operating system fundamentals.	-	2	-	3	-	-	-	-	-	-	-	-	2	-	-
<b>CLR-5:</b>	Understand the integration of Hardware controllers with ROS.	-	-	-	3	-	-	-	-	-	-	-	-	3	-	3

<b>Unit-1 - Robot Fundamentals</b>	<b>9 Hour</b>
Basic of Robots – Anatomy - Links and joints - Basic terminology- Accuracy, Repeatability, Resolution, Degree of freedom - Robot Movement: Pitch, Roll, Yaw - Mechanisms and transmission - Work volume - End effectors.	
Tutorial:	
1. Study the anatomy of Robot and create a Robot structure for pick and place operation. 2. Problems on Degrees of Freedom, understanding robot work space and movement.	
<b>Unit-2 - Embedded Programming</b>	<b>9 Hour</b>
Basic Embedded File system – hex files - Simulators and Emulators - Integrated development environments - commonly used IDE. Basics of Embedded C for Robot Programming – Python for Robot Programming - Program structure, data types, control structure.	
Practice:	
1. Understanding file system and using IDE. 2. Create a Embedded C program for I/O operation.	
<b>Unit-3 - Robot Programming Interface</b>	<b>9 Hour</b>
Sensor- Principle of sensors - Analog signal - Digital signal - I/O of Sensors – Calibration of sensors – Interfacing -Serial - I2C. Actuator – Types – I/O of Actuator, Direct control, and speed control, PWM, analog control. Programming and interfacing of sensors. Programming and interfacing of actuators.	
Practice:	
1. Interfacing of sensor and calibration. 2. Interfacing of motor and control of motors.	

**Unit-4 - Robot Operating System:****9 Hour**

ROS Basics- Sensors and Robots Supporting ROS - ROS Architecture and Concepts - ROS File system - ROS Computation Graph Level, ROS Community Level - Creating ROS Workspace and Package, Using ROS Client Libraries, Programming Embedded Board using ROS - Interfacing Arduino with ROS, ROS on a Raspberry Pi.

Practice:

1. Serial and I2C communication.
2. Programming with Raspberry Pi.

**Unit-5 - Building the Robots:****9 Hour**

Introduction to Wheeled Robot - Building Robot Hardware - Block Diagram and Assembling Robot Hardware - Programming Robot Firmware - path planning. Case study: Tetrix – NAO – Ned Niryo – Auto Auto.

Practice:

1. Programs of Tetrix and NAO.
2. Programs on Ned Niryo and Auto Auto.

<b>Learning Resources</b>	1. Mikell P. Groover, "Industrial Robotics", McGraw Hill, 2nd edition, 2012 2. Lentin Joseph, Robot Operating System (ROS) for Absolute Beginners: Robotics Programming Made Easy, 1st Edition, APress, 2018. 3. Mark Siegesmund, "Embedded C Programming Techniques and Applications of C and PIC® MCUS", Newnes, 2014 4. Jonathan Cacace; Lentin Joseph, Mastering ROS for Robotics Programming: Design, build, and simulate complex robots using the Robot Operating System, 2nd Edition, Packt Publishing, 2018. 5. John J. Craig, "Introduction to Robotics", 3rd Edition, Addison Wesley, ISE 2008. 6. Jacob Fraden, "Handbook of Modern Sensors", Springer 2016 7. W. Bolton, "Mechatronics", Pearson, 2018						
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**Learning Assessment**

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	--	15%	-	15%	-	-
Level 2	Understand	25%	-	-	20%	-	20%	-	-
Level 3	Apply	30%	-	-	25%	-	25%	-	-
Level 4	Analyze	30%	-	-	25%	-	25%	-	-
Level 5	Evaluate	-	-	-	10%	-	10%	-	-
Level 6	Create	-	-	-	5%	-	5%	-	-
	Total	100 %		100 %		100 %		-	

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Rijo Jackson Tom Lead Data Scientist Augusta hitech soft solution	1. Dr. Thiagarajan R Assistant Professor, Department of Mechanical Engineering, Indian Institute of Technology Tirupati	1. Dr.J.J. Jayakanth, SRMIST

<b>Course Code</b>	21CSE312P	<b>Course Name</b>	SOFTWARE ENGINEERING IN ARTIFICIAL INTELLIGENCE	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>					
<b>CLR-1:</b>	The purpose of learning this course is to:												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>				
<b>CLR-1:</b>	Learn the different GPU Components	1	Problem Analysis	2	Design/development of solutions	3	Conduct investigations of complex problems	4	Modern Tool Usage	5	The engineer and society	6	Environment & Sustainability	7	Ethics	8	Individual & Team Work		
<b>CLR-2:</b>	Know how to access NGC Containers and docker images	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
<b>CLR-3:</b>	Utilize the Pytorch and Jupyter notebook	-	2	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-	
<b>CLR-4:</b>	Learn the CUDA ecosystem	-	3	3	-	-	-	-	-	-	-	-	-	-	-	-	2	3	
<b>CLR-5:</b>	Explore the DL deployments	-	3	3	-	3	-	-	-	-	-	-	-	-	-	-	-	3	
<b>Course Outcomes (CO):</b>	At the end of this course, learners will be able to:	-	2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	
<b>CO-1:</b>	Distinguish the different components in GPU systems	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<b>CO-2:</b>	Create environments to work with different NGC container packages	-	2	3	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
<b>CO-3:</b>	Implement codes using Jupyter notebook and PyTorch	-	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-
<b>CO-4:</b>	Develop and work with CUDA	-	3	3	-	3	-	-	-	-	-	-	-	-	-	-	-	-	3
<b>CO-5:</b>	Visualize different DL deployments for various scientific applications	-	2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-

#### **Unit-1 - Introduction to System Software Engineering** 9 Hour

System S/W Platforms: Virtualization, Containerization- Introduction to NVIDIA NGC Cloud, DockerHub

T1: Accessing DGX A100

T2: Working with DOCKER Images and NGC Container

T3: Installation and Pulling Specific NGC Packages

#### **Unit-2 - Scheduling and Resource Management** 9 Hour

Introduction to Schedulers/Orchestration Tools - Fundamentals of Ansible/Kubernetes/KubeFlow/SLURM

T4: Implementing and executing Kubernetes

T5: Working with Ansible

T6: Demo Executions on Kubeflow/SLURM

#### **Unit-3 - Introduction to IDE / Exploratory Programming** 9 Hour

Introduction to various IDE like VSCode/PyCharm/Others-Introduction to Jupyter-Ecosystem for Exploratory Programming- Features of Jupyter-Ecosystem for building Python Packages/Scientific Manuscript

T7: Working with VSCode/ PyCharm

T8: Using Jupyter Note and PyTorch

T9: Run a simple data centric application using Jupyter Note.

#### **Unit-4 - System Software for Accelerated Computing** 9 Hour

ML/DL/DS/HPC Workloads-Overview of CUDA Platform: GPGPU Computing Platform - Overview of CUDA-X Platform: cuBLAS/cuDNN/cuTensor [Compute]- Framework for Differential Computation

T10: Testing the GPGPU Computing T11: Testing and working with Tensor (CUDA-X) T12: Implementing Mixed Precision and Quantization Aware training	<b>Unit-5 – GPU Programming</b>	<b>9 Hour</b>
Distributed Computing Software Stack-Multi-GPU/Multi-Node: [MPI/NCCL/RDMA] Horovod- Accelerating DL Deployments- MLOps: Hands-on		
T13: Accelerating Neural Network Inference: TensorRT & Triton Inference Server		
T14: Monitoring load Balancers & Schedulers		
T15: Deployment of various services for monitoring, jupyter environment and other services.		

<b>Learning Resources</b>	1. Ekman, M., 2021. <i>Learning Deep Learning: Theory and Practice of Neural Networks, Computer Vision, NLP, and Transformers Using TensorFlow</i> . Addison-Wesley Professional. 2. Sanders, J. and Kandrot, E., 2010. <i>CUDA by example: an introduction to general-purpose GPU programming</i> . Addison-Wesley Professional.	3. Christopher Love, Jay Vyas, Core Kubernetes, 2022 4. Chollet, F., 2021. <i>Deep learning with Python</i> . Simon and Schuster.
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<b>Learning Assessment</b>									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	15%	-	--	15%	-	15%	-	
Level 2	Understand	25%	-	-	20%	-	20%	-	
Level 3	Apply	30%	-	-	25%	-	25%	-	
Level 4	Analyze	30%	-	-	25%	-	25%	-	
Level 5	Evaluate	-	-	-	10%	-	10%	-	
Level 6	Create	-	-	-	5%	-	5%	-	
	Total	100 %		100 %		100 %		-	

<b>Course Designers</b>		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. A.G.Rangaraj,Deputy Director (Technical),R&D, RDAF and SRRA Division, National Institute of Wind Energy (NIWE)	1. Dr.I.Joe Louis Paul, Associate Professor, SSN College of Engineering	1. Dr.Kottilingam K

<b>Course Code</b>	21CSE313P	<b>Course Name</b>	ACCELERATED DATA SCIENCE	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>			
<b>CLR-1:</b>	The purpose of learning this course is to:												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>		
<b>CLR-1:</b>	Learn the different GPU Components	1	Problem Analysis	2	Design/development of solutions	3	Conduct investigations of complex problems	4	Modern Tool Usage	5	The engineer and society	6	Environment & Sustainability	7	Ethics	8	Individual & Team Work
<b>CLR-2:</b>	Know to work with GPUs for Accelerated Data Sciences	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
<b>CLR-3:</b>	Utilize CUDA and RAPIDS for Accelerated Data Science and Array Computing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
<b>CLR-4:</b>	Learn and work with Data Wrangling and Machine learning	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
<b>CLR-5:</b>	Explore the cuSignal worklets	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
<b>Course Outcomes (CO):</b>	At the end of this course, learners will be able to:	Engineering Knowledge	1	2	3	4	5	6	7	8	9	10	11	12			
<b>CO-1:</b>	Distinguish the different components in GPU systems	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>CO-2:</b>	Create environments to work with different packages for data science environments	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2
<b>CO-3:</b>	Implement codes using CUDA and RAPIDS for Data Science and Array Computing	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	2
<b>CO-4:</b>	Develop and work with cuML and RAPIDS Memory manager	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	2
<b>CO-5:</b>	Working with cuSignal	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	2

<b>Unit-1 - Introduction to GPU Systems</b>	<b>9 Hour</b>
Introduction to GPU and DGX A100, Accessing DGX A100, Working DOCKER Images and NGC Container, Installation and Pulling Specific NGC Packages	
<b>Unit-2 - GPUs for Data Sciences</b>	<b>9 Hour</b>
Introduction to Data Science Packages in Python Ecosystem: NumPy, Pandas, Scikit-Learn, SciPy, NetworkX- Overview of Jupyter Environment, GPU Accelerated Data Science Workflow with RAPIDS, Data Preparation- NVTABULAR, ETL for RecSys-Model Training and XGBoost: Distributed XGBoost with DASK Visualization- cuXFilter	
<b>Unit-3 – CUDA and RAPIDS</b>	
Accelerated Data Science and Array Computing, CUDA and GP-GPU Computing, RAPIDS: GPU Accelerated Data Science Python Ecosystem, CuPy, cuDF, cuML, cuSignal,cuGraph, Deep-Dive: CuPy & Numba for accelerated Array Computation- Dask: Distributed Array Processing Scheduler, Multi-GPU training	
<b>Unit-4 - Accelerated Data Wrangling and Machine Learning</b>	
GPU Accelerated Data Wrangling using cuDF- RAPIDS Memory Manager & NVTabular, Hands-on practical labs on cuDF with practical problem statement & benchmarking, GPU Accelerated Machine Learning using cuML -Hands-on practical on cuDF + cuML on a practical problem statement & benchmarking	
<b>Unit-5 - Accelerated Signal Processing</b>	
GPU Accelerated Signal Processing using cuSignal, Hands-on practical on cuSignal, Hands-on practical on cuSignal + Dask on a practical problem statement & benchmarking	

<b>Learning Resources</b>	1. Goodfellow, I., Bengio, Y. and Courville, A., 2017. Deep learning (adaptive computation and machine learning series). Cambridge Massachusetts, pp.321-359. 2. Ng, A., 2017. Machine learning yearning. URL: <a href="http://www.mlyarning.Org/">http://www.mlyarning.Org/</a> (96), 139.	3. Christopher Love, Jay Vyas, Core Kubernetes, 2022 4. Chollet, F., 2021. Deep learning with Python. Simon and Schuster.
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Learning Assessment		Continuous Learning Assessment (CLA)						Final Examination (0% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20% weightage)					
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	--	15%	-	15%	-	-		
Level 2	Understand	25%	-	-	20%	-	20%	-	-		
Level 3	Apply	30%	-	-	25%	-	25%	-	-		
Level 4	Analyze	30%	-	--	25%	-	25%	-	-		
Level 5	Evaluate	-	-	-	10%	-	10%	-	-		
Level 6	Create	-	-	-	5%	-	5%	-	-		
	Total	100 %		100 %		100 %		-			

#### Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Thamaraiselvam S, Zoho Corporation Private Limited, Estancia IT Park, Guduvancherry, Tamil Nadu-603202	1. T. Sudhakar Associate professor School of computer science and engineering VIT-AP University	1. Dr. K. Kottilingam SRMIST 2. Dr.N. Arivazhagan, SRMIST

<b>Course Code</b>	21CSE323T	<b>Course Name</b>	MARKETING ANALYTICS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>								
<b>CLR-1:</b>	The purpose of learning this course is to:												<b>PSC-1</b>	<b>PSC-2</b>	<b>PSC-3</b>							
<b>CLR-1:</b>	Learn to build brand architecture on brand value	1	Problem Analysis	2	Design/development of solutions	3	Conduct investigations of complex problems	4	Modern Tool Usage	5	The engineer and society	6	Environment & Sustainability	7	Ethics	8	Individual & Team Work					
<b>CLR-2:</b>	Know to create functions to access and manipulate numbers, strings and date time data	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	3	-	-	1	-	-
<b>CLR-3:</b>	Know the emphasis on scaling for brands	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	3	-	-	2	-	-
<b>CLR-4:</b>	Utilize the information for strategic marketing alternatives	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	2	-	-
<b>CLR-5:</b>	Explore the experiments for digital marketing efforts	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>	9	Communication	10	Project Mgt. & Finance	11	Life Long Learning	12														
<b>CO-1:</b>	analyse user Generated Contents	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	3	-	-	1	-	-
<b>CO-2:</b>	analyse the digital products	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	3	-	-	2	-	-
<b>CO-3:</b>	understand customer Lifetime Value	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
<b>CO-4:</b>	analyse the marketing with ML models	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	2	-	-
<b>CO-5:</b>	communicate with digital analytics	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-

<b>Unit-1 - User Generated Contents</b>	<b>9 Hour</b>
Marketing Analytics, Data for Marketing Analytics, Business Intelligence, Analytics, and Data Science, Analysis, Exploratory Data Analysis, Descriptive Analysis, Predictive Analytics, Prescriptive Analytics, Benefits of Customer Analytics, Factors Essential for Obtaining Benefits from Customer Analytics, Segmentation Analytics, Cluster Analysis.	
T1: Data for Marketing Analytics	
T2: Predictive Analysis	
T3: Segmentation and cluster analysis	
<b>Unit-2 - Product Analysis</b>	<b>9 Hour</b>
Product Analytics, Perceptual Mapping, White Spaces, Umbrella Brands, Multidimensional Scaling, Analyzing Digital Products, Analyzing Non-Digital Products,	
T4: Product analysis	
T5: Multimodel scaling	
T5: Digital and Non - digital Products	
<b>Unit-3 - Customer Lifetime Value</b>	<b>9 Hour</b>
Customer Lifetime Value (CLV), Calculating CLV, Understanding the CLV Formula, Applying the CLV Formula, Extending the CLV Formula, Using CLV to Make Decisions, A Forward-Looking Measure.	
T7: Customer Lifetime Value (CLV)	
T5: Applying the CLV Formula,	
T6: Using CLV to Make Decisions	
<b>Unit-4 - Market Analysis</b>	<b>9 Hour</b>

*Market Mix Modeling, Variables in Market Mix Modeling, Techniques of Market Mix Modeling, Metrics for Tracking Customer Experience, Upgrading Customers: Use Case of Upselling, Logistic Regression Analysis, Use of Logistic Regression as a Classification Technique*

T10: Regression Analysis

T11: Multivariable Regressions

T12: Marketing Mix Models

#### **Unit-5 - Digital Analytics**

**9 Hour**

*Search Engine Marketing, Search Engine Optimization, Social Media Analytics, App Marketing Metrics, Importance of AI in Marketing, Random Forests, Model Evaluation Using ROC, AUC, and Confusion Matrix, Simple Feed-Forward Network, Deep Neural Network, Recommendation Systems, Necessity of Data Visualization, Visualizations Useful with Common Data Science Techniques*

T13: Search Engine Marketing

T14: AI in Marketing

T15: Data Visualization Techniques

<b>Learning Resources</b>	1. Seema Gupta, Avadhoot Jathar, "Marketing Analytics", ISBN: 9789354242625 2. Brea Cesar (2014), "Marketing and Sales Analytics: Proven Techniques and Powerful Applications from Industry Leaders", FT Press, ISBN-0133761711 3. Emmett Cox (2012), "Retail Analytics: The Secret Weapon", Wiley, ISBN- 978-1-118-09984-1	4. Fok Dennis (2003), "Advanced Econometric Marketing Models", ERIM, ISBN 90-5892-049-6 5. Mireles Carlos Hernández (2010), "Marketing Modeling for New Products", ERIM, ISBN 978-90-5892-237-3 6. Rackley Jerry (2015), "Marketing Analytics Roadmap: Methods, Metrics, and Tools", Apress, ISBN-1484202597
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	40%	-	20%	-	40%	-		
Level 2	Understand	40%	-	20%	-	40%	-		
Level 3	Apply	10%	-	20%	-	10%	-		
Level 4	Analyze	10%	-	20%	-	10%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	10%	-	-	-		
	Total	100 %		100 %		100 %			

#### **Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.K.Jafar Ali MBA, Ph.D. Consultant, iSpark Learning Solutions, Chennai.	1. Angeline Gautami Fernando, Associate Professor (Marketing & Analytics) at Great Lakes Institute of Management	1. Dr. R. Rajkumar, SRMIST

<b>Course Code</b>	21CSE326T	<b>Course Name</b>	ARTIFICIAL NEURAL NETWORKS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the biological background and basic concepts of neural networks												<b>PSO-1</b>			
<b>CLR-2:</b>	Gain knowledge about perceptron and back propagation												<b>PSO-2</b>			
<b>CLR-3:</b>	Know about various training rules and error minimization												<b>PSO-3</b>			
<b>CLR-4:</b>	Learn the concepts of unsupervised neural networks															
<b>CLR-5:</b>	Explore the fine-tuning procedures and case studies for designing neural network models															
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Explain the basic concepts of neural networks															
<b>CO-2:</b>	Describe perceptron and back propagation															
<b>CO-3:</b>	Apply various training rules in neural networks															
<b>CO-4:</b>	Explain unsupervised neural networks															
<b>CO-5:</b>	Fine tune the neural networks															

<b>Unit-1 - Introduction to Neural Networks</b>																
<b>9 Hour</b>																
History of neural network research- Biological inspiration: Neural computation, Models of computation, Elements of computing models- Network of neurons: structure, Information processing at neurons and synapses, Information storage, Neurons as self-organizing systems- Artificial Neural Networks: Network of primitive functions, approximation of functions- Neuron Model: Single and multiple input neurons, Transfer functions- Network architectures: Single layered and multi layered neurons, Recurrent Networks																
Tutorials:																
1. Implement various neural network architectures 2. Implement and study the effect of various activation functions																
<b>Unit-2 - Perceptron</b>																
<b>9 Hour</b>																
Introduction to Perceptron- Perceptron Architecture: Single Neuron Perceptron, Multi Neuron Perceptron- Perceptron learning rule: Constructing Learning rules, Unified Learning rule, Training multi neuron perceptron- Complexity of perceptron learning-Computational Limits of Perception-Linearity separable functions- Learning XOR-Feed forward Networks- Back propagation: Chain of rule Calculus, Back-Propagation Computation in Fully-Connected Multi-layer Perceptron																
Tutorials:																
1. Implement Feed forward networks 2. Implement back propagation																

<b>Unit-3 - Learning and Training</b>	<b>9 Hour</b>
Paradigms of Learning - Using training samples - Gradient Optimization Procedure- Batch Gradient Descent, Stochastic Gradient Descent, Mini-Batch Gradient Descent - Hebbian learning rule – Delta learning rule- Convergence and local minima, representational power of feed forward networks, hypothesis search space and inductive bias, generalization, overfitting and stopping criterion-Error functions, Error minimizing procedures-Hebbian learning	
Tutorials:	
5. Implementation of gradient descent 6. Implementation of delta learning rule	
<b>Unit-4 - Unsupervised Neural Networks</b>	<b>9 Hour</b>
Unsupervised learning in neural networks: Hebbian learning rule, Principle Component Learning, Learning Vector Quantizer-I- Self Organizing Maps: Functionality, Training, Topology Function, Decreasing Learning Rate, Variations of SOMs, Neural gas, Multi-SOM, Multi-neural gas, Growing neural gas- Adaptive Resonance Theory, Orienting subsystems, Learning Laws	
7. Implementation of Principle Component analysis 8. Implementation of Self Organizing Maps	
<b>Unit-5 - Tuning the Neural Networks</b>	<b>9 Hour</b>
Pretraining the model: Data selection, Preprocessing, Selection of network architecture- Training the network: Initializing weights, Choice of training algorithm, stopping criteria, Choice Of performance function, Committees of Networks-Post Training Analysis: Fitting, Pattern Recognition, Clustering- Time delay and Recurrent Neural Networks-Case Studies: Smart Sensor system with function approximation- Myocardial Infarction Recognition using pattern recognition-Forest cover problem using Clustering	
<b>Learning Resources</b>	1. Martin T. Hagan, Neural Network Design, 2nd edition. 2. Tom M. Mitchell, Machine Learning, McGraw-Hill Education (India) Private Limited. 3. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT Press, 2016 4. Andries P., Computational Intelligence: An Introduction, Second Edition, Wiley, 2007 5. David Kriesel, A Brief Introduction to Neural Networks, 2009

<b>Learning Assessment</b>		<b>Continuous Learning Assessment (CLA)</b>				<b>Summative Final Examination (40% weightage)</b>	
<b>Bloom's Level of Thinking</b>	<b>Formative CLA-1 Average of unit test (50%)</b>	<b>Life-Long Learning</b>					
		<b>Theory</b>	<b>Practice</b>	<b>CLA-2 (10%)</b>			
Level 1	Remember	20%	-	20%	-	20%	
Level 2	Understand	20%	-	20%	-	20%	
Level 3	Apply	30%	-	30%	-	30%	
Level 4	Analyze	30%	-	30%	-	30%	
Level 5	Evaluate	-	-	-	-	-	
Level 6	Create	-	-	-	-	-	
	Total	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
		1. Dr. Sharanya, SRMIST

<b>Course Code</b>	21CSE371T	<b>Course Name</b>	ADVANCED ALGORITHMS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>				
<b>CLR-1:</b>	The purpose of learning this course is to:												<b>PSC-1</b>	<b>PSC-2</b>	<b>PSC-3</b>			
<b>CLR-1:</b>	Interpret the recurrence relations for analyzing the algorithms	1	Problem Analysis	2	Design/development of solutions	3	Conduct investigations of complex problems	4	Modern Tool Usage	5	The engineer and society	6	Environment & Sustainability	7	Ethics	8	Individual & Team Work	
<b>CLR-2:</b>	Classify various algorithmic techniques for appropriate applications and problems	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	
<b>CLR-3:</b>	Evaluate the worst-case, average-case, and best-case analysis of various algorithms	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
<b>CLR-4:</b>	Illustrate string matching algorithms	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	2	
<b>CLR-5:</b>	Understand the purpose of different randomized, approximation and Geometric Algorithms	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	1	
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>	<b>CO-1:</b>	Analyze the performance of algorithms	-	2	-	-	-	-	-	-	-	-	-	-	-	-	2
<b>CO-2:</b>	Choose appropriate data structures and algorithm design methods for a specified application.	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
<b>CO-3:</b>	Assess the case analysis of various algorithms	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	2
<b>CO-4:</b>	Infer the performance of string-matching algorithms	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	1	1
<b>CO-5:</b>	Compare and contrast various randomized, approximation and Geometric Algorithms	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2

#### **Unit-1 - Introduction to Algorithm Analysis** 9 Hour

Role of algorithms in computation, Notation order, Recurrences, Probabilistic Analysis, Statistics of Sorting, and its order notations: Heap Sort and Quick Sort in Linear time and space, Dynamic Programming: Matrix Chain Multiplication, Operations on Polynomials, DFT & FFT Algorithms, longest common Subsequence, and optimal binary Search trees

#### **Unit-2 - Graph Algorithms and Network Flow** 9 Hour

Greedy Algorithms - Huffman Codes, Activity Selection Problem, Amortized Analysis. Graph Algorithms - Topological Sorting, Minimum Spanning trees, Single Source Shortest Paths, Maximum Flow algorithms, Augmenting Paths, and Push-Relabel Methods. Network Flow – Ford-Fulkerson Algorithm, Push-relabel algorithm, Maximum bipartite matching, and Hopcroft-Karp algorithm. Parallel Algorithms – PRAM, Pointer Jumping and Parallel Prefix, Tree Contraction, Randomized Symmetry Breaking, Maximal Independent Set. Case Study: Finding the shortest path between two cities using Travelling salesperson problem

#### **Unit-3 - Sorting Networks and Matrix Operations** 9 Hour

Sorting Networks: Comparison Networks, Zero-one principle, Bitonic Sorting Networks, Merging Network, Sorting Network. Matrix Operations- Strassen's Matrix Multiplication, inverting matrices, Solving system of linear Equations

#### **Unit-4 - String Matching & Randomized Algorithms** 9 Hour

String Matching - Naive String Matching, Rabin-Karp algorithm, Matching with finite Automata, Knuth- Morris - Pratt algorithm, Suffix Trees. Randomized Algorithms – Mathematical Background, Introduction and analysis, Monte Carlo Algorithms, Las Vegas Algorithms, Atlantic City Algorithms, Computational Complexity

#### **Unit-5 - Approximation Algorithms and Linear Programming** 9 Hour

Polynomial time, polynomial time verification, NP-Completeness and reducibility, NP-Complete problems. Approximation Algorithms- Vertex cover Problem, Travelling Sales person problem, Set Vector and Subset Sum. Geometric Algorithms – Preliminaries, Convex Hull, Segment Intersection, Closest Pair, Voronoi-Delaunay diagrams, Flip algorithm. Linear Programming – Framework, Formulation of Problems as Linear Programs. Duality. Simplex, Interior Point, and Ellipsoid Algorithms. Case Study : Types of algorithms used for finding convex hull for any given area

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. <i>Introduction to Algorithms</i>, T. H. Cormen, C.E. Leiserson, R. L. Rivest, and C. Stein, Third Edition, PHI.</li> <li>2. <i>Fundamentals of Computer Algorithms</i>, Ellis Horowitz, Satraj Sahni and Rajasekharam, Galgotia publications pvt. Ltd</li> <li>3. <i>Design and Analysis Algorithms</i> - Parag Himanshu Dave, Himanshu Bhalchandra Dave Publisher: Pearson</li> <li>4. <i>Algorithm Design: Foundations, Analysis and Internet examples</i>, M.T. Goodrich and R. Tomassia, John Wiley and sons</li> <li>5. <i>Data structures and Algorithm Analysis in C++</i>, Allen Weiss, Second edition, Pearson education.</li> <li>6. Cormen, Leiserson, Rivest, and Stein. <i>Introduction to Algorithms</i>. 2nd ed. Cambridge, MA: MIT Press, 2001. ISBN: 0262032937.</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>			
	<i>Bloom's Level of Thinking</i>	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	20%	-	10%	-	20%	-		
Level 2	Understand	20%	-	10%	-	20%	-		
Level 3	Apply	30%	-	40%	-	30%	-		
Level 4	Analyze	30%	-	40%	-	30%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Dr. Bragadeesh SA, Associate Analyst, Infosys PvT Limited	1. Mr. Mani Deepak, PGP College of Engineering, Coimbatore	1. Mrs. Akshya J, SRMIST

<b>Course Code</b>	21CSE375T	<b>Course Name</b>	COMPUTATIONAL NEUROSCIENCE	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 3	T 0	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3		
CLR-1:	Know What happens in your brain when you make a decision															
CLR-2:	Gain knowledge mathematical and computational models that are used in the field of theoretical neuroscience															
CLR-3:	Understand basics of adaptively and learning,															
CLR-4:	Acquire knowledge on Basic models of cognitive processing and neuro models.															
CLR-5:	Acquire knowledge on various computational algorithm															
<b>Course Outcomes (CO):</b>		<b>At the end of this course, learners will be able to:</b>														
CO-1:	Describe the design Models of single neurons, and small networks															
CO-2:	Illustrate Implementation of all simple as well as more complex numerical computations with few neurons.															
CO-3:	Analyse connected networks in the mean-field limit															
CO-4:	Formalize biological facts into mathematical models															
CO-5:	Understand a simple mathematical model of memory formation in the brain															

#### **Unit-1 - Introduction to Computational Neuroscience** 9 Hour

History of Computational Neuroscience- Models in Computational Neuroscience - Intro- Neuron - axons, dendrites etc, the four components of Neural Signalling Neuro transmission: neuro transmitter, reception channel, Electrophysiology -Nernst potential, resting potential, Goldman- Hodgkin-Katz voltage equation, outline of the Hodgkin- Huxley model. Modelling channel kinetics, activation, and inactivation gates Complete formulation of Hodgkin- Huxley model.

#### **Unit-2 - Components of Neural Signalling** 9 Hour

Four components of Neural Signalling -Neurotransmission -Population dynamics -Modelling the average behaviour of neurons- Modelling the average behaviour of neurons - Huxley Model -Spiking neuron models Single Spiking neuron models - Detailed Spiking neuron models – 2D Model Integrate and firing model -Leaky integrate-and-fire model - Integrate and firing model -Nonlinear integrate-and-fire model - Integrate and firing model -

#### **Unit-3 - Artificial Neural Network to Realistic** 9 Hour

Introduction Modelling the ventral stream Modelling the dorsal and auditory stream Mechanical behaviour of ceramics-flexural strength -The Perceptron. Mapping function Multi-layer Perceptron Back-propagation – Intuition, Derivation Back-propagation -Loss Function Back-propagation – Limitation Support Vector Machines - Classification Support Vector Machines - Regression Support Vector Machines – Kernel Function Self-Organizing Maps - Introduction Self-organizing Maps - Variable Self-organizing Maps - Algorithm Self-organizing Maps – SOM Initialization Self-organizing Maps

Case studies: Regression Support Vector Machines, Koronen Algorithm

**Unit-4 - Memory Classification** 9 Hour

Memory Classification Scheme – Declarative, Non-declarative Auto-associative network and hippocampus - Learning and retrieval phase Point-attractor neural networks - Network dynamics and training Signal-to-noise analysis - Noisy weights and diluted attractor networks- Asymmetrical networks Non-monotonic networks Complementary memory systems Distributed model of working memory- Limited capacity of working memory The spurious synchronization hypothesis The interacting-reverberating-memory hypothesis Motor Learning and Control Feedback controller Forward and inverse model controller The cerebellum and motor control

**Unit-5 - Different Learning Methods** 9 Hour

Hebbian Learning-Hebbian- versus Perceptron Learning- Gradient Descent Learning-Stabilizing Hebbian Learning-Variations of Hebbian Learning Nonlinear Hebbian learning -Linker's Model of the Visual System - Lateral Geniculate Nucleus -Striate Cortex Linker's model for orientation columns - Reinforcement Learning -Elements of Reinforcement Learning -Markov decision process-Dynamic programming algorithms for solving MDPs - Algorithms for large state spaces. Case studies: Gradient temporal difference learning, Reinforcement Learning,

<b>Learning Resources</b>	1. Thomas Trappenberg, "Fundamentals of Computational Neuroscience" Oxford University Press, January 2010 2. Peter Dayan & LF Abbott, "Theoretical Neuroscience: Computational and Mathematical Modelling of Neural Systems", MIT Press, 2005	3. Richard S. Sutton and Andrew G. Barto, "Reinforcement Learning an Introduction", 2nd Edition, The MIT Press, 2018
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Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	40%	-	40%	-	40%	-		
Level 2	Understand	40%	-	40%	-	40%	-		
Level 3	Apply	20%	-	20%	-	20%	-		
Level 4	Analyze	-	-	-	-	-	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. P S Saravanan, Associate Consultant, CTS, USA	1. Dr.A Balaji , Senior Assistant Professor at VIT Bhopal University, 2. Prof.K Somasundram, Department of Computer Science and Engineering, Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences,	1. Dr. K Suresh, SRMIST 2. Dr. R.Siva, SRMIST

<b>Course Code</b>	21CSE376T	<b>Course Name</b>	NATURE INSPIRED COMPUTING TECHNIQUES	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>			
<b>CLR-1:</b>	The purpose of learning this course is to:												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>		
<b>CLR-1:</b>	Analyze concepts of Natural systems and its applications	1	Problem Analysis	2	Design/development of solutions	3	Conduct investigations of complex problems	4	Modern Tool Usage	5	The engineer and society	6	Environment & Sustainability	7	Ethics	8	Individual & Team Work
<b>CLR-2:</b>	Study new basic natural systems functions(operations)	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
<b>CLR-3:</b>	Introduce fundamentals of nature inspired techniques which influence computing	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
<b>CLR-4:</b>	Integrate Hardware and software in Natural applications	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
<b>CLR-5:</b>	Understand natural design considerations	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3

**Course Outcomes (CO):** At the end of this course, learners will be able to:

<b>CO-1:</b>	Illustrate the basic concepts of Swarm Intelligence processes	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	1
<b>CO-2:</b>	Examine the principle of Immune computing techniques	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	1
<b>CO-3:</b>	Manage the scope changes of nature inspired techniques which influence computing	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2
<b>CO-4:</b>	Identify optimization Techniques to provide functionality and value	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2
<b>CO-5:</b>	Understand the needs and familiarize the DNA Computing	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	3

**Unit-1 - Introduction**

**9 Hour**

Introduction, Overview of Philosophy, Nature to Nature Computing, A Brief Overview of Three Branches, Computing Inspired by nature, Simulation and Emulation of Nature in Computers, Computing with Natural Materials, Nature Inspired Computing Approaches.

**Unit-2 - Conceptualization**

**9 Hour**

Natural Phenomena, Models and metaphors, Nature to computing and back again, Individuals, Entities and agents, Parallelism and Distributivity Interactivity, Adaptation- Feedback, Self-Organization, Complexity, Emergence, Bottom-up Vs Top-Down Approach, Determination, Chaos and Fractals.

**Unit-3 - Evolutionary Computing**

**9 Hour**

Hill Climbing, Simulated Annealing, Simulated Annealing, Genetics Principles, Standard Evolutionary Algorithm, Genetic Algorithms, Reproduction, Crossover Mutation, Evolutionary Programming, Genetic Programming

**Unit-4 - Neurocomputing**

**9 Hour**

The Nervous System, Levels of Organization in the Nervous System, Networks Layers and Maps, Basis of learning and Memory, Artificial Neural Networks, Network Architectures, Learning Approaches, ANNs and Learning Algorithms- Hebbian Learning, Single Layer Perceptron, Multilayer Perceptron. Case Study: Bank loan approval using ANN

**Unit-5 - Swarm Intelligence**

**9 Hour**

Introduction, Ant Colony Optimization, Ant Foraging Behaviour, Ant Colony Optimization, SACO algorithm, Ant Colony Algorithm (ACA), scope of ACO algorithms, Swarm Robotics, Social Adaptation of Knowledge, Particle Swarm Optimization - Case Study: Swarm Intelligence in Bio Inspired Computing Problem.

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. "Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications", Chapman &amp; Hall/CRC, Taylor and Francis Group, 2007.</li> <li>2. Floreano D. and Mattiussi C., "Bio-Inspired Artificial Intelligence: Theories, Methods and Technologies", MIT Press, Cambridge, MA, 2008.</li> <li>3. Nature-Inspired Computing and Optimization Theory and Applications, Srikanta Patnaik • Xin-She Yang, Kazumi Nakamatsu, Springer, 2018</li> <li>4. Albert Y. Zomaya, "Handbook of Nature-Inspired and Innovative Computing ", Springer, 2006</li> <li>5. Marco Dorigo, Thomas Stutzle, "Ant Colony Optimization", PHI, 2005.</li> <li>6. Nature-Inspired Computing Concepts, Methodologies, Tools, and Applications, IGI Global, 2016</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>			
	<i>Bloom's Level of Thinking</i>	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	30%	-	30%	-	30%	-		
Level 2	Understand	40%	-	40%	-	40%	-		
Level 3	Apply	30%	-	30%	-	30%	-		
Level 4	Analyze	-	-	-	-	-	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. Jothi Basu Kamaraj, jothibasu.kamaraj@gmail.com	1. Dr.D.Paulraj, Professor, RMK Cet, kingrajpaul@gmail.com	1. Dr.B.Hariharan, SRMIST
2. Mr.Sankara Mukunthan sankaramukunthan@gmail.com	2. Dr.S.Kaliraj, Assistant Professor, MAHE, kaliraj.se@gmail.com	

<b>Course Code</b>	21CSE377T	<b>Course Name</b>	INFORMATION RETRIEVAL	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>													
<b>CLR-1:</b>	Outline of theoretical basis behind the standard models of Information Retrieval												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>												
<b>CLR-2:</b>	Analyze relevance feedback and query expansion processes												-	-	-	1											
<b>CLR-3:</b>	Classify text and usage of supervised and unsupervised algorithms												-	-	-	2											
<b>CLR-4:</b>	Study Information Retrieval process and Web Retrieval Techniques												-	-	-	2											
<b>CLR-5:</b>	Understand content Based Image Retrieval and Deep learning models for Information Retrieval												-	-	-	2											
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>												Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
<b>CO-1:</b>	Apply the standard retrieval models and comprehend the operations of information processing												2	3	2	-	-	-	-	-	-	-	-	-	-	1	
<b>CO-2:</b>	Analyze the query expansion mechanism and evaluate the model by applying various metrics												-	3	3	-	-	-	-	-	-	-	-	-	-	2	
<b>CO-3:</b>	Gain the knowledge on text classification algorithms and apply for the process of feature selection												-	3	3	-	-	-	-	-	-	-	-	-	-	-	
<b>CO-4:</b>	Acquire the concepts of Probabilistic Information Retrieval models and practice mechanisms for web crawling												-	3	3	-	-	-	-	-	-	-	-	-	-	2	
<b>CO-5:</b>	Gain insight into image retrieval techniques and analyze the deep learning models for information retrieval												-	3	3	-	-	-	-	-	-	-	-	-	-	2	

#### **Unit-1 - Introduction to Information Retrieval** 9 Hour

Information Retrieval Process, Indexing, Information retrieval model, Boolean and Vector-Space Retrieval models; Ranked retrieval; Text-similarity metrics; TF-IDF weighting; Dictionary and Postings - Tokenization, stop words, Stemming, Inverted index, Skip pointers, Phrase queries.

#### **Unit-2 - Query Evaluations and Metrics** 9 Hour

Query Expansion - Relevance feedback, Rocchio algorithm, Query Expansion and its types, Query drift; XML Indexing - A vector space model for XML retrieval, Evaluation of XML retrieval, Text-centric vs. Data-centric XML retrieval; Evaluation - Precision, Recall, F-measure, E-measure, Normalized recall, Evaluation problems

#### **Unit-3 - Text Classification and Clustering** 9 Hour

Text Classification and Clustering - Characterization of Text Classification – Unsupervised Algorithms: Clustering – Naïve Text Classification – Supervised Algorithms – Decision Tree – k-NN Classifier – SVM Classifier – Feature Selection or Dimensionality Reduction - Case study using Clustering.

#### **Unit-4 - Probabilistic and Web-based Retrieval** 9 Hour

Probabilistic Information Retrieval - Probabilistic relevance feedback, Probability ranking principle, Binary Independence Model, Bayesian network for text retrieval; Web Retrieval and Web Crawling - Web search basics, crawling, indexes, Link analysis - Web Characteristic, Crawling, Web As a graph, Page Rank, Hubs and Authorities - Case study on Web Retrieval.

#### **Unit-5 - Image Retrieval Methods** 9 Hour

Content Based Image Retrieval - Introduction to content Based Image retrieval, Challenges in Image retrieval, Image representation, Indexing and retrieving images, Relevance feedback.

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>C. Manning, P. Raghavan, and H. Schütze, <i>Introduction to Information Retrieval</i>, Cambridge University Press, 2008.</li> <li>Stefan Buettcher, Charles L. A. Clarke and Gordon V. Cormack, <i>Information Retrieval: Implementing and Evaluating Search Engines</i>, the MIT Press, 2010.</li> <li>Tanveer Siddiqui and U. S. Tiwary, <i>Natural Language Processing And Information Retrieval</i>, Oxford Higher Education, 2008</li> <li>Ricardo Baeza-Yates, Berthier Ribeiro-Neto, "Modern Information Retrieval: The Concepts and Technology Behind Search", Addison Wesley, 2010.</li> <li>ChengXiangZhai, Sean Massung, "Text Data Management and Analysis: A Practical Introduction to Information Retrieval and Text Mining", ACM Books, 2016.</li> <li>Soumen Chakrabarti, <i>Mining the Web Discovering Knowledge from Hypertext Data</i>, Morgan-Kaufmann Publishers, 2002</li> <li>David A. Grossman, Ophir Frieder, <i>Information Retrieval: Algorithms and Heuristics</i>, the Information Retrieval Series, 2nd Edition, 2004.</li> <li>Hang Li, <i>Learning to Rank for Information Retrieval and Natural Language Processing</i>, Morgan &amp; Claypool publishers, Second Edition, 2014</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>			
	<i>Bloom's Level of Thinking</i>	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	40%	-	30%	-	20%	-		
Level 2	Understand	40%	-	40%	-	40%	-		
Level 3	Apply	20%	-	30%	-	40%	-		
Level 4	Analyze	-	-	-	-	-	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Ms. Padmapriya Madhivanan, Senior Data Scientist, DXC Technologies	1. Dr.P.Shanthi Bala, CS, Pondicherry University, Puducherry	1. Dr. M Vimaladevi, SRMIST

<b>Course Code</b>	21CSE396T	<b>Course Name</b>	DESIGN PRINCIPLES OF SMART SPACE MANAGEMENT	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Understand Space fundamentals and IoT Architecture												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	Learn different Protocols for IoT Design												-	-	-										
<b>CLR-3:</b>	Familiarize the Concepts of smart space design												-	1	2	-									
<b>CLR-4:</b>	Build IoT with Raspberry Pi and Arduino for smart space												-	1	2	3									
<b>CLR-5:</b>	understand the role of psychology in space making and applying IoT in space design												-	1	2	3									
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>												Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	
<b>CO-1:</b>	Distinguish IoT applications in different domains												3	2	2	-	-	-	-	-	-	-	1	-	-
<b>CO-2:</b>	Apply various protocols for design of IoT systems												3	2	2	-	-	-	-	-	-	-	1	2	-
<b>CO-3:</b>	Illustrate the techniques for smart spaces												3	2	2	-	-	-	-	-	-	-	-	-	-
<b>CO-4:</b>	Deploy an IoT application using Raspberry Pi/Ardiuno												3	2	2	-	-	-	-	-	-	-	1	2	3
<b>CO-5:</b>	Analyze applications of IoT in Real time scenario												3	2	2	-	-	-	-	-	-	-	1	2	3

**Unit-1 - Introduction to Space Design and IoT** 9 Hour  
 Introduction to spatial design, Characteristics of space design aspects, Spatial Requirements, User & function, Standards & Requirements in spatial Design, Introduction to Internet of Things - Characteristics of IoT, IoT Network Architecture and Design, Drivers Behind New Network Architectures, Comparing IoT Architectures – The oneM2M IoT Standardized Architecture, The IoT World Forum (IoTWF) Standardized Architecture, A Simplified IoT Architecture, The Core IOT Functional Stack, IoT Data Management and Compute Stack Hierarchy of Ede, Fog and Cloud, Smart Objects: Things in IOT, Sensors, Actuators, Micro-Electro-Mechanical Systems (MEMS) and Smart objects, Sensor Networks, Wireless Sensor Networks (WSNs)

**Unit-2 - IoT Protocols** 9 Hour  
 Protocol Standardization for IoT, M2M and WSN Protocols, SCADA and RFID Protocols, Unified Data Standards, WPAN Technologies for IoT, Protocols – IEEE 802.15.4, Zigbee Architecture, Wireless HART, Near-field communication (NFC), Z-Wave, Bluetooth Low Energy (BLE), BACnet, Modbus IP Based Protocols for IoT, Network layer – 6LowPAN, CoAP, Edge connectivity and protocols, Cloud Platforms for IoT

**Unit-3 - Smart Space Design** 9 Hour  
 introduction to smart spaces, Need and Significance of smart space, Example projects for smart space, Presentation, Factors considered for smart space design, Need User profile, Factors considered for smart space design Activity Efficiency required, Application of smart concepts in space Lighting, Application of smart concepts in space Automation Signage, Exercise and Discussion (essential factors and applications)

**Unit-4 - IoT Development Boards** 9 Hour  
 IoT Development Boards: Arduino IDE and Board Types, Building IOT with Raspberry Pi, IoT Systems - Logical Design using Python, IoT Physical Devices & Endpoints, IoT Device -Building blocks - Raspberry Pi -Board-,Linux on Raspberry Pi, Raspberry Pi Interfaces, Programming Raspberry Pi with Python, Other IoT Platforms – Arduino, Interfacing Relay Driver with Arduino Uno, Programming Logic to Control Electrical Devices via Bluetooth using Arduino, Control Electrical Devices via Bluetooth Communication, Check Electrical Device status over Internet, Implementation of Home Automation using Arduino.

**Unit-5 - Psychology and Future Trends** 9 Hour  
 Role of user experience in spatial design, Introduction to Psychology in space making – smart spaces, Impact of Psychology in space making – IQ, Impact of Psychology in space making – EQ, Impact of Psychology in space making – SQ, Applications in smart spatial Design, Examples for Current research and Future trends in smart spatial design, Case Study: Smart Home Automation, Case Study: Smart Lighting.

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>David Hanes, Gonzalo Salgueiro, Rob Barton, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", Cisco Press, 2017</li> <li>Arshdeep Bahga, Vijay Madisetti, —Internet of Things – A hands-on approach!, Universities Press, 2015</li> <li>Hakima Chaouchi, — “The Internet of Things Connecting Objects to the Web” ISBN : 978-1-84821-140-7, Wiley Publications</li> <li>Olivier Hersistent, David Boswarthick, and Omar Elloumi, — “The Internet of Things: Key Applications and Protocols”, Wiley Publications</li> <li>Juan Carlos Augusto, Chris D Nugent, “Designing Smart Homes”, Springer</li> <li>Tom Hargreaves, Charlie Wilson, “Smart Homes and their users”, Springer</li> <li>Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), —Architecting the Internet of Things!, Springer, 2011.</li> <li><a href="https://in.pc当地.com/simplisafe-home-security-system/129484/how-to-set-up-your-smart-home-a-beginners-guide">https://in.pc当地.com/simplisafe-home-security-system/129484/how-to-set-up-your-smart-home-a-beginners-guide</a></li> <li><a href="https://www.homebuilding.co.uk/advice/how-to-design-a-smart-home">https://www.homebuilding.co.uk/advice/how-to-design-a-smart-home</a></li> <li><a href="https://www.archdaily.com/936027/psychology-of-space-how-interiors-impact-our-behavior">https://www.archdaily.com/936027/psychology-of-space-how-interiors-impact-our-behavior</a></li> <li><a href="https://sushantuniversity.edu.in/blog/do-you-know-how-psychology-of-space-is-impacting-interior-designing/">https://sushantuniversity.edu.in/blog/do-you-know-how-psychology-of-space-is-impacting-interior-designing/</a></li> <li><a href="https://www.ylighting.com/blog/smart-home-lighting-guide/">https://www.ylighting.com/blog/smart-home-lighting-guide/</a></li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)	Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice	Theory	Practice
		Level 1 Remember	30%	-	20%	-	20%
Level 2 Understand	40%	-	-	40%	-	40%	-
Level 3 Apply	30%	-	-	40%	-	40%	-
Level 4 Analyze	-	-	-	-	-	-	-
Level 5 Evaluate	-	-	-	-	-	-	-
Level 6 Create	-	-	-	-	-	-	-
Total		100 %		100 %		100 %	

<b>Course Designers</b>		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Ar.Apsaran Raja,Kaaloo, NID, Chennai	1. Prof. Premkumar, NIT Trichy	1. Dr.R.Annie Uthra,SRMIST 2. Dr.M.Ferni Ukrat, SRMIST
		3. Mrs.Sri Vallaba, Architecture and Interior Design, SRMIST 4. Dr.A.Alice Nithya, SRMIST

<b>Course Code</b>	21CSE397T	<b>Course Name</b>	PHILOSOPHY OF COGNITIVE SCIENCE	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the fundamentals of cognitive Science and Computing												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Identify the role of brain simulation in the area of cognitive system															
<b>CLR-3:</b>	Comprehend the relationship between Machine learning algorithms and cognitive systems and the different types of Knowledge representation.															
<b>CLR-4:</b>	Apply the techniques of advanced analytics to cognitive computing and cloud															
<b>CLR-5:</b>	Create a cognitive application and analyse their implementation in various sectors															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
<b>CO-1:</b>	Understand the basic concept and building blocks of cognitive Science												-	1	-	2
<b>CO-2:</b>	Apply the base concept of Brain simulation in cognitive computing.												-	2	-	2
<b>CO-3:</b>	Develop the relationship between Machine learning and cognitive systems												-	3	-	3
<b>CO-4:</b>	Experiment with the various advanced analytics to cognitive computing.												-	2	-	3
<b>CO-5:</b>	Build a cognitive application and their deployment in various domains.												-	2	-	3

<b>Unit-1 - Introduction to Cognitive Science</b>	<b>9 Hour</b>
Introduction –Philosophy of cognitive science- Interdisciplinary Nature of Cognitive Science and Cognitive Computing Systems-Representations for information and knowledge - Principal technology enablers of cognitive computing- Cognitive Computing Architectures and Approaches	
<b>Unit-2 - Analytics on Neuroscience</b>	<b>9 Hour</b>
Brain scalability - Neocortical Brain Organisation- Concept of a basic circuit- Hardware support for brain simulation- Visual Analytics as an approach to cognitive computing- time evolving graphs- Description of Cygraph	
<b>Unit-3 - Role of Machine Learning in Cognitive science</b>	<b>9 Hour</b>
Types of Learning - Machine Learning Algorithms- Supervised Learning -Unsupervised Learning -Predictive Analytics -Business Value of Predictive Analytics -Text Analytics -Business Value of Text Analytics-Image and Speech Analysis Cognitive analytics applications- Random Forest Classifiers- STE-M Model - Cognitive random forest- Cognitive computing system.	
<b>Unit-4 - Advanced Analytics</b>	<b>9 Hour</b>
Applying Advanced Analytics to Cognitive Computing -Advanced Analytics Is on a Path to Cognitive Computing -Key Capabilities in Advanced Analytics -The Relationship Between Statistics, Data Mining, and Machine Learning –Using Machine Learning in the Analytics Process – Role of Cloud Computing in Cognitive science- Case study: Role of Cognitive science in human behaviour analysis, Monitoring the facial expression of down syndrome patient	

**Unit-5 - Application and Case studies.****9 Hour**

The Process of Building a Cognitive Application -The Emerging Cognitive Platform -Defining the Objective -Defining the Domain -Understanding the Intended Users and Defining their Attributes -Defining Questions and Exploring Insights - Typical Question-Answer pairs -Anticipatory Analytics -Acquiring the Relevant Data Sources -The Importance of Leveraging Structured Data Sources the Business Implications of Cognitive Computing. Case study: Recording the data in healthcare concierge, detection of anomaly in cerebral palsy

<b>Learning Resources</b>	1. Vijay V Raghavan, Venkat N.Gudivada, Venu Govindaraju, C.R. Rao, Cognitive Computing: Theory and Applications: (Unit 1, 2, 3) 3. VJudit Hurwitz, Marcia Kaufman, Adrian Bowles, Cognitive Computing and Big Data Analytics, Wiley 4. Publications, 2015Volume 35 (Handbook of Statistics), chapter 5, 2016(Unit 4,5)	5. Computational Intelligence for Big Data Analysis Frontier Advances and Applications, D.P. Acharya 6. Satchidananda Dehuri, Sugata Sanyal 7. Cognitive Computing for Human-Robot Interaction: Principles and Practices, Mamta Mittal, Sudipta Roy, Rajiv Ratn Shah.
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	40%	-	40%	-	40%	-		
Level 2	Understand	40%	-	40%	-	40%	-		
Level 3	Apply	20%	-	20%	-	20%	-		
Level 4	Analyze	-	-	-	-	-	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

**Course Designers****Experts from Industry**

1. K. Selvanayagam, Practise Lead CPQ, Salesforce, Preldesys India Pvt Lrd

**Experts from Higher Technical Institutions**

1. Dr. Mariammal, Anna University

**Internal Experts**

1. Dr.M. Maheswari, SRMIST

<b>Course Code</b>	21CSE398T	<b>Course Name</b>	LOGIC AND KNOWLEDGE REPRESENTATION	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Gain knowledge on propositional logic and first order logic												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Understand the concept of description logic and reasoning methods												-	-	-	
<b>CLR-3:</b>	Know about uncertainty, probability notations and non-monotonic reasoning												-	-	-	
<b>CLR-4:</b>	Gain knowledge on qualitative modeling representations												-	-	-	
<b>CLR-5:</b>	Understand and construct Bayesian Networks and apply inference techniques.												-	-	-	
<b>Course Outcomes (CO):</b>		<b>At the end of this course, learners will be able to:</b>														
<b>CO-1:</b>	Understand and illustrate propositional and First order logic representations												-	1	-	-
<b>CO-2:</b>	Understand inference in FOL and description logic representations												-	2	-	-
<b>CO-3:</b>	Apply Bayes rule in uncertainty and understand non-monotonic reasoning methods												-	-	-	2
<b>CO-4:</b>	Illustrate qualitative modeling representation techniques												-	-	-	2
<b>CO-5:</b>	Construct Bayesian network and apply its inference methods												-	-	-	3

**Unit-1 - Introduction to Knowledge and Logic** 9 Hour  
Knowledge Representation terminologies: syntax –Semantics, Representation languages, Inference validity and satisfiability, Inference in Computers, Logics, Fuzzy logic Propositional Logic: syntax, semantics, validity and inference, Rules of inference for propositional logic, An agent for the Wumpus world, First order Logic: syntax and semantics, Extensions and Notational variations, Logical agent for Wumpus world

**Unit-2 - Procedural Control of Reasoning** 9 Hour  
Inference in FOL: inference rules involving quantifiers forward and backward chaining, Resolution, Description Logics, Introduction A basic DL and its Extensions, Relationships with other Formalisms, Tableau Based Reasoning Techniques, The Automata Based Approach, Structural Approaches.

**Unit-3 - Uncertainty** 9 Hour  
Uncertainty: Handling uncertain knowledge basic probability notation, Conditional probability, The axioms of probability, The joint probability distribution, Bayes' rule and its use Applying Bayes' rule. Nonmonotonic Reasoning Introduction, Default Logic, Auto epistemic Logic, Circumscription, Nonmonotonic Inference Relations, Semantic Specification of Inference Relations, Default Conditionals, Relating Default and Auto epistemic Logics, Case study: Relating Default Logic and Circumscription

**Unit-4 - Qualitative Modeling** 9 Hour  
Qualitative Modelling, introduction Qualitative Mathematics, Ontology, Component Ontologies, Process Ontologies, Field Ontology, Causality, Compositional Modelling, Qualitative Spatial Reasoning, Topological Representations, Shape, Location, and Orientation Representations, Diagrammatic Reasoning, Qualitative Modelling Applications, Automating or Assisting Professional Reasoning, Education, Cognitive Modelling

**Unit-5 - Bayesian Networks** 9 Hour  
Bayesian Networks: Introduction Syntax and Semantics of Bayesian Networks Exact Inference, Inference with Local (Parametric) Structure, Solving MAP and MPE by Search, Compiling Bayesian Networks, Inference by Reduction to Logic, Approximate Inference: Inference by Stochastic Sampling, Inference as Optimization, Constructing Bayesian Networks: Knowledge Engineering, High-Level Specifications, Learning Bayesian Networks, Case study: Knowledge representation and Question Answering

<b>Learning Resources</b>	1. S. Russell and P. Norvig. <i>Artificial Intelligence</i> 2nd ed. Prentice Hall, 2002. 2. <i>Handbook of Knowledge Representation</i> . Frank van Harmelen, Vladimir Lifschitz and Bruce Porter (Eds). <i>Foundations of Artificial Intelligence</i> , 2008.	3. Boolos, G. S., Burgess, J. P., Jeffrey, R. C. <i>Computability, and logic</i> . – Cambridge university press, 2002. 4. <i>An Introduction to Description Logic</i> . Franz Baader, Ian Horrocks, Carsten Lutz, Uli Sattler
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Learning Assessment						
Bloom's Level of Thinking	Continuous Learning Assessment (CLA)					Summative Final Examination (40% weightage)
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	20%	-	20%
Level 2	Understand	40%	-	40%	-	40%
Level 3	Apply	30%	-	40%	-	40%
Level 4	Analyze	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-
Level 6	Create	-	-	-	-	-
	Total	100 %		100 %		100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Kanitha Anand, CTS	1. Dr.A. Padmavathy, Amrita University Chennai Campus	1. Dr.A. Maheswari, SRMIST

<b>Course Code</b>	21CSE411T	<b>Course Name</b>	ARTIFICIAL INTELLIGENCE IN GENOMICS AND DISEASE PREDICTION	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Generate knowledge about biological macromolecules and bioinformatics												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Provide knowledge on bioinformatics terms and file formats															
<b>CLR-3:</b>	Create an interest about integrating artificial intelligence and genomics															
<b>CLR-4:</b>	Initiate interest on the role of artificial intelligence cancer diagnosis															
<b>CLR-5:</b>	Understand the applications of artificial intelligence in proteomics and drug discovery															

<b>Course Outcomes (CO):</b>		<b>At the end of this course, learners will be able to:</b>												<b>Program Specific outcomes</b>		
<b>CO-1:</b>	Illustrate knowledge about biological macromolecules and bioinformatics												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CO-2:</b>	Discuss about different file formats, NGS pipelines and tools												-	-	-	2
<b>CO-3:</b>	Outline the concepts of artificial intelligence in genomics and pandemic predictions												3	-	-	2
<b>CO-4:</b>	Demonstrate applicability of AI in cancer forecasting and diagnosis												2	-	-	3
<b>CO-5:</b>	Develop an approach in artificial intelligence for proteomics and drug discovery												2	-	-	-

#### **Unit-1 – Introduction to Molecular Biology** 9 Hour

Overview of Central Dogma of Molecular Biology - Post Transcriptional & Post Translational Modifications; Classification of Nucleic Acid Bases and Amino Acids; Genomics, Transcriptomics and Proteomics; Mutation and its types; Evolution of Sequencing methods – first, next and third generation – differences; Sequence Data and Quality

#### **Unit-2 – File Formats and NGS Pipelines** 9 Hour

Evolution of Bioinformatics – Sequence alignment – Indels – Homology, Identity, Similarity, Orthology, Paralogy&Xenology; Similarity Search Tools and its types; NCBI – Genbank; Unitprot – Swissprot; KEGG; File formats – Fasta, Fastq, CSFasta; Mutalyzer and HGVS Python Pacakge - Transvar

#### **Unit-3 – AI Genomics and Pandemic Prediction** 9 Hour

Numpy, Pandas, Supervised learning algorithms, Random Forest, KNN, SVM, ANN, Clustering in bioinformatics, Supervised learning methods in analyzing transcriptomics data, AI and ML methods to the investigation of Pandemics, Case study :Forecasting of pandemic using LSTM and in infectious disease diagnostics

#### **Unit-4 – AI in Cancer Forecasting and Diagnosis** 9 Hour

AI, ML and DL in cancer – determining cancer susceptibility, enhanced cancer diagnosis and staging, treatment response, recurrence and survival and personalized cancer pharmacotherapy, Random Forest classification for breast cancer, ML approach to diagnose cancer at early stage.

#### **Unit-5 – AI in Proteomics and Drug Discovery** 9 Hour

AI in proteomics, AI in proteomics data integration, Scope of AI in drug discovery, Molecular modeling and databases in AI for drug molecules, computational mechanics ML methods in molecular modeling, Drug characterization using isopotential surfaces, Case study :Drug design for neuroreceptors using ANN techniques

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Krane, D. E., Raymer, M. L. "Fundamental Concepts of Bioinformatics", Benjamin Cummings, (2003).</li> <li>2. Federico Divina, Francisco A. Gómez Vela, Miguel Garcia-Torres. "Computational Methods for the Analysis of Genomic Data and Biological Processes", MDPI (AG) (2021).</li> <li>3. Attwood.T.K. Parry-Smith D.J., "Introduction to Bioinformatics", 1st Edition, 11th Reprint, Pearson Education. 2005.</li> <li>4. Adam Bohr and Kaveh Memarzadeh. Artificial Intelligence in Healthcare. 1st Edition. Academic publishers. Elsevier Science. 2020</li> <li>5. Christophe Lambert, Darrol Baker, George P. Patrinos. "Human Genome Informatics - Translating Genes into Health", Elsevier Science, (2018).</li> <li>6. Smith KP, Kirby JE. Image analysis and artificial intelligence in infectious disease diagnostics. Clin Microbiol Infect. 2020 Oct; 26(10):1318-1323. doi: 10.1016/j.cmi.2020.03.012.</li> <li>7. Mann M, Kumar C, Zeng WF, Strauss MT. Artificial intelligence for proteomics and biomarker discovery. Cell Syst. 2021 Aug 18; 12(8):759-770. doi: 10.1016/j.cels.2021.06.006.</li> </ol>
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Learning Assessment						
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)		
		Theory	Practice	Theory	Practice	Theory
Level 1	Remember	15%	-	15%	-	15%
Level 2	Understand	25%	-	25%	-	25%
Level 3	Apply	25%	-	25%	-	25%
Level 4	Analyze	25%	-	25%	-	25%
Level 5	Evaluate	10%	-	10%	-	10%
Level 6	Create	-	-	-	-	-
	Total	100 %		100 %		100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.C.Ramakrishnan, Principal Scientist, Molecular Design Division Aroniter Co., Seoul, South Korea ramakrishnan@arontier.co	1. Dr Shandar Ahamad, Professor, Jawaharlal Nehru University,shandar@jnu.ac.in	1. Dr.Habeeb. S. K. M, SRMIST
2. Mr. Sudheendra Rao, Director, DataLore Labs, Bengaluru sudheendra@datalorelabs.ai	2. Dr. Balachandran Manavalan, Research Professor, Department of Physiology, Ajou University School of Medicine, World Cup-ro, Yeongtong-gu, Suwon,	2. Dr.ThirumurthyMadhavan, SRMIST 3. Dr.G.Maragatham, SRMIST

	21CSE412T	Course	MACHINE LEARNING IN DRUG DISCOVERY	Course	E	PROFESSIONAL ELECTIVE	L	T	P	C
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Course Code		Name		Category								3	0	0	3																								
Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil																																		
Course Offering Department	School of Computing	Data Book / Codes / Standards			Nil																																		
<b>Course Learning Rationale (CLR):</b>		<i>The purpose of learning this course is to:</i>																																					
<b>CLR-1:</b>	Generate knowledge about macromolecules and their structural importance																																						
<b>CLR-2:</b>	Acquire the basis of small molecule descriptor calculations and their algorithms																																						
<b>CLR-3:</b>	Provide the knowledge about drug discovery process																																						
<b>CLR-4:</b>	Manipulate data using Python																																						
<b>CLR-5:</b>	Understand various ML algorithms and their application in biological dataset																																						
<b>Course Outcomes (CO):</b>		<i>At the end of this course, learners will be able to:</i>																																					
<b>CO-1:</b>	Recall knowledge about macromolecules and their structural importance																																						
<b>CO-2:</b>	Apply knowledge on developing various models																																						
<b>CO-3:</b>	Discuss knowledge about drug discovery pipeline																																						
<b>CO-4:</b>	Learn how to use Scikit-learn to apply powerful machine learning algorithms																																						
<b>CO-5:</b>	Apply knowledge on ML models and learn best practices for drug discovery dataset																																						
<b>Unit-1 - Macromolecules and Their Structural Importance</b>															<b>9 Hour</b>																								
Central Dogma of molecular Biology, Structure of DNA, RNA, Amino acids, Classes of Proteins, Protein architecture, Structure stabilizing interactions, Protein folding problem, Solving protein structures, Mechanisms of enzyme actions																																							
<b>Unit-2 - Computer Representation for Developing 2D and 3D Models</b>															<b>9 Hour</b>																								
Computer representation of 2D chemical structures, Graph theory to represent Chemical Structures, Connection table, Computer representation of 3D chemical structures, biological databases																																							
<b>Unit-3 - Drug Discovery Pipeline</b>															<b>9 Hour</b>																								
Sequence analysis, Methods of sequence analysis, Introduction to drug discovery process and computational approaches, "Drug-Likeness" and Compound Filters, ligand and Structure based drug design, Virtual screening, Protein-Ligand Docking																																							
<b>Unit-4 - Scikit-Learn for Machine Learning Analysis</b>															<b>9 Hour</b>																								
Basics of Python for ML data analysis, String function for nucleic acid sequence, Numpy, and Pandas, basic graph theory																																							
<b>Unit-5 - Knowledge of ML Models for Drug Discovery</b>															<b>9 Hour</b>																								
Machine learning pathway overview, Types of Machine learning algorithms, Cross validation: Test and Training split, Introduction to Biological Dataset construction, case studies of drug molecules benchmarking datasets and ML model generation																																							

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Attwood.T.K. Parry-Smith D.J., "Introduction to Bioinformatics", 1st Edition, 11th Reprint, Pearson Education. 2005.</li> <li>2. Murthy.C.S.V. "Bioinformatics", 1st Edition, Himalaya Publishing House.2003.</li> <li>3. Rastogi.S.C. Namita., M., Parag, R., "Bioinformatics- Concepts, Skills, and Applications", CBS Publishing. 2009.</li> <li>4. Online Sources: <a href="https://wiki.python.org/moin/BeginnersGuide/Programmers">https://wiki.python.org/moin/BeginnersGuide/Programmers</a>.</li> <li>5. Mount D., "Bioinformatics: Sequence and Genome Analysis", 2 nd Edition, Cold Spring Harbor Laboratory Press, New York. 2004.</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>	
<i>Bloom's Level of Thinking</i>	<i>Formative CLA-1 Average of unit test (50%)</i>	<i>Life-Long Learning CLA-2 (10%)</i>					
		<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>
Level 1	<i>Remember</i>	15%	-	10%	-	10%	-
Level 2	<i>Understand</i>	25%	-	20%	-	20%	-
Level 3	<i>Apply</i>	30%	-	35%	-	35%	-
Level 4	<i>Analyze</i>	30%	-	35%	-	35%	-
Level 5	<i>Evaluate</i>	-	-	-	-	-	-
Level 6	<i>Create</i>	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Dr.C.Ramakrishnan, Principal Scientist, Molecular Design Division Aroniter Co., Seoul, South Korea ramakrishnan@arontier.co	1. Dr Shandar Ahamad, Professor, Jawaharlal Nehru University, shandar@jnu.ac.in	1. Dr.ThirumurthyMadhavan, SRMIST
2. Mr. Sudheendra Rao, Director, DataLore Labs, Bengaluru	2. Dr. Balachandran Manavalan, Research Professor, Department of Physiology, Ajou University School of Medicine, Yeongtong-gu, Suwon, South Korea	2. Dr. Habeeb. S. K. M, SRMIST 3. Dr.G.Maragatham G, SRMIST

<b>Course Code</b>	21CSE414T	<b>Course Name</b>	IOT CONCEPTS AND APPLICATIONS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	The purpose of learning this course is to:												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-1:</b>	Introduce the concept of Basics of IoT and different devices and architecture of IoT Technology.	1	2	3	4	5	6	7	8	9	10	11	12			
<b>CLR-2:</b>	Outline the State of the Art – Data Management and IoT Component Explanation.	1	2	3	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance			
<b>CLR-3:</b>	Acquire the knowledge of Data Link Layer and Network Layer protocols.	1	2	3	-	-	-	-	-	-	-	-	-	1	-	-
<b>CLR-4:</b>	Learn the IoT Reference Architecture, Transport, Session, and Service Layer Protocols	1	2	3	-	-	-	-	-	-	-	-	-	1	-	-
<b>CLR-5:</b>	Exploit the various IoT Security attacks and Applications	1	2	3	-	-	-	-	-	-	-	-	-	2	-	-
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>	2	3	3	-	-	-	-	-	-	-	-	-	1	-	-
<b>CO-1:</b>	Interpret the vision of IoT architecture from a global context.	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
<b>CO-2:</b>	Articulate the state-of-the-art Data management and IoT component.	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>CO-3:</b>	Compare and Contrast the use of data link and Network layer protocols in different applications.	1	2	-	-	-	-	-	-	-	-	-	-	1	-	-
<b>CO-4:</b>	Implement using the available IoT Transport, Session, and Service Layer Protocols to different applications.	1	1	1	-	-	-	-	-	-	-	-	-	-	-	2
<b>CO-5:</b>	Apply the IOT Security Techniques to avoid several attacks in relevant areas of IoT Product development	2	3	3	-	-	-	-	-	-	-	-	-	1	-	3

#### **Unit-1 - IoT Fundamentals and Architecture Overviews** 9 Hour

IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. M2M and IoT Technology Fundamentals- Devices and gateways, State of the art-ETSI M2M, IoT Reference model-IoT Domain model, Communication Model.

#### **Unit-2 - Data Management Introduction and IoT Components** 9 Hour

Managing M2M data: Data generation, Data acquisition, Data validation, Data storage, Data processing, Data remanence, Data analysis, Business Process in IOT, M2M and IoT Analytics, Basics of Sensors and Actuators,, Introduction to Arduino and its applications ,Sensor Interfacing Using Tinker CAD, Interfacing Sensor with Raspberry Pi 4.

#### **Unit-3 - IoT Data Link Layer & Network Layer Protocols** 9 Hour

PHY/MAC Layer (3GPP MTC, IEEE 802.11, IEEE 802.15), Wireless HART, Z-Wave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - Network Layer-IPv4, IPv6, 6LoWPAN, 6TiSCH, DHCP (Dynamic Host Configuration Protocol), ICMP(Internet Control Message Protocol), RPL(Routing Protocol for Low-Power and Lossy Networks), CORPL(Cognitive RPL), CARP(Common Address Redundancy Protocol).

#### **Unit-4 - Transport, Session, and Service Layer Protocols** 9 Hour

Transport Layer (TCP, MPTCP (Multipath TCP), UDP, DCCP(Datagram Congestion Control Protocol), SCTP(Stream Control Transmission Protocol)) -(TLS, DTLS) – Session Layer-HTTP, CoAP(Constrained Application Protocol), XMPP(Extensible Messaging Presence Protocol), AMQP(Advanced Message Queuing Protocol), MQTT(Message Queuing Telemetry Transport.), Service Layer -oneM2M(Machine to Machine), ETSI M2M, OMA(Open Mobile Alliance), BBF. Real-Time Case Studies: Smart Travel Applications, Smart Home using Drones

#### **Unit-5 - IoT Security Attacks and Applications** 9 Hour

Understanding Security and Interoperability, Modes of attack: Web Crawl, Search Features and Wild Cards, Breaking Cipher Tools for achieving Security: VPN, X.509, Authentication, Tools for achieving Security: User names and Passwords, Message Brokers, Real-Time Case Studies: Disaster Prevention, Smart Agriculture.

<b>Learning Resources</b>	<p>1. "IoT Fundamentals: Definitions, Architectures, Challenges, and Promises", by Farshad Firouzi, Bahar Farahani, Markus Weinberger, and Fereidoon Shams Aliee. DOI: 10.1007/978-3-030-30367-9_1, January 2020.</p> <p>2. Uckelmann, D., Harrison, M., &amp; Michahelles, F. (Eds.). <i>Architecting the Internet of Things</i>. doi:10.1007/978-3-642-19157-2, 2011.</p> <p>3. IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things by Rob Barton, Gonzalo Salgueiro, David Hanes, Publisher: Cisco Press, Release Date: June 2017, ISBN: 9780134307091 (<a href="https://www.oreilly.com/library/view/iot-fundamentals-networking/9780134307091/">https://www.oreilly.com/library/view/iot-fundamentals-networking/9780134307091/</a>).</p> <p>4. Jan Holler, Vlasis Tsatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014</p> <p>5. Peter Waher, "Learning Internet of Things", PACKT publishing, BIRMINGHAM – MUMBAI</p> <p>6. Daniel Minoli: <i>Building the Internet of Things with IPv6 and MIPv6 evolving World of M2M Communication</i>, ISBN 978-1-118-47347-4 Willy Publications. WebSite Reference:</p> <p>1) <a href="https://onlinecourses.nptel.ac.in/noc22_cs53">https://onlinecourses.nptel.ac.in/noc22_cs53</a>, preview</p> <p>2) <a href="https://www.coursera.org/specializations/uiuc-iot">https://www.coursera.org/specializations/uiuc-iot</a></p> <p>3) <a href="https://www.mygreatlearning.com/academy/learn-for-free/courses/what-is-iot">https://www.mygreatlearning.com/academy/learn-for-free/courses/what-is-iot</a></p> <p>4) <a href="https://www.edx.org/learn/iot-internet-of-things">https://www.edx.org/learn/iot-internet-of-things</a></p>
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<b>Learning Assessment</b>							
<i>Bloom's Level of Thinking</i>		<i>Continuous Learning Assessment (CLA)</i>				<i>Summative Final Examination (40% weightage)</i>	
		<i>Formative CLA-1 Average of unit test (50%)</i>		<i>Life-Long Learning CLA-2 (10%)</i>			
		<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>		
Level 1	<i>Remember</i>	30%	-	20%	-	20%	
Level 2	<i>Understand</i>	40%	-	25%	-	25%	
Level 3	<i>Apply</i>	15%	-	30%	-	30%	
Level 4	<i>Analyze</i>	15%	-	25%	-	25%	
Level 5	<i>Evaluate</i>	-	-	-	-	-	
Level 6	<i>Create</i>	-	-	-	-	-	
	<i>Total</i>	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. Vinay Solanki, Head IoT, Lenovo (APAC & MEA)	1. Dr.Zayaraj, Professor / CSE, PEC, Pondicherry	1. Dr. S.Amudha, SRMIST
2. Dr. Paventhan Arumugam, Director (R&D), ERNET India	2. Dr.Vijalakshmi Associate Professor / CSE, PEC, Pondicherry	2. Dr.Kayalvizhi Jayavel, SRMIST
3. Shiv Kumar Ganesh, Full Stack Developer, Altimetrik	3. Dr.P.Yogesh, Professor/IT, Anna University, Chennai.	3. Dr. S.Babu, SRMIST

<b>Course Code</b>	21CSE415T	<b>Course Name</b>	FUZZY LOGIC AND ITS APPLICATIONS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 3	T 0	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3		
<b>CLR-1:</b>	Outline the ideas of fuzzy sets, fuzzification and defuzzification.															
<b>CLR-2:</b>	Explain fuzzy logic and fuzzy systems with examples															
<b>CLR-3:</b>	Introduce decision making with fuzzy information															
<b>CLR-4:</b>	Gain knowledge on fuzzy classification and pattern recognition															
<b>CLR-5:</b>	Design and implement fuzzy control systems and industrial applications															
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Gain knowledge on Fuzzy sets to recognize the appropriateness of computational task															1 - -
<b>CO-2:</b>	Learn the foundations of fuzzy logic and methods for fuzzy systems															1 - -
<b>CO-3:</b>	Understand rule-based inference and decision making with fuzzy information															2 -
<b>CO-4:</b>	Acquire and apply fuzzy classification and recognition methods															2 -
<b>CO-5:</b>	Apply and Design fuzzy control systems with example applications															2 3

<b>Unit-1 - Introduction</b>	<b>9 Hour</b>
The Case for Imprecision, The Utility of Fuzzy Systems, Limitations of Fuzzy Systems, Uncertainty and Information, Fuzzy Sets and Membership, Chance versus Fuzziness - Fuzzy Sets: Fuzzy Set Operations, Properties of Fuzzy Sets, Noninteractive Fuzzy Sets, Alternative Fuzzy Set Operations - Fuzzy Relations: Crisp Relations, Fuzzy Relations, Fuzzy Tolerance and Equivalence Relations, Value Assignments, Problems on fuzzy relation - Membership function – various forms –fuzzification – defuzzification to crisp sets.	

<b>Unit-2 - Logic and Fuzzy Systems</b>	<b>9 Hour</b>
classical logic, fuzzy logic, fuzzy systems – Development of Membership functions: membership value assignments, intuition, Inference, rank ordering – Automated Methods for Fuzzy Systems: Definitions, Batch Least Squares Algorithm, Recursive Least Squares Algorithm, Gradient Method, Learning From Example, Modified Learning From Example, Problems on logic and fuzzy systems	

<b>Unit-3 - Rule-Based Reduction Methods</b>	<b>9 Hour</b>
: Fuzzy Systems Theory and Rule Reduction, Singular Value Decomposition, Combs Method, SVD and Combs Method Examples, problems on SVD and Combs method for rapid inference - Decision Making with Fuzzy Information: Fuzzy Synthetic Evaluation, Fuzzy Ordering, Nontransitive Ranking, Preference and Consensus, Multiobjective Decision Making, Decision Making under Fuzzy States and Fuzzy Actions, problems on decision making with fuzzy information.	

<b>Unit-4 - Fuzzy Classification and Pattern Recognition</b>	<b>9 Hour</b>
Classification by Equivalence Relations, Cluster Analysis, Cluster Validity, c-Means Clustering, Fuzzy c-Means, Classification Metric, Similarity Relations from Clustering - Pattern Recognition: Feature Analysis, Partitions of the Feature Space, Single-Sample Identification, Multifeature Pattern Recognition, problems on fuzzy classification and pattern recognition, Case Study: Hand written character recognition using fuzzy logic.	

<b>Unit-5 - Fuzzy Control Systems</b>	<b>9 Hour</b>
Control System Design Problem, Control (Decision) Surface, Assumptions in a Fuzzy Control System Design, Simple Fuzzy Logic Controllers, Examples of Fuzzy Control System Design, Aircraft Landing Control Problem - Fuzzy Optimization - Fuzzy Linear Regression – problems on fuzzy optimization and regression, Case study: Robot Navigation using fuzzy logic.	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Ross, T. J., "Fuzzy logic with engineering applications," John Wiley &amp; Sons, Second Edition, 2017</li> <li>2. H.-J. Zimmermann, "Fuzzy Set Theoryand Its Applications", 4<sup>th</sup> edition, Springer Science+Business Media, LLC, 2001</li> <li>3. J.-S. R. Jang, C.-T. Sun, and E. Mizutani, "Neuro-Fuzzy and Soft Computing" Prentice Hall. 1997.</li> <li>4. Klir.G, Yuan B.B. Fuzzy sets and Fuzzy Logic Prentice Hall of India private limited, 1997</li> <li>5. <a href="https://ieeexplore.ieee.org/document/519069/">https://ieeexplore.ieee.org/document/519069/</a></li> <li>6. <a href="https://www.academia.edu/2073261/A_case_study_of_fuzzy_logic_based_robot_navigation">https://www.academia.edu/2073261/A_case_study_of_fuzzy_logic_based_robot_navigation</a></li> </ol>
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<b>Learning Assessment</b>						
<i>Bloom's Level of Thinking</i>	<i>Continuous Learning Assessment (CLA)</i>				<i>Summative Final Examination (40% weightage)</i>	
	<i>Formative CLA-1 Average of unit test (50%)</i>		<i>Life-Long Learning CLA-2 (10%)</i>			
	<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>
Level 1 <i>Remember</i>	20%	-	20%	-	20%	-
Level 2 <i>Understand</i>	30%	-	20%	-	20%	-
Level 3 <i>Apply</i>	50%	-	50%	-	50%	-
Level 4 <i>Analyze</i>	-	-	10%	-	10%	-
Level 5 <i>Evaluate</i>	-	-	-	-	-	-
Level 6 <i>Create</i>	-	-	-	-	-	-
Total	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Dr.A.Vasanthi, Senior Consultant, Slalom - Sydney, New South Wales, Australia	1. Dr.A.Punitha, Associate Professor, Annamalai University	1. Mr.S.Joseph James, SRMIST

<b>Course Code</b>	21CSE416T	<b>Course Name</b>	ROBOTICS: COMPUTATIONAL MOTION PLANNING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	The purpose of learning this course is to:												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-1:</b>	understand the concepts of motion planning	1	2	3	4	5	6	7	8	9	10	11	12			
<b>CLR-2:</b>	Able to study the potential functions and navigations	2	3	-										1	-	-
<b>CLR-3:</b>	Acquire knowledge of different Algorithms	2	3	1	-	-	-	-	-	-	-	-	-	1	-	2
<b>CLR-4:</b>	Discuss the localization and mapping methods.	2	3	2	-	-	-	-	-	-	-	-	-	2	-	-
<b>CLR-5:</b>	Gain knowledge about Trajectory and motion planning	2	3	2	-	-	-	-	-	-	-	-	-	2	-	3
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Discuss the methods of motion planning	2	3	-										1	-	-
<b>CO-2:</b>	Apply knowledge of Potential functions and Navigations	2	3	1	-	-	-	-	-	-	-	-	-	1	-	2
<b>CO-3:</b>	Implement the Sampling Algorithms	2	3	2	-	-	-	-	-	-	-	-	-	2	-	-
<b>CO-4:</b>	Gain knowledge of mapping and path planning	2	3	2	-	-	-	-	-	-	-	-	-	2	-	-
<b>CO-5:</b>	Design and deploy trajectory and motion planning	3	3	2	-	-	-	-	-	-	-	-	-	3	-	-

#### **Unit-1 - Motion Planning** 9 Hour

Overview of Motion Planning –introduction to basic concepts and methods for motion planning – Simultaneous Localization and Mapping (SLAM) - GPS based obstacle avoidance – path finding - A\* Algorithm - Bug Algorithms -Bug1 and Bug 2 - Tangent Bug - Implementation: The Tangent Line - Distance On Gradient - Continuation Method.

#### **Unit-2 - Potential Function** 9 Hour

Addictive Attractive/Repulsive Potential - Gradient Descent - Computing Distance from Implementation In The Plane - Local Minima Problem - Wave-Front Planner - Navigation Potential Function: Sphere world, from sphere to stars and beyond - Potential Functions for Rigid-Body Robots - Robot path planning using generalized Voroni diagrams.

#### **Unit-3 - Probabilistic Road Map Path Planning** 9 Hour

Sampling Based Algorithms- Basic PRM - Implementation of basic PRM - PRM sampling Strategies - PRM connection Strategies - Single-Query Sampling Based Planners: Expensive Spaces Trees - Rapidly Exploring Random Trees - Connection Strategies and SBL Planner - Integration of Planners Sampling Based Roadmap- Analysis of PRM - Control based Planning - Multiple Robots - Manipulation Planning - Assembly Planning.

#### **Unit-4 - Filtering and Mapping** 9 Hour

Linear Kalman Filtering - Kalman Filter: Example - Bayesian Methods: Localization - Basic Idea Probabilistic Localization - Probabilistic Localization as Recursive Bayesian Filtering - Derivation of Probabilistic Localization - Representation Of Posterior - Sensor Model - Mapping: Mapping with known locations - Bayesian Simultaneous Localization and Mapping. Case study: Vision-based multi-robot simultaneous localization and mapping.

#### **Unit-5 - Trajectory Planning** 9 Hour

Preliminaries - Decoupled Trajectory Planning - Direct Trajectory Planning: Optimal Control - Nonlinear Optimization - Grid-Based Search - Nonholonomic and Underactuated Systems: preliminaries - Control Systems – Controllability - Motion Planning: Optimal Control - Steering Chained -Form Systems Using Sinusoids - Nonlinear Optimization. Case study: Motion planning.

<b>Learning Resources</b>	1. Howie M. Choset, Seth Hutchinson, Kevin M. Lynch, George Kantor, Wolfram Burgard, Lydia E. Kavraki, Sebastian Thrun, "Principles of Robot Motion: Theory, Algorithms, and Implementation", 2016 2. Jean-Claude Latombe, "Robot Motion Planning", Springer Science & Business Media, 2012	3. Rafael Valencia, Juan Andrade-Cetto, "Mapping, Planning and Exploration with Pose SLAM", Springer, 2018
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	20%	-	10%	-	10%	-		
Level 2	Understand	15%	-	10%	-	10%	-		
Level 3	Apply	35%	-	45%	-	45%	-		
Level 4	Analyze	30%	-	35%	-	35%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Rijo Jackson Tom Lead Data Scientist Augusta hitech soft solution	1. Dr. Thiagarajan R Assistant Professor, Department of Mechanical Engineering, Indian Institute of Technology Tirupati	1. Dr. J.J. Jayakanth, SRMIST

<b>Course Code</b>	21CSE417T	<b>Course Name</b>	REINFORCEMENT LEARNING TECHNIQUES	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	The purpose of learning this course is to:												<b>PSC-1</b>	<b>PSC-2</b>	<b>PSC-3</b>	
<b>CLR-1:</b>	Introduce the fundamentals of Reinforcement Learning	1	2	3	4	5	6	7	8	9	10	11	12			
<b>CLR-2:</b>	Illustrate model-based prediction and control using dynamic programming	3	2	-	2	-	-	-	-	-	-	-	-	-	-	2
<b>CLR-3:</b>	Illustrate model-free prediction and control	3	3	-	3	-	-	-	-	-	-	-	-	-	-	2
<b>CLR-4:</b>	Introduce planning and learning with tabular methods	3	3	-	3	-	-	-	-	-	-	-	-	-	-	3
<b>CLR-5:</b>	Explain approximation of a value function	3	3	-	3	-	-	-	-	-	-	-	-	-	-	3

<b>Course Outcomes (CO):</b>		<b>At the end of this course, learners will be able to:</b>
<b>CO-1:</b>		Understand basic concepts of reinforcement learning
<b>CO-2:</b>		Perform model-based prediction and control using dynamic programming
<b>CO-3:</b>		Apply model-free prediction and control
<b>CO-4:</b>		Comprehend the use of tabular methods
<b>CO-5:</b>		Understand how a value function can be approximated

<b>Unit-1 - Introduction</b>																
<b>9 Hour</b>																
Introduction to Reinforcement learning, examples - Elements of reinforcement learning - Limitations and Scope- An extended example - multi-armed bandits - k-armed bandit problem - action-value methods - the 10-armed testbed - incremental implementation - tracking a nonstationary problem - optimistic initial values - upper-confidence-bound action selection - associative search (contextual bandits)																
T1: Implementing the 10-armed testbed																
T2: Comparing performance for different $\epsilon$ values																
T3: Upper-confidence bound action selection performance comparison with $\epsilon$ -greedy																
<b>Unit-2 - Markov Decision Process and Model-Based Prediction and Control</b>																
<b>9 Hour</b>																
Finite Markov Decision Process - The Agent-Environment Interface - Goals and Rewards - Returns and Episodes - Unified Notation for Episodic and Continuing Tasks - Policies and Value Functions - Optimal Policies and Optimal Value Functions - Optimality and Approximation - Dynamic Programming - Policy Evaluation (Prediction) - Policy Improvement - Policy Iteration - Value Iteration - Generalized Policy Iteration - Efficiency of Dynamic Programming - Asynchronous Dynamic Programming																
T4: MDP for Recycling Robot																
T5: Policies and value functions for Gridworld example																
T6: Policy evaluation for Gridworld example																

<b>Unit-3 - Model-Free Prediction and Control</b>	<b>9 Hour</b>
Model-free learning - Model-free prediction - Monte Carlo methods - Monte Carlo Prediction - Monte Carlo Estimation of Action Values - Temporal-Difference Learning - TD Prediction - Advantages of TD Prediction Methods - Optimality of TD(0) - n-step Bootstrapping - n-step TD Prediction - n-step Sarsa - Model-free control - Monte Carlo Control - Monte Carlo Control without Exploring Starts - Off policy learning - Importance sampling - Off-policy Monte Carlo Control - Sarsa: On-policy TD Control - Q-learning: Off-policy TD control	
T7: Monte Carlo Policy Evaluation for Blackjack	
T8: TD Prediction for Driving Home example	
T9: Sarsa vs Q-learning using Cliff Walking example	
<b>Unit-4 - Planning and Learning with Tabular Methods</b>	<b>9 Hour</b>
Models and planning - Dyna: Integrated Planning, Acting and Learning - When the model is wrong - Prioritized Sweeping - Real-time Dynamic Programming - Monte Carlo Tree Search	
T10: Simple maze using Dyna-Q	
T11: Prioritized sweeping on Maze example	
T12: Real-time Dynamic Programming for Racetrack example	
<b>Unit-5 - Value Function Approximation</b>	<b>9 Hour</b>
On-policy Prediction with Approximation - Value Function Approximation - The Prediction Objective (VE) - Stochastic-gradient and Semi-gradient Methods - Linear Methods - Least-Squares TD	
T13: State aggregation on the 1000-state Random Walk	
T14: Bootstrapping on the 1000-state Random Walk	
T15: Least squares TD example	

<b>Learning Resources</b>	1. Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An introduction, 2nd edition, The MIT Press, 2015. 2. Martijn van Otterlo, Marco Wiering, Reinforcement Learning: State-of-the-Art, Springer-Verlag Berlin Heidelberg, 2012. 3. Artificial Intelligence: A Modern Approach, Stuart J. Russell and Peter Norvig, 3rd edition, Pearson, 2015.	4. I. Goodfellow, Y. Bengio, A. Courville, Deep Learning, MIT Press Ltd., 2016. 5. <a href="https://deepmind.com/learning-resources/introduction-reinforcement-learning-david-silver">https://deepmind.com/learning-resources/introduction-reinforcement-learning-david-silver</a> 6. Reinforcement Learning with MATLAB, MathWorks Inc., 2020.
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<b>Learning Assessment</b>							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice		
Level 1	Remember	40%	-	40%	-	40%	
Level 2	Understand	40%	-	40%	-	40%	
Level 3	Apply	20%	-	20%	-	20%	
Level 4	Analyze	-	-	-	-	-	
Level 5	Evaluate	-	-	-	-	-	
Level 6	Create	-	-	-	-	-	
	Total	100 %		100 %		100 %	

<b>Course Designers</b>	<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
	1. Mr. Ghulam Ahmed Ansari, Applied Research Engineer, LinkedIn	1. Dr. Manikantan Srinivasan, , Adjunct Faculty, CSE, IIT Madras	1. Dr. Saad Y. Sait, SRMIST

<b>Course Code</b>	21CSE418T	<b>Course Name</b>	CYBER PHYSICAL SYSTEMS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Outline the basic concepts, requirements, principles, and techniques in emerging cyber physical systems	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
<b>CLR-2:</b>	Understand the components that define the physical and cyber aspects of real-world technologies.															
<b>CLR-3:</b>	Analyze the processing units applicable for cyber physical system.															
<b>CLR-4:</b>	Understand embedded systems vs Internet of Things implementing a cyber-physical system from a computational perspective															
<b>CLR-5:</b>	Acquire knowledge on Security and Privacy in Cyber Physical System															
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
<b>CO-1:</b>	Acquire the basic concepts and purpose of the different components of Cyber Physical Systems.	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
<b>CO-2:</b>	Analyze the new system and ability to interact with Cyber Physical System	1	2	2	-	-	-	-	-	-	-	-	-	2	-	-
<b>CO-3:</b>	Illustrate the abstraction of various system architectures and understand the semantics of a CPS model	2	2	-	-	-	-	-	-	-	-	-	-	1	-	2
<b>CO-4:</b>	Implement the ability to interact with cyber-physical systems protocols with Internet of Things	3	3	2	-	-	-	-	-	-	-	-	-	2	-	3
<b>CO-5:</b>	Apply the common methods used to secure cyber-physical systems	3	3	-	-	-	-	-	-	-	-	-	-	-	-	3

**Unit-1 - Framework for Cyber-Physical Systems (CPS)** 9 Hour  
 Introduction to CPS- IoT Vs CPS- Concept map- CPS analysis by example- Application Domains-Significance of CPS- Hybrid System Vs. CPS- Multi dynamical system- Component of CPS- Physical- Cyber and Computational Components.

**Unit-2 - Physical Components** 9 Hour  
 Introduction to sensors and actuators – Deployment- assignment and coordination – Network criteria designs- Importance of sensors- causality-sensor reliability-memory requirement- computational complexity-redundant sensors-Operational criteria- Testbed.

**Unit-3 - Cyber Components** 9 Hour  
 Networking technologies for CPS- sensing networks and data connectivity- M2M communication- characteristics of IP and Non-IP solutions, 6LoWPAN, RPL- CoAP and HTTP- CoAP- Mobile cloud computing- Definition and types.

**Unit-4 - Computational Components** 9 Hour  
 Embedded system design flow for CPS- processing units-Overview-ASIC-Processor-DSP, Multimedia processor- VIEW-microcontroller and MPSoC- Reconfigurable logics.

**Unit-5 - Secure Deployment of CPS & Applications of CPS** 9 Hour  
 Secure Task mapping and Partitioning - State estimation for attack detection - Automotive Vehicle ABS hacking - Power Distribution Case study: Attacks on Smart Grids – Virtual Instrumentation; Case study: Applications of CPS.

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. A. Platzer, <i>Logical Foundations of Induction</i>. 2018</li> <li>2. <i>Principles of Cyber Physical Systems</i>, Rajeev Alur, MIT Press, 2015</li> <li>3. E. A. Lee, Sanjit Seshia , "Introduction to Embedded Systems – A Cyber–Physical Systems Approach", Second Edition, MIT Press, 2017, ISBN: 978-0-262-53381-2</li> <li>4. P. Ashok, G. Krishnamoorthy, and D. Tesar, "Guidelines for managing sensors in cyber physical systems with multiple sensors," <i>J. Sensors</i>, vol. 2011, 2011.</li> <li>5. P. Marwedel, <i>Embedded System Design: Embedded system foundations of Cyber-Physical Systems</i>, vol. 16. 2010.</li> <li>6. Wolf, Marilyn. <i>High-Performance Embedded Computing: Applications in Cyber-Physical Systems and Mobile Computing</i>. Elsevier, 2014.</li> <li>7. Guido Dartmann, Houbing Song, Anke Schmeink, "Big data analytics for Cyber Physical System", Elsevier, 2019</li> <li>8. Chong Li, Meikang Qiu, "Reinforcement Learning for Cyber Physical Systems with Cyber Securities Case Studies", CRC press, 2019</li> <li>9. Christopher Greer, Martin Burns, David Wollman, Edward Griffor "Cyber-Physical Systems and Internet of Things", NIST Special Publication, <a href="https://doi.org/10.6028/NIST.SP.1900-202">https://doi.org/10.6028/NIST.SP.1900-202</a></li> </ol>
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<b>Learning Assessment</b>		<b>Continuous Learning Assessment (CLA)</b>				<b>Summative Final Examination (40% weightage)</b>	
<i>Bloom's Level of Thinking</i>	<i>Formative CLA-1 Average of unit test (50%)</i>	<i>Life-Long Learning CLA-2 (10%)</i>					
		<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>
	<i>Remember</i>	50%	-	20%	-	20%	-
Level 1	<i>Understand</i>	50%	-	30%	-	30%	-
Level 2	<i>Apply</i>	-	-	20%	-	20%	-
Level 3	<i>Analyze</i>	-	-	30%	-	30%	-
Level 4	<i>Evaluate</i>	-	-	-	-	-	-
Level 5	<i>Create</i>	-	-	-	-	-	-
<i>Total</i>		100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr.Ponnambalam Mudivai Arun, Director of Products Citrix System, Bangalore	1. Dr. Munesh Pal Singh,IITDM,Kancheepuram 2. Dr. N.Balaji, SSN College of Engineering	1. Dr. Krishnaveni, SRMIST

<b>Course Code</b>	21CSE421T	<b>Course Name</b>	BUSINESS INTELLIGENCE AND ANALYTICS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1 :</b>	Familiarize with Business Intelligence, Analytics and Decision Support												<b>PSC-1</b>	<b>PSC-2</b>	<b>PSC-3</b>										
<b>CLR-2 :</b>	Understand the technologies for Decision making												-	-	-										
<b>CLR-3 :</b>	Familiarize with predictive modeling techniques												-	-	-										
<b>CLR-4 :</b>	Familiarize with sentiment analysis techniques												-	-	-										
<b>CLR-5 :</b>	Understand about Decision making systems												-	-	-										
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>												Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	
<b>CO-1:</b>	Gain knowledge on Business Intelligence, Analytics and Decision Support												-	-	-	-	-	-	-	-	1	-	-		
<b>CO-2:</b>	Understand the technologies for Decision making												-	-	-	-	-	-	-	-	-	2	-		
<b>CO-3:</b>	Apply predictive modeling techniques												-	-	-	-	-	3	-	3	-	-	2	-	
<b>CO-4:</b>	Apply sentiment analysis techniques												-	-	-	-	-	3	-	3	-	-	-	2	
<b>CO-5:</b>	Gain knowledge on Decision making systems												-	-	-	-	-	3	-	3	-	-	-	1	1

#### **Unit-1 - Introduction: Business Intelligence, Analytics and Decision Support** 9 Hour

Information Systems Support for Decision Making - An Early Framework for Computerized Decision Support - The Concept of Decision Support Systems - A Framework for Business Intelligence - Business Analytics Overview - Brief Introduction to Big Data Analytics - Clickstream Analysis – Metrics - Clickstream Analysis - Practical Solutions - Competitive Intelligence Analysis

T1: Introduction to Power BI and SSMS

T2: Installing Power BI and SSMS

T3: Prepare data in Power BI Desktop

#### **Unit-2 - Decision Making** 9 Hour

Decision Making - Introduction and Definitions - Phases of the Decision - Making Process - The Intelligence Phase - Design Phase - Choice Phase - Implementation Phase - Decision Support Systems Capabilities - Decision Support Systems Classification - Decision Support Systems Components

T4: Load data in Power BI Desktop

T5: Model data in Power BI Desktop part-1

T6: Model data in Power BI Desktop part-2

#### **Unit-3 - Predictive modeling and sentiment analysis** 9 Hour

Basic Concepts of Neural Networks - Developing Neural Network - Based Systems - Illuminating the Black Box of ANN with Sensitivity - Support Vector Machines - A Process Based Approach to the Use of SVM - Nearest Neighbor Method for Prediction -Sentiment Analysis Overview - Sentiment Analysis Applications - Sentiment Analysis Process - Sentiment Analysis - Speech Analytics

T7: Implement data model using SQL in Power BI

T8: Create DAX calculations in Power BI Desktop part-1

T9: Create DAX calculations in Power BI Desktop part-2

<b>Unit-4 - Multi-criteria Decision making systems</b>	<b>9 Hour</b>
Decision Support Systems modeling - Structure of mathematical models for decision support - Decision making under certainty - Uncertainty and Risk - Decision modeling with spreadsheets - Mathematical programming optimization - Decision analysis introduction - Decision tables - Decision Trees - Multi-criteria decision making - Pairwise comparisons	
T10: Design a report in Power BI Desktop part-1	
T11: Design a report in Power BI Desktop part-2	
T12: Create a Power BI dashboard	
<b>Unit-5 - Automated Decision Systems</b>	<b>9 Hour</b>
Automated Decision Systems - The Artificial Intelligence field - Basic concepts of Expert Systems - Applications of Expert Systems - Structure of Expert Systems - Knowledge Engineering - Development of Expert Systems - Location based Analytics - Cloud Computing - Business Intelligence	
T13: Create a Power BI paginated report	
T14: Perform data analysis in Power BI Desktop	
T15: Enforce Row-level security	

<b>Learning Resources</b>	1. Ramesh Sharda, Dursun Delen, Efraim Turban, J.E. Aronson, Ting-Peng Liang, David King, "Business Intelligence and Analytics: System for Decision Support", 10 <sup>th</sup> Edition, Pearson Global Edition, 2013. 2. Brett Powell, "Mastering Microsoft Power BI: Expert techniques for effective data analytics and business intelligence", 2018	3. Alberto Ferrari Marco Russo, "Definitive Guide to DAX, The: Business intelligence for Microsoft Power BI, SQL Server Analysis Services, and Excel", Second Edition, By Pearson, 2020
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<b>Learning Assessment</b>						
Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%
Level 2	Understand	25%	-	20%	-	25%
Level 3	Apply	30%	-	25%	-	30%
Level 4	Analyze	30%	-	25%	-	30%
Level 5	Evaluate	-	-	10%	-	-
Level 6	Create	-	-	5%	-	-
	Total	100 %		100 %		100 %

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr.V.Selvakumar,Hexaware Technologies, selvakumars@hexaware.com	1. Dr. T. Veerakumar, Professor, NIT Goa	1. Dr. T. Karthick, SRMIST

**ACADEMIC CURRICULA**

**UNDERGRADUATE/ INTEGRATED POST  
GRADUATE DEGREE PROGRAMMES**

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume - 11C

(Syllabi for Computer Science and Engineering w/s in  
Software Engineering Programme Courses)



**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

# ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021



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(Deemed to be University u/s 3 of UGC Act, 1956)

**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

<b>Course Code</b>	21CSC309J	<b>Course Name</b>	SOFTWARE ARCHITECTURE AND DESIGN	<b>Course Category</b>	C	PROFESSIONAL CORE	L 2	T 0	P 2	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>			
<b>CLR-1:</b>	Classify the essential elements of software architecture												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>		
<b>CLR-2:</b>	Understand the issues related to architecting a large-scale software system												-	-	-		
<b>CLR-3:</b>	Understand different software architectures views and styles												-	-	-		
<b>CLR-4:</b>	Able to use the four-views approach for developing and documenting a software architectures												-	-	-		
<b>CLR-5:</b>	Understand the implications of different design patterns and critique an architecture of a software system												-	-	-		
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>			
<b>CO-1:</b>	Describe different approaches to design software application												-	-	-	3	
<b>CO-2:</b>	Analyze specifications and identify appropriate design strategies.												2	3	-	2	-
<b>CO-3:</b>	Develop an appropriate design for a given set of requirements												-	-	-	2	-
<b>CO-4:</b>	Identify applicable design patterns for the solution												-	3	-	3	-
<b>CO-5:</b>	Abstract, document and evaluate reusable design patterns specifications												1	-	-	-	3

<b>Unit-1 - Introduction to Software Architecture</b>	<b>12 Hour</b>
Software Architecture –Software Design, Importance and Need of Software Architecture, 4 +1 View Model, Activities in Software Architecture, Fundamental design issues, Understanding quality attributes, Six parts of Quality Scenario, Design for quality attributes - Availability, Design for quality attributes - Modifiability, Design for quality attributes – Security, Design for quality attributes - Usability, Testability (General Scenario, Tactics)	

<b>Unit-2 - Software Architecture Patterns</b>	<b>12 Hour</b>
Software Architectural Patterns & Styles, Types of Architectural Styles, Layered pattern, Merits and Demerits of Layered Pattern, Pipe-Filter pattern, Merits and Demerits of Pipe and Filter, Shared Data Pattern, Merits and Demerits of Shared Data Pattern, Client Server pattern, Merits and Demerits of Client Server, Blackboard Architectural Pattern, Merits and Demerits, Flight Simulation: A Case Study in an Architecture for Integrability, Relationship to the Architecture Business Cycle, Requirements and Qualities related to flight simulation, Architectural Solution for flight simulation	

<b>Unit-3 - Software Architecture Analysis</b>	<b>12 Hour</b>
Evaluating a Software Architecture, evaluate Architecture, What Qualities Can We Evaluate an Architecture?, Outputs of an Architecture Evaluation, Evaluating the Architecture – ATAM, Participants and Outputs of ATAM, Phases of ATAM, CASE Study for ATAM, Evaluating the Architecture – CBAM, Decision-Making Context, Basis for the CBAM - Case Study A, Evaluating Software Architecture - SAAM D, SAAM Evaluation Process, Evaluating Software Architecture – ARID, ARID Evaluation Process	

<b>Unit-4 - Design Process</b>	<b>12 Hour</b>
Introduction to Design Process, Design Strategy, Describing the design process the D-Matrix,, Views associated with D-matrix, Design by top-down decomposition, Design by composition, Function-oriented design, Object-oriented design, Aspect Oriented Design, Design Metrics - Need for Metrics, WMC –DIT, NOC – CBC, RFC - LCOM	

<b>Unit-5 - Design Patterns</b>	<b>12 Hour</b>
Introduction to Design Pattern, Component of Design Pattern – Types, Creational Design Pattern - Abstract Factory Pattern, Factory Method, Singleton Pattern, Structural design Pattern – Types, Adaptor pattern, Decorator Pattern, Proxy Pattern, Behavioral Design Pattern – Types, Observer Pattern, Strategy Pattern, Iterator pattern, Introduction to ADL, Components of ADL- Example, Future Directions in Architecture	
<b>Practice</b>	
<b>Lab1:</b> Introduction to Design patterns. Describe the organization of catalogue along with the following design patterns. a. Creational Patterns. b. Structural Patterns. c. Behavioral Patterns.(Use case Diagram for Scenario to work on future Labs) <b>Lab2:</b> Program to implement Factory pattern. <b>Lab3:</b> Program to implement abstract factory. <b>Lab4:</b> Program to implement Singleton pattern	<b>Lab5:</b> Program to implement Composite design pattern <b>Lab 6:</b> Program to implement decorator pattern <b>Lab 7:</b> Program to implement proxy design pattern. <b>Lab 8:</b> Program to implement Iterator Design pattern <b>Lab 9:</b> Program to design mediator pattern <b>Lab 10:</b> program to implement visitor pattern.

<b>Learning Resources</b>	1. Len Bass, Paul Clements, & Rick Kazman. Software Architecture in Practice (Third Edition). AddisonWesley,2013 2. Mark Richard, Neal Ford. Fundamentals of Software Architecture: An Engineering Approach, O'Reilly, 2020 3. Humberto Cervantes, Rick Kazman, Designing Software Architectures: A Practical Approach. Pearson Education,2016 4. CarlosOtero,"Software Engineering Design: Theory and Practice", CRC Press, 2012. 5. Paul Clements, Rick Kazman, Mark Klein, Evaluating Software Architectures: Methods and Case Studies. Addison Wesley; 1 edition (22 October2001)	6. Jason McC. Smith, –Elemental design Patternsll. Addison Wesley, 2012 VasudevaVarma, Software Architecture: A Case Based Approach. Pearson Education,2009. 7. Adrian Ostrowski, Piotr Gaczkowski · "Software Architecture with C++ - Design Modern Systems Using Effective Architecture Concepts, Design Patterns, and Technique with C++", Packt Publishing, 2021. 8. Essential Software Architecture (2. Ed.). 9. <a href="https://www.researchgate.net/publication/220690558_Essential_Software_Architecture_2_ed">https://www.researchgate.net/publication/220690558_Essential_Software_Architecture_2_ed</a> , 2011.
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Learning Assessment						
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)		
		Theory	Practice	Theory	Practice	Theory
Level 1	Remember	20%	-	-	10%	10%
Level 2	Understand	20%	-	-	20%	20%
Level 3	Apply	30%	-	-	30%	30%
Level 4	Analyze	20%	-	-	40%	40%
Level 5	Evaluate	-	-	-	-	-
Level 6	Create	-	-	-	-	-
	Total	100 %		100 %		100 %

Course Designers		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Dr.Mariappan Vaithilingam, Engineering Leader Amazon, dr.v.m@ieee.org 2. Mr. Badinath, SDET, Amzon, sbadhrinath@gmail.com	1. Dr.B. Dhanalakshi, AP-CSE, BS Abdul Rahman Crescent, Chennai.	1. Mrs. Sasi Rekha Sankar, SRMIST

<b>Course Code</b>	21CSC403T	<b>Course Name</b>	SOFTWARE MEASUREMENTS AND METRICS	<b>Course Category</b>	C	PROFESSIONAL CORE	L 3	T 0	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>												
<b>CLR-1:</b>	Familiarize with different metrics used in different process levels												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>											
<b>CLR-2:</b>	Apply metrics knowledge to measure Engineering problems																									
<b>CLR-3:</b>	Improve their ability in making decisions via continuous practice like assessment and usage of metrics.																									
<b>CLR-4:</b>	Design, implement, and change metrics based on industry practice																									
<b>CLR-5:</b>	Discuss current research trends in software metrics																									
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	
<b>CO-1:</b>	Understand and measure the software features													2	2	-			-	-	-	-	-	3		
<b>CO-2:</b>	Understand the need of software quality													3	3	-		3	-	-	-	2	-	2	-	-
<b>CO-3:</b>	Will be able to understand the software development tools													3	2	2	-	-	-	-	-	2	-	-	-	-
<b>CO-4:</b>	Evaluate the stages of process improvement and its necessities in Development Life Cycle													-	2	-	-	3	-	-	-	-	2	-	-	-
<b>CO-5:</b>	Apply the process quality models in development life cycle													-	2	-	-	-	-	-	-	-	-	-	-	-

**Unit-1 - Introduction** 9 Hour  
Software Sizing Metrics- Fundamentals in Measurement- Basic Measures- Reliability and Validity- Measurement Errors- Assessing Reliability- Evolution in software Metrics- Functional Size Measurements- Cost of counting function point metrics- Software measures and metrics not based on function points- Future Technical Developments in Functional Metrics- Case Study to Measure software size using various size Metrics

**Unit-2 - Metrics and Models** 9 Hour  
Complexity Metrics and Models- Lines of Code- Halstead's Software Science- Cyclomatic Complexity- Syntactic Constructs- Structure Metrics- Case Study for the usage of complexity metrics with tools- Testing Metrics: Test Progress S Curve- Testing Defect Arrivals Over Time- Product Size Over Time- CPU Utilization- Effort/Outcome Model- Case Study to apply Testing metrics

**Unit-3 - Sampling Methods** 9 Hour  
Customer Satisfaction Surveys: Methods of survey data collection- Analyzing Satisfaction with practice- Satisfaction with Company terms- Metrics for Object-Oriented Projects with tools- Concepts and Constructs- Design and Complexity Metrics- Lorenz Metrics and Rules of Thumb- CK OO Metrics Suite- Productivity Metrics- Case Study for the usage of Object-oriented metrics with tools

**Unit-4 - Software Quality Model** 9 Hour  
Software Quality - Five steps to software quality control- Product Quality Metrics with practice- In-Process Quality Metrics- Metrics for Software Maintenance- shikawa's Seven Basic Tools with practice- Defect removal Effectiveness The Rayleigh Model- Reliability Growth Models - Jelinski Moranda Model- Goel-Okumoto Model- Musa-Okumoto Model

**Unit-5 - Software Process Assessment** 9 Hour  
Conducting In-Process Quality Assessments- The Preparation Phase- The Evaluation Phase- The Summarization Phase- Conducting Software Project Assessments- Audit and Assessment- Software Process Maturity Assessment and Software Project Assessment- Software Process Assessment Cycle- Measures and metrics of industry leaders- Measures and metrics of industry leaders- Measures, Metrics, Innovation- Measurements, Metrics and outsource Litigation- Software Process Improvement Sequences- Measuring Process Maturity- Measuring Process Capability

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>Stephen H. Kan, "Metrics and Models in Software Quality Engineering", Addison Wesley, Second Edition, 2020</li> <li>Caper Jones, "Applied Software Measurement: Global Analysis of Productivity and Quality", Third Edition, McGraw Hill Companies, 2020</li> <li>Mark Lorenz, Jeff Kidd, "Object-Oriented Software Metrics", Prentice Hall, 2000</li> <li>Naresh Chauhan, "Software Testing Principles and Practices", Oxford University Press, 2010.</li> <li>Ravindranath Pandian C, "Software Metrics A Guide to Planning, Analysis, and Application", Auerbach, First Indian Reprint, 2011</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>	
<i>Bloom's Level of Thinking</i>	<i>Formative CLA-1 Average of unit test (50%)</i>	<i>Life-Long Learning CLA-2 (10%)</i>					
		<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>
Level 1	Remember	30%	-	20%	-	20%	-
Level 2	Understand	30%	-	40%	-	40%	-
Level 3	Apply	40%	-	40%	-	40%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. Girish Raghavan, Senior DMTS Member, Wipro Ltd.	1. Dr.N.Prakash, Associate Professor, Department of Information technology, B.S.A Crescent Institute of Science and Technology.	1. Mrs.B.Jothi SRMIST

<b>Course Code</b>	21CSC404T	<b>Course Name</b>	SOFTWARE VERIFICATION AND VALIDATION	<b>Course Category</b>	C	PROFESSIONAL CORE	L 3	T 0	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Provide an understanding of concepts and techniques for testing software												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Prepare test plan based on the requirement document, design test plans and document test plans															
<b>CLR-3:</b>	Design test cases suitable for a software development in various domains															
<b>CLR-4:</b>	Validate and document test cases, assuring software component or system satisfies its requirements and meets stakeholder expectations															
<b>CLR-5:</b>	Use of automation testing tools															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CO-1:</b>	Identify, design different types of test cases for software development in any domain												3	3	3	3
<b>CO-2:</b>	Design, develop, implement, validate, and document test plans at various levels												3	3	-	-
<b>CO-3:</b>	Develop Test cases for a given Software/System Specification												3	3	-	-
<b>CO-4:</b>	Validate Test Cases with the Requirement Specifications												3	3	-	-
<b>CO-5:</b>	Use various automation tools to implement test cases												3	3	-	-

**Unit-1 - Introduction** 9 Hour  
Fundamentals of Testing: Necessity of Testing-Case Studies on “Impact of Software bugs”, Objectives of Testing, Basics Definitions, Testing Principles-Illustrations, Fundamental Test Process, The tester’s role in a software development organization, Test Planning, Establishing Test Policy, Structured approach to testing Test Factors, Eleven Step software testing process, Origin of Defects, Defect Repository and Test Design, Developer/Tester support of developing a defect repository, Defect Examples, Case Studies – “Identify the defect”, Defect Analysis and Prevention Strategies, Project: Developing adhoc test cases for a case study

**Unit-2 - Test Case Design Strategies** 9 Hour

Test Case Design Strategies: Introduction to basic design strategies. White Box Strategies - Peer Reviews, Inspections, Walkthrough, Comparative Analysis, Static Analysis Tools: Coding Standards, Code Metrics, Code Structure, Activity: Static Analysis of a source code, Coverage and Control Flow Graphs, Activity: Calculate Complexity for a given source code, Paths Code Complexity, Activity: Calculate Path Code Complexity for a given source code, Evaluating test adequacy criteria, Case Studies-“Applying the suitable White Box Strategy”, Black Box Testing Strategies: Requirements Based Testing, Random Testing, Boundary Value Analysis, Equivalence Class Partitioning, Cause Effect graphing , Activity: Designing test cases for the given requirement specification using Boundary value analysis and Equivalence Class Partitioning, cause effect graphing and developing decision tables

**Unit-3 - Levels of Testing** 9 Hour

The need for levels of testing, Unit Testing: Planning, Test Harness , Running the tests Recording Results , Integration Testing: Goals, Design and Plan, Integration Testing: Goals, Design and Plan, Performance Testing, Stress Testing ,Configuration Testing, Security Testing, Recovery Testing, Reliability Testing, Usability Testing, Regression Testing, Alpha, Beta and Acceptance Testing, Role of use cases in testing, Applying Testing Skills: Compatibility testing, Internationalization testing, Testing Documentation plan, Recording test cases, Reporting and Measurement of Success

<b>Unit-4 - Test Management</b>	<b>9 Hour</b>
Test Management: Choice of Standards, Infrastructure Management, Test People Management, Test Plan Components, Test Plan Attachments, Locating Test Items, Managing Issues, Addressing Perception, Taking team together, Document Uses and Types, Test Analysis report Documentation, Analyze reports and Problem tracking, Controlling and Monitoring Test Progress, Test Metrics and measurements: Role, need and types, Project Metrics with Practice, Progress Metrics with Practice, Productivity Metrics with Practice	
<b>Unit-5 - Software Test Automation</b>	<b>9 Hour</b>
Software Test Automation: Skills and Scope Design, Architecture for Automation, Requirements for a test tool, Process Model for Automation, Selecting the test tool, Demonstration of a Functional Testing Tool, Demonstration of a Web Testing Tool Demonstration of a Unit Testing Tool, Demonstration of an Test Management Tool , Challenges in Automation, The Future: Software Quality Assurance	

<b>Learning Resources</b>	1. Srinivasan Desikan and Gopalaswamy Ramesh, "Software Testing – Principles and Practices", Pearson Education, 2006 2. Ron Patton, "Software Testing", Second Edition, Sams Publishing, Pearson Education, 2007. 3. Ilene Burnstein, "Practical Software Testing", Springer International Edition, 2003.	4. Aditya P. Mathur, "Foundations of Software Testing _ Fundamental Algorithms and Techniques", Dorling Kindersley (India) Pvt. Ltd., Pearson Education, 2008 5. Renu Rajani, Pradeep Oak, "Software Testing-Effective Methods, Tools and Techniques", Tata McGraw Hill Education, 2011.
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)	Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice		
Level 1	Remember	30%	-	20%	-	20%	
Level 2	Understand	30%	-	40%	-	40%	
Level 3	Apply	40%	-	40%	-	40%	
Level 4	Analyze	-	-	-	-	-	
Level 5	Evaluate	-	-	-	-	-	
Level 6	Create	-	-	-	-	-	
	Total	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. ShrikantSatyanarayan, Technical Manager LDRA Technology PVT LTD 2. Mr. Girish Raghavan, Senior DMTS Manager, Wipro Technologies	1. Dr. N. Bhalaji, Associate Professor, SSN Institutions	1. Mrs. Anupama.C.G, SRMIST 2. Mr. Arun C , SRMIST

# ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021



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Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

<b>Course Code</b>	21CSE275T	<b>Course Name</b>	REQUIREMENTS ENGINEERING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Identify the sources, collect, organize, and classify the requirements												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Improve their ability to choose the appropriate Elicitation Techniques for any systems															
<b>CLR-3:</b>	Familiarize with the various requirements documentation and validation techniques															
<b>CLR-4:</b>	Familiarize with the various requirements quality drivers, Traceability models and requirements change control techniques															
<b>CLR-5:</b>	Expose to the Conflicts, Escalation model, Settlements, Analytics of Cost Benefit analysis and tools															
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Acquire the knowledge on identifying the Source, organizing, and classifying requirements															
<b>CO-2:</b>	Acquire the ability to identify and apply the appropriate Elicitation Techniques for any systems															
<b>CO-3:</b>	Understand the basic ideas about various requirements documentation and validation techniques															
<b>CO-4:</b>	Apply the knowledge on various requirements quality drivers, Traceability models and requirements change control techniques for any system															
<b>CO-5:</b>	Appreciate the concepts of Conflict, Escalation model, Settlements, Analytics of Cost Benefit analysis and requirements engineering tools															

**Unit-1 - Requirement Engineering** **9 Hour**  
 Introduction to Requirements and Requirements Engineering, Requirements Types, Classification of Requirements , Requirements Gathering relevant to Software Life Cycle Models, Stakeholders in the requirements, Requirements Engineering Process Framework, Requirements Engineering Maturity Model process, Generic Process for requirements, Levels of Requirements Engineering, System Model for Requirements Engineering, Representation of Requirements-Data Flow, ER Diagram, View Point Controlled Requirements, Structured Analysis and Design Technique, Viewpoint Oriented Requirements Definition, Object Oriented Methods of Requirements Engineering, Case Study : For the given application identify the stakeholders, gather and classify the requirements according to the types

**Unit-2 - Elicitation** **9 Hour**  
 Requirement Inception, sources of requirements, Introduction to requirement Elicitation, Classical Elicitation Techniques-Interview, Questionnaire, Social analysis, Modern Elicitation Techniques- Brainstorming, Modern Elicitation Techniques- Prototyping, Use Centered Design, Modern Elicitation Techniques- Walkthrough, Use case Joint Application Development, Requirement reuse, Feature Oriented Domain Analysis, Case Study: For the given application apply various techniques and Elicitation the requirements

**Unit-3 - Documentation** **9 Hour**  
 Introduction to Requirement Document, Structure of Document, Vision, Scope and Elicitation notes, Requirement Specification techniques, Introduction to requirement validation- Classical Requirement Validation techniques-Inspection, Simple Check, . Introduction to requirement validation- Classical Requirement Validation Techniques-Desk Check, Walkthrough, Format review, Prototype & Enactments, Functional test Design, Development of User manual, Case study. For the given application validate and document the specifications

<b>Unit-4 - Traceability</b>	<b>9 Hour</b>
Business drivers of Quality-components of Integrated Quality approach, Quality improvement techniques, Requirements Quality Assurance, PDCA Cycle, Introduction to Requirement Management- Requirement Identification-Requirements Traceability, Requirement Traceability models, Traceability Matrix- Traceability List & Tree, Introduction to Requirement Traceability- Requirement traceability methods, Advance Traceability, Requirement Change Control	
<b>Unit-5 - Conflicts &amp; Cost Benefit Analysis</b>	<b>9 Hour</b>
Conflict types, Mastering and using detection of the 5 conflicts types on the basis of indication in project, Glasl's conflicts escalation model, Conflicts Settlement techniques, Analytic Methods – Mastering and using Consider All Facts (CAF), Analytic Methods – Plus –Minus- Interesting(PMI), Analytic Methods – Cost Benefit Analysis, Case study : Requirement Engineering Tools	

<b>Learning Resources</b>	1. Elizabeth Hull, Ken Jackson, Jeremy Dick, Requirements Engineering, Springer, 2013	5. A. Laplante, Mohamad h. Kassab, Requirements Engineering for Software and Systems, CRC Press, 2022
	2. Ralph R. Young, "The Requirements Engineering Handbook", 2004	6. Jeremy Dick, Elizabeth Hull, Ken Jackson, Requirements Engineering, Springer International Publishing, 2018.
	3. Axel van Lamsweerde, "Requirements Engineering: From System Goals to UML Models to Software Specifications", Wiley, 2014	7. Requirements Engineering – Springer E-Learning Material, <a href="https://www.springer.com/journal/766">https://www.springer.com/journal/766</a>
	4. Karl Wiegers, Joy Beatty, Software Requirements (Developer Best Practices) (3rd Edition), Microsoft Press, 2014.	

Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	30%	-	20%	-	20%	-		
Level 2	Understand	30%	-	40%	-	40%	-		
Level 3	Apply	40%	-	40%	-	40%	-		
Level 4	Analyze	-	-	-	-	-	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Mariappan Vaithilingam, Engineering Leader Amazon, dr.v.m@ieee.org 2. Mr. Badinath, SDET, Amzon, sbadrinath@gmail.com	1. Dr. B. Dhanalakshi, AP-CSE, BS Abdul Rahman Crescent, Chennai.	1. Mrs. Sasi Rekha Sankar, SRMIST

<b>Course Code</b>	21CSE276T	<b>Course Name</b>	SOFTWARE QUALITY MANAGEMENT	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Learn the fundamentals of Software Quality and its standards.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Introduce the concepts of Software Engineering principles.															
<b>CLR-3:</b>	Gain Knowledge on Quality tasks and testing.															
<b>CLR-4:</b>	Become familiar with the elements of the quality management system and quality tools.															
<b>CLR-5:</b>	Learn the basics of TQM and quality systems.															

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CO-1:</b>	Apply the concepts of software quality factors and its challenges.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CO-2:</b>	Understand the characteristics of Software Quality Assurance.															
<b>CO-3:</b>	Solve the issues in quality tasks and testing.															
<b>CO-4:</b>	Articulate the elements of quality management system and software quality tools.															
<b>CO-5:</b>	Utilize the concepts of TQM and quality systems.															

<b>Unit-1 - Introduction</b>	<b>9 Hour</b>
Software Quality - The Software Quality Factors and Challenges - Quality measurement – Metrics measurement and analysis – Gilb's approach - Demystifying Quality Concepts - Software Quality Processes (Agile Methods) – role of process frameworks - methodologies and tools – CMM and CMMI – Seven QC Tools - Six Sigma concepts	
<b>Unit-2 - Software Engineering Principles</b>	<b>9 Hour</b>
Introduction to Software Engineering principles - Software Project Management - Software Processes - Project Metrics - Process Metrics – object-oriented metrics – Software Configuration management – importance of SCM - SCM processes- Identification of objects in SCM – version control – change control – configuration audit – status reporting - SCM Tools - Risk Management -	
<b>Unit-3 - Quality Tasks and Testing</b>	<b>9 Hour</b>
Quality tasks - SQA Activities – defect prevention and defect detection - defect measurement and analysis - Software Testing – Testing strategies—white-box and black-box testing—introducing Usage Based Testing and Coverage Based Testing – Testing Techniques - Partition Based Testing, Testing based on Check-lists, Usage Based Statistical Testing and Coverage Based Testing - Reviews and Inspections – walkthroughs - Fault Tolerance Basics – Fault Tolerance Techniques- Review of SQA activities in the Organization - Analyse cost of SQA activities Vs overall software development effort - trade-offs in cost-of-quality vs cost-of-delivery; Case Study - Testing	

<b>Unit-4 - Software Quality Tools</b>	<b>9 Hour</b>
Tools for Quality – Ishikawa's basic tools – CASE tools – Defect prevention and removal – Quality Planning in Projects - Quality Plan document - Quality Metrics and Base lining - measurement and control in project management - S.M.A.R.T attributes - Software Product Metrics & Defect Propagation - Internal vs. External software attributes - types of product metrics (Static vs. Dynamic) - Reliability models – Rayleigh model – Reliability growth models for quality assessment - Elements of QMS – planning the implementation of QMS - The quality charter – changing the organizational culture – Organizational considerations – development organization considerations – Implementation strategies – SQS improvement - Reliability Growth models for QMS – Complexity metrics and models – Customer satisfaction analysis; Case Study - Software Quality Tools	
<b>Unit-5 - TQM and Quality Systems</b>	<b>9 Hour</b>
Introduction to TQM - Software reuse for TQM - Software testing methods for TQM - Defect prevention and TQM - Zero defect software development - Clean Room Engineering – Benefits of ISO registration – ISO 9000 series of standards – sector specific standards - AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements—Implementation— Documentation—Internal Audits—Registration. ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction—ISO 14000 Series Standards—Concepts of ISO 4001—Requirements of ISO 14001—Benefits of EMS - GQM Model - Hierarchical models of Boehm and McCall -- role of process frameworks	

<b>Learning Resources</b>	1. Nitin C Shah, "Software Quality Assurance and Testing for Beginners", 2019.	7. Roger pressman "Software engineering" 5th edition McGraw hill 1999.
	2. Besterfield Dale H., Besterfield Carol, ET "al., "Total Quality Management (TQM)" 5e by Pearson by 2018.	8. G.Gordan Schulmeyer, James "Total Quality Management for software" International Thomson computer press 1998.
	3. Jeff Tian, "Software Quality Engineering", Wiley India, 2015.	9. <a href="http://www.sei.cmu.edu/cmmi/">http://www.sei.cmu.edu/cmmi/</a>
	4. Allan C. Gillies, "Software Quality: Theory and Management", Thomson Learning, 2003. (UI: Ch 1-4 ; UV : Ch 7-8)	10. <a href="http://www.scs.shtr.org/pccm1.html">http://www.scs.shtr.org/pccm1.html</a>
	5. Stephen H. Kan, "Metrics and Models in Software Quality Engineering", Pearson Education (Singapore) Pte Ltd., 2002. (UI: Ch 3-4; UIII: Ch 5-8; UV: Ch 9-11).	11. <a href="http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA512354">http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA512354</a>
	6. Watt S Humphery "Managing software process", Addison – Wesley 1998.	12. <a href="http://www.isixsigma.com/hew-to-six-sigma/getting-started/what-six-sigma/">http://www.isixsigma.com/hew-to-six-sigma/getting-started/what-six-sigma/</a> <a href="http://www.iso.org/iso/catalogue_detail?csnumber=21823">http://www.iso.org/iso/catalogue_detail?csnumber=21823</a>
		13. <a href="http://www.math.mun.ca/~variyyath/7QC.pdf">http://www.math.mun.ca/~variyyath/7QC.pdf</a>
		14. <a href="http://www.softwaresixsigma.com/PDFs/0103%20NjSpin1.pdf">http://www.softwaresixsigma.com/PDFs/0103%20NjSpin1.pdf</a>

Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1 Remember	30%	-	20%	-	20%	-
Level 2 Understand	30%	-	40%	-	40%	-
Level 3 Apply	40%	-	40%	-	40%	-
Level 4 Analyze	-	-	-	-	-	-
Level 5 Evaluate	-	-	-	-	-	-
Level 6 Create	-	-	-	-	-	-
Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.R. Durairaj, Clayfin Technologies Private Limited, Chennai	1. Dr.M.S. Bhuvaneswari, Asso. Professor, Mepco Schlenk Engineering College, Sivakasi	1. Dr.R. Beaulah Jeyavathana, SRMIST

<b>Course Code</b>	21CSE277T	<b>Course Name</b>	SOFTWARE PROCESS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the basic concepts of software Process												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Discuss various Phases of Software Process and its Economics															
<b>CLR-3:</b>	Acquire Knowledge on Process Workflow and Planning.															
<b>CLR-4:</b>	Understand the knowledge of process metrics and Risk Management															
<b>CLR-5:</b>	Gain knowledge using SPM case studies															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12			
<b>CO-1:</b>	Acquire the Knowledge of various software process maturity models.															
<b>CO-2:</b>	Understand the software economics and different phases.															
<b>CO-3:</b>	Apply the knowledge of software Process checkpoints and workflows.															
<b>CO-4:</b>	Identify the various risks in Process Metrics															
<b>CO-5:</b>	Design and Develop software Products using conventional and model principles of SPM.															

**Unit-1 - Software Process** 9 Hour  
Maturity Software Maturity Framework, Principles of Software Process Change, Software Process Assessment, The Initial Process, The Repeatable Process, The Defined Process, The Managed Process, The Optimizing Process. Process Reference Models Capability Maturity Model (CMM), CMMI, PCMM, PSP , TS

**Unit-2 - Software Project** 9 Hour  
Management Renaissance Conventional Software Management, Evolution of Software Economics, Improving Software Economics, The old way, and the new way. Life-Cycle Phases and Process artifacts Engineering and Production stages, inception phase, elaboration phase, construction phase, transition phase, artifact sets, management artifacts, engineering artifacts and pragmatic artifacts, model-based software architectures.

**Unit-3 - Work Flows and Process Planning** 9 Hour  
Workflows and Checkpoints of process Software process workflows, Iteration workflows, Major milestones, minor milestones, periodic status assessments. Process Planning Work breakdown structures, planning guidelines, cost and schedule estimating process, iteration planning process, Pragmatic planning.

**Unit-4 - Process and Project Metrics** 9 Hour  
Metrics in the Process and Project Domains, Software Measurements, Metrics for Software Quality, Risk Management: Risk versus Proactive Risk Strategies, Software Risks, Risk Identification, Risk Projection, Risk Refinements, Risk Mitigation Monitoring and Management (RMMM), The RMMM Plan

**Unit-5 - Case Studies** 9 Hour  
CCPDS-R Case Study and Future Software Project Management Practices Modern Project Profiles, Next-Generation software Economics, Modern Process Transitions

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. <i>Managing the Software Process</i>, Watts S. Humphrey, Pearson Education, 1989</li> <li>2. <i>An Introduction to the Team Software Process</i>, Watts S. Humphrey, Pearson Education, 2000</li> <li>3. <i>Process Improvement essentials</i>, James R. Persse, O'Reilly, 2006</li> <li>4. <i>Software Engineering, A practitioner's Approach</i>- Roger S. Pressman, 6th edition, Mc Graw Hill International Edition</li> <li>5. <i>Software Project Management</i>, Walker Royce, Pearson Education</li> <li>6. <i>Software Engineering principles and practice</i>- Waman S Jawadekar, The Mc Graw-Hill Companies.</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>			
	<i>Bloom's Level of Thinking</i>	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	<i>Remember</i>	30%	-	20%	-	20%	-		
Level 2	<i>Understand</i>	40%	-	40%	-	40%	-		
Level 3	<i>Apply</i>	30%	-	40%	-	40%	-		
Level 4	<i>Analyze</i>	-	-	-	-	-	-		
Level 5	<i>Evaluate</i>	-	-	-	-	-	-		
Level 6	<i>Create</i>	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Dr.R. Jaya, Data Scientist, Great Learning, Bangalore.	1. Dr.R. Senthilkumar, Associate professor, Dept of CSE, New Horizon college of Engineering, Bangalore. 2. Dr.N. Thillai Arasu, Associate Professor, School of CSE &IT, Reva University, Bangalore	1. Dr. Dinesh G, SRMIST

<b>Course Code</b>	21CSE271T	<b>Course Name</b>	PROGRAMMING IN JAVA	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Introduce the fundamental concepts and programming environment.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	Outline the Concepts of classes and IO streams																								
<b>CLR-3:</b>	Acquire Object oriented concepts like inheritance, reusability, and encapsulation																								
<b>CLR-4:</b>	Learn the custom exceptions and employ concurrency concepts																								
<b>CLR-5:</b>	Exploit the power of advanced data structures and basic GUI design.																								
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>																								
<b>CO-1:</b>	Summarize the knowledge of fundamentals of Java Programming												3	-	1	2	-	-	-	-	-	1	1	-	
<b>CO-2:</b>	Determine the type of constructor and class concepts used in OOPS based programming paradigms.												3	2	-	2	-	-	-	-	-	-	2	-	-
<b>CO-3:</b>	Articulate the different concepts involved in information hiding and reusability techniques.												3	2	1	-	-	-	-	-	-	-	3	2	-
<b>CO-4:</b>	Understand the different concepts of Exception Handling and Concurrency topics.												3	2	1	-	-	-	-	-	-	-	-	-	-
<b>CO-5:</b>	Acquire the integration of Collection Frameworks and GUI programming to product development.												3	2	-	1	-	-	-	-	-	-	1	-	-

#### **Unit-1 - Fundamentals of Java Technology and Programming** 9 Hour

Java platform features, Java technologies-JSR, JCP, Data types, Key words, and Scoping rules, Automatic Type Conversion, Type Casting and Arrays, Operators Precedence & Associativity, Expression, Flow control, enhanced for loop, switch statements, String handling

#### **Unit-2 - Classes, Objects and Streams** 9 Hour

Class fundamentals: Declaring objects, Assigning object reference variable, Methods & Method Signatures, Method with parameters, Variable arguments, I/O Basics: Byte stream& Character Stream, Getting user input: Reading console input & Writing console output, Reading and Writing files, Command Line arguments, Constructors and its Types, this keyword, Garbage Collector, finalize() method, Overloading methods and constructors, Using object as parameters, returning object in methods, recursion, Access control, static and final keyword, Nested and Inner classes.

#### **Unit-3 - Information Hiding & Reusability** 9 Hour

Inheritance basics, Using super, Method Overriding, Dynamic method dispatch, Abstract class, Using final with inheritance, Default Package, Path & Class Path Environment Variables, Package level access, Importing Packages, Interface: Multiple Inheritance, Extending interface, Wrapper Class, Auto Boxing.

#### **Unit-4 - Exception, Concurrency, Enumeration and Annotations** 9 Hour

Exception handling mechanism, try/catch mechanism, Thread class & Runnable Interface, Inter Thread Communication, Synchronization of threads using Synchronized keyword and lock method, Thread pool and Executors framework, Futures and callable, Fork-Join, Deadlock conditions, Enumeration, Annotations: basics of annotation.

#### **Unit-5 - Generics, Collections Framework and GUI Programming** 9 Hour

Generics: Basics, Collections Interfaces – Set, List, Queue, Collections Classes – Array List, Hash Set, Tree Set. Abstract Map, Hash Map, Tree Map, Introduction to GUI and its component basics

<b>Learning Resources</b>	7. Herbert Schildt, "The Complete Reference (Fully updated for jdk7)", Oracle press Ninth Edition, 2014. 8. Cay S. Horstmann, "Core Java Volume –I Fundamentals", Prentice Hall, 11th Edition, 2018. 9. Deitel&Deitel, "Java How to Program", Prentice Hall, 10th Edition, 2016.	10. Herbert Schildt, "Java: A Beginner's Guide", Eight Edition, Oracle Press, 2018. 11. <a href="https://docs.oracle.com/javase/tutorial">https://docs.oracle.com/javase/tutorial</a> 12. NPTEL Course: <a href="https://onlinecourses.nptel.ac.in/noc22_cs47/preview">https://onlinecourses.nptel.ac.in/noc22_cs47/preview</a>
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<b>Learning Assessment</b>		<b>Continuous Learning Assessment (CLA)</b>				<b>Summative Final Examination (40% weightage)</b>			
	<b>Bloom's Level of Thinking</b>	<b>Formative CLA-1 Average of unit test (50%)</b>		<b>Life-Long Learning CLA-2 (10%)</b>					
		<b>Theory</b>	<b>Practice</b>	<b>Theory</b>	<b>Practice</b>				
Level 1	<i>Remember</i>	35%	-	30%	-	30%	-		
Level 2	<i>Understand</i>	40%	-	40%	-	40%	-		
Level 3	<i>Apply</i>	25%	-	30%	-	30%	-		
Level 4	<i>Analyze</i>	-	-	-	-	-	-		
Level 5	<i>Evaluate</i>	-	-	-	-	-	-		
Level 6	<i>Create</i>	-	-	-	-	-	-		
	<b>Total</b>	<b>100 %</b>		<b>100 %</b>		<b>100 %</b>			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
2. Mr.Jero Terrence, Assistant Consultant in Tata Consultancy Services, United Kingdom	2. Dr.R.Ganeshan, VIT Bhopal, Madhya Pradesh.	2. Dr.S.Amudha, SRMIST

<b>Course Code</b>	21CSE391P	<b>Course Name</b>	USER INTERFACE DESIGN	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the concepts of design; Utilize by learning various color models												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Learn the fundamental laws in UX design															
<b>CLR-3:</b>	understand the task for requirement gathering															
<b>CLR-4:</b>	Gain guidelines for UI design															
<b>CLR-5:</b>	design on various domains or applications															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12			
<b>CO-1:</b>	design the concepts of various color models												-	-	-	-
<b>CO-2:</b>	apply the basic laws in UX design												-	-	-	2
<b>CO-3:</b>	Construct the task for requirement gathering												-	-	-	2
<b>CO-4:</b>	Adopt the guidelines for UI design												-	-	-	3
<b>CO-5:</b>	Apply the design on real time applications												-	-	-	3

<b>Unit-1 - Typography</b>	<b>9 Hour</b>
type properties, baseline, cap height, X-height, ascenders, descenders and weight, Font classifications-Serif, sans serif fonts, handwriting and Display, Readability, letter spacing, line height, Paragraph spacing, power of alignment, Leading and Kerning, Color Models Introduction-RGB, CMYK, Color harmony: monochromatic, analogous, Complementary, triadic, double-complementary.	

Practice:

- 1: Creating sample standard webpage for restaurant to order items by satisfying the fonts, colors and spacing
- 2: User Interfacing check by applying option buttons/ menus in it using Node JS/ Angular JS
- 3: Various color models checking in the developed page

<b>Unit-2 - Laws of UX Designing</b>	<b>9 Hour</b>
Hicks law, Jakob's law, Fitts's Law, Ockham's Razor, Pareto Principle, Weber's law, Tesler's law, Law of proximity, Law of similarity and human eye	

Practice:

- 1: Applying Hicks Law, Jakob's law, Ockham' Razor in a sample ecommerce webpage designed
- 2: Applying Weber's law, Tesler's law in the webpage
- 3: Variations to be done for demonstrating the law of similarity colors in various designs/buttons and human eye

<b>Unit-3 - Design</b>	<b>9 Hour</b>
Interaction design task analysis, Data for task requirements, Requirements gathering, Eliciting Qualitative data, analyzing qualitative data, Qualitative metrics User narratives, Scenario implementation and its challenges, Wireframes, Prototypes, UX design for mobile application, Application design example, Responsive Design, Adaptive design and difference with Responsive design	
Practice 1: Interaction design analysis in the webpage designed, 2: Compatibility check with both Web and Mobile application oriented, 3: Browser independent check along with database connectivity	
<b>Unit-4 - Guidelines</b>	<b>9 Hour</b>
Universal usability, Inclusive interaction, principles of accessibility, Universal design, Font weight, color, Contrast, Screen readers, Alt text using a tool, Introduction to Multifaceted Users, Designing for Multifaceted Users, Guidelines for helping adults	
Practice 1: Designing a sample chatbot web page and check for lightweight and heavyweight components with various frames in webpage 2: Design check for Multifaceted users, 3: To check whether the guidelines to adult users are followed	
<b>Unit-5 - Case Study</b>	<b>9 Hour</b>
Tracking APP Introduction, Tracking APP Design guidelines, Tracking APP demo, Introduction of how to Design a new UX, concept to reduce driver distraction, Designing concepts of Driver distraction, Importance of User data in UX designing, Approach to design without user data, Designing concept, Dynamic web pages	
Practice 1: Building a webpage for vehicle booking with location enabled, 2: Track the Vehicle by its location and display it in your app, 3. Calculate the amount after travel with its tariff	

<b>Learning Resources</b>	1. Jeff Johnson, Kate Finn- "Designing user Interfaces for an aging population towards Universal design- Morgan Kauffman publishers – Elsevier- 2017 2. Elvis Canziba- "Hands-on UX Design for Developers " – PacktBirmingham, mumbai -2018	3. Andrew Rogerson- "User Experience Design" – Smashin media 2012- Freiburg, Germany 4. Barbara Ballard, "Designing the mobile user experience" Wiley publications 2007 5. <a href="https://uxdesign.cc/tagged/case-study">https://uxdesign.cc/tagged/case-study</a>
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Learning Assessment								
Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
	Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20%)			
	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	-	20%	-	40%	-
Level 2	Understand	40%	-	-	20%	-	40%	-
Level 3	Apply	10%	-	-	20%	-	10%	-
Level 4	Analyze	10%	-	-	20%	-	10%	-
Level 5	Evaluate	-	-	-	10%	-	-	-
Level 6	Create	-	-	-	10%	-	-	-
	Total	100 %		100 %		100%		-

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Joe Antony, Senior Manager, Cognizant 2. Mr.Sasiram, Senior Software Engineer, TCS	1. Dr.T.Sukumar, Associate Professor, SVCE 2. Dr.P.Sudakar, Associate Professor, Annamalai University	1. Dr.S.Karthick, SRMIST

<b>Course Code</b>	21CSE392P	<b>Course Name</b>	VISUAL PROGRAMMING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Gain knowledge about Visual basics												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Utilize object-oriented aspects of C# to develop applications															
<b>CLR-3:</b>	design Windows applications utilizing forms, menus etc.															
<b>CLR-4:</b>	create Database applications using ActiveX Data Objects															
<b>CLR-5:</b>	Utilize web forms to develop Web based applications															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12			
<b>CO-1:</b>	Design and develop concept in visual basic programming															
<b>CO-2:</b>	Develop applications using object-oriented aspects of C#															
<b>CO-3:</b>	Design Windows applications															
<b>CO-4:</b>	Design Data base applications															
<b>CO-5:</b>	Develop Web based applications using ADO .Net															

<b>Unit-1 - Visual Basic Programming</b>	<b>9 Hour</b>
Visual Basic Applications – Creating and using Controls – Menus and Dialogs – Managing projects – Programming fundamentals – Objects and instances – Debugging – Responding to mouse events – Using grid control – Creating graphics for application – Displaying and printing information – Interacting with the environment – File system controls - Processing files – Accessing databases with the data controls.	

<i>Practice:</i>	1. Create an Application using VB, 2. Create Menus, Dialogs, and mouse Events, Create and implement to Access databases with the data controls	<b>9 Hour</b>
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<b>Unit-2 - Introducing C#</b>	<b>9 Hour</b>
Understanding .NET Framework - Overview of C# - Literals – Variables Data Types – Operators – Constants – Expressions, Program Control Statements: Branching, Program Control Statements: Looping, Casting – Methods, Arrays: Array Class, Array List, String, String Builder, Structures – Enumerations, Class – Objects, Constructors, Inheritance, Indexers and Properties, Polymorphism, Interfaces, Abstract Class, Event Handling, Errors, and Exception Handling.	

<i>Practice:</i>	1. Implementing Visual Studio IDE with Decompiling Code, 2. Create an simple application using C#, Develop an exception handling with polymorphism	<b>9 Hour</b>
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<b>Unit-3 - Building Windows Application</b>	<b>9 Hour</b>
Creating Window Forms with Events and Controls, Examples: Window Forms with Events and Controls, Menu and Toolbar, Delegates - Inheriting Window Forms, SDI and MDI application, Dialog Box: Modal and Modeless.	

<i>Practice:</i>	1. Create windows form with menu and Toolbar, 2. Create Windows application using C#, Create Simple SDI and MDI application
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<b>Unit-4 - ADO .Net</b>	<b>9 Hour</b>
Accessing data with ADO.NET: Dataset, Types Dataset, Data Adapter, and Updating Database using Stored Procedures, SQL Server with ADO.NET, Handling Exceptions, Validating Controls, and Windows Application Configuration.	
Practice:	
1. Create a Database connectivity using SQL Server, 2. Apply Exception handling concept. Create an application using Validation control.	
<b>Unit-5 - ASP.NET</b>	<b>9 Hour</b>
Introduction to ASP.NET, - Working with XML and .NET, Creating Virtual Directory and Web Application, Session Management, Web Services – web.config, Passing Datasets and Returning Datasets from Web Services, Transaction Handling, Exception Handling – Returning Exceptions from SQL Server	
Practice:	
1. Implement a server with session management. 2. Create a dataset with passing and returning with SQL Server., 3. Write a simple ASP.NET program to display the following Web Controls: A button with text "click me". The button control must be in the center of the form. A label with a text hello, A checkbox. The form name must be Web Controls	

<b>Learning Resources</b>	1. Herbert Schildt, –The Complete Reference: C# 4.0II, Tata McGraw Hill, 2012. 2. Andrew Troelsen, Philip Japikse, –C# 6.0 and the .NET 4.6 FrameworkII, Seventh Edition, Apress, 2015 3. Christian Nagel et al. –Professional C# 2012 with .NET 4.5II, Wiley India, 2012.	4. Andrew Troelsen, Philip Japikse , –Pro C# 7 with .NET and .NET CoreII, Eighth Edition, Apress, 2017 5. Stephen C. Perry, –Core C# and .NETII, Prentice Hall, 2005
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<b>Learning Assessment</b>									
Bloom's Level of Thinking		Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20%)			
		Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	40%	-	-	20%	-	40%	-	
Level 2	Understand	40%	-	-	20%	-	40%	-	
Level 3	Apply	10%	-	-	20%	-	10%	-	
Level 4	Analyze	10%	-	-	20%	-	10%	-	
Level 5	Evaluate	-	-	-	10%	-	-	-	
Level 6	Create	-	-	-	10%	-	-	-	
	Total	100 %		100 %		100%		-	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr.Naveen Baskaran, ADP Solution Chennai	1. Dr.P.SivaKumar, VIT Chennai 2. Dr.Senthil, NHCE Bangalore	1. Dr.S.Nagendra Prabhu, SRMIST

<b>Course Code</b>	21CSE393P	<b>Course Name</b>	MACHINE LEARNING TECHNIQUES	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes											
CLR-1:	Explore the principles, algorithms, and applications of machine learning.												PSO-1	PSO-2	PSO-3										
<b>CLR-2:</b>	Understand machine learning models to perform classification on various applications																								
<b>CLR-3:</b>	Familiarize about neural network models to perform classification on various applications																								
<b>CLR-4:</b>	Gain knowledge on machine learning models to perform clustering on various applications																								
<b>CLR-5:</b>	Understand sequence prediction models																								
<b>Course Outcomes (CO):</b>		At the end of this course, learners will be able to:												Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Evaluate machine learning models and report its performance												-	1	-	-	-	-	-	-	-	-	-	2	2
<b>CO-2:</b>	Apply linear classifier models for text classification												-	2	-	-	-	-	-	-	-	-	-	2	-
<b>CO-3:</b>	Design neural network models for image classification												-	3	-	-	3	-	-	-	-	-	-	3	-
<b>CO-4:</b>	Design clustering models to solve real-world problems												-	3	-	-	-	-	-	2	-	3	-	3	-
<b>CO-5:</b>	Design and analyze the sequence prediction models using recurrent neural network												-	3	-	-	-	-	-	2	-	3	-	3	-

<b>Unit-1 - Introduction to machine learning</b>	<b>9 Hour</b>
What and why? supervised learning, unsupervised learning, Parametric vs non-parametric models, overfitting, model selection; Probability – Discrete random variables, Bayes rule, Independence and conditional independence, continuous and random variables, Quantiles, mean and variance, Gaussian Normal distribution	

Practice:	1. Select any numerical dataset and perform statistical analysis, 2. Perform Exploratory data analysis on the selected dataset	<b>9 Hour</b>
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<b>Unit-2 - Supervised learning</b>	<b>9 Hour</b>
Linear classifiers – Regression – linear regression- ordinary least square, ridge regression - Features –feature representation – Decision tree, Random Forest– K Nearest neighbour – Multi class classification- Naïve Bayes classifier, Support vector machine.	

Practice:	1. Use linear and ridge regression and perform prediction, 2. Perform classification on the selected dataset using Random Forest, KNN, SVM and Naïve Bayes and analyse its performance
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<b>Unit-3 - Clustering</b>	<b>9 Hour</b>
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Curse of Dimensionality – Principal component analysis; K-means clustering, Mixture of Gaussians- maximum likelihood, EM for Gaussian mixtures	
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Tutorial:	1. Perform PCA on a large dataset, 2. Categorize the dataset using K-means clustering and GMM
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<b>Unit-4 - Introduction to Neural Network</b>	<b>9 Hour</b>
feed forward Network function, Network training, Error Backpropagation; Deep learning – Deep generative models, Deep neural networks, Application of deep networks	
Practice:	
1. Handwritten digit classification using DBN, 2. Information retrieval using deep-auto encoders, 3. Learning Image features using 2D convolutional DBN	
<b>Unit-5 - Sequential Data</b>	<b>9 Hour</b>
Markov models, HMM, Recurrent neural network – sequence to sequence RNN – Back propagation through time- forward and back pass- training a language model – LSTM	
Practice:	
1. Develop model for the following applications: Machine translation, 2. video tagging and speech recognition	
<b>Learning Resources</b>	1. Machine Learning: A Probabilistic Perspective, Kevin P Murphy, MIT press, Cambridge, 2012 2. Pattern recognition and Machine Learning, Christopher M Bishop, Springer, 2006.
3. Machine Learning, Tom Mitchell McGraw-Hill (1997 A Course in Machine Learning, Hal Daume III (preprint available online)	

Learning Assessment		Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)			
			Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20%)					
			Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	Remember	40%	-	-	20%	-	40%	-	-		
Level 2	Understand	Understand	40%	-	-	20%	-	40%	-	-		
Level 3	Apply	Apply	10%	-	-	20%	-	10%	-	-		
Level 4	Analyze	Analyze	10%	-	-	20%	-	10%	-	-		
Level 5	Evaluate	Evaluate	-	-	-	10%	-	-	-	-		
Level 6	Create	Create	-	-	-	10%	-	-	-	-		
	Total		100 %		100 %		100%		-	-		

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Vaishak P S Staff Engineering Manager/System Intelligence, Samsung Electronics, Bangalore Vaisakh.ps@samsung.com	1. Dr.C. Oswald Assistant Professor, NIT, Trichy swald.mecse@gmail.com	1. Mrs.A. Jackulin Mahariba, SRMIST

<b>Course Code</b>	21CSE312P	<b>Course Name</b>	SOFTWARE ENGINEERING IN ARTIFICIAL INTELLIGENCE	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>			
<b>CLR-1:</b>	The purpose of learning this course is to:												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>		
<b>CLR-1:</b>	Learn the different GPU Components	1	Problem Analysis	2	Design/development of solutions	3	Conduct investigations of complex problems	4	Modern Tool Usage	5	The engineer and society	6	Environment & Sustainability	7	Ethics	8	Individual & Team Work
<b>CLR-2:</b>	Know to access NGC Containers and docker images	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>CLR-3:</b>	Utilize the Pytorch and Jupyter notebook	-	2	3	-	-	-	-	-	-	-	-	-	-	-	2	-
<b>CLR-4:</b>	Learn the CUDA ecosystem	-	3	3	-	-	-	-	-	-	-	-	-	-	-	-	2
<b>CLR-5:</b>	Explore the DL deployments	-	3	3	-	3	-	-	-	-	-	-	-	-	-	-	3
<b>Course Outcomes (CO):</b>	At the end of this course, learners will be able to:	-	2	-	-	3	-	-	-	-	-	-	-	-	-	-	-
<b>CO-1:</b>	Distinguish the different components in GPU systems	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>CO-2:</b>	Create environments to work with different NGC container packages	-	2	3	-	-	-	-	-	-	-	-	-	-	-	2	-
<b>CO-3:</b>	Implement codes using jupyter notebook and pytorch	-	3	3	-	-	-	-	-	-	-	-	-	-	-	-	3
<b>CO-4:</b>	Develop and work with CUDA	-	3	3	-	3	-	-	-	-	-	-	-	-	-	-	3
<b>CO-5:</b>	Visualize different DL deployments for various scientific applications	-	2	-	-	3	-	-	-	-	-	-	-	-	-	-	-

#### **Unit-1 - Introduction to System Software Engineering** 9 Hour

System S/W Platforms: Virtualization, Containerization- Introduction to NVIDIA NGC Cloud, DockerHub

T1: Accessing DGX A100

T2: Working DOCKER Images and NGC Container

T3: Installation and Pulling Specific NGC Packages

#### **Unit-2 - Scheduling and Resource Management** 9 Hour

Introduction to Schedulers/Orchestration Tools - Fundamentals of Ansible/Kubernetes/KubeFlow/SLURM

T4: Implementing and executing Kubernetes

T5: Working with Ansible

T6: Demo Executions on Kubeflow/SLURM

#### **Unit-3 - Introduction to IDE / Exploratory Programming** 9 Hour

Introduction to various IDE like VSCode/PyCharm/Others-Introduction to Jupyter-Ecosystem for Exploratory Programming- Features of Jupyter-Ecosystem for building Python Packages/Scientific Manuscript

T7: Working with VScode/ Pycharm

T8: Using Jupyter note and PyTorch

T9: Run a simple data centric application using Jupyter note.

#### **Unit-4 - System Software for Accelerated Computing** 9 Hour

ML/DL/DS/HPC Workloads-Overview of CUDA Platform: GPGPU Computing Platform - Overview of CUDA-X Platform: cuBLAS/cuDNN/cuTensor [Compute]- Framework for Differential Computation

T10: Testing the GPGPU Computing T11: Testing and working with Tensor (CUDA-X) T12: Implementing Mixed Precision and Quantization Aware training	<b>Unit-5 – GPU Programming</b>	<b>9 Hour</b>
Distributed Computing Software Stack-Multi-GPU/Multi-Node: [MPI/NCCL/RDMA] Horovod- Accelerating DL Deployments- MLOps: Hands-on		
T13: Accelerating Neural Network Inferencing: TensorRT & Triton Inference Server		
T14: Monitoring load Balancers & Schedulers		
T15: Deployment of various services for monitoring, jupyter environment and other services.		

<b>Learning Resources</b>	5. Ekman, M., 2021. <i>Learning Deep Learning: Theory and Practice of Neural Networks, Computer Vision, NLP, and Transformers Using TensorFlow</i> . Addison-Wesley Professional. 6. Sanders, J. and Kandrot, E., 2010. <i>CUDA by example: an introduction to general-purpose GPU programming</i> . Addison-Wesley Professional.	7. Christopher Love, Jay Vyas, Core Kubernetes, 2022 8. Chollet, F., 2021. <i>Deep learning with Python</i> . Simon and Schuster.
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<b>Learning Assessment</b>									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	15%	-	--	15%	-	15%	-	
Level 2	Understand	25%	-	-	20%	-	20%	-	
Level 3	Apply	30%	-	-	25%	-	25%	-	
Level 4	Analyze	30%	-	-	25%	-	25%	-	
Level 5	Evaluate	-	-	-	10%	-	10%	-	
Level 6	Create	-	-	-	5%	-	5%	-	
	Total	100 %		100 %		100 %		-	

<b>Course Designers</b>		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
2. A.G.Rangaraj,Deputy Director (Technical),R&D, RDAF and SRRA Division, National Institute of Wind Energy (NIWE)	2. Dr.I.Joe Louis Paul, Associate Professor, SSN College of Engineering	2. Dr.Kottilingam K, SRMIST

<b>Course Code</b>	21CSE391T	<b>Course Name</b>	OBJECT ORIENTED SOFTWARE ENGINEERING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	The purpose of learning this course is to:												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Acquire the Knowledge of object-oriented software and development methodologies	1	2	3	4	5	6	7	8	9	10	11	12			
<b>CLR-3:</b>	Improve their ability to choose the appropriate Elicitation Technique and document the requirements															
<b>CLR-4:</b>	Familiarize with the various Analysis and design techniques															
<b>CLR-5:</b>	Practice the concepts of implementing high quality software															
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Recognize object-oriented software and development methodologies	3	2	-												
<b>CO-2:</b>	Identify the appropriate Elicitation Technique and document the requirements	-	3	2	-											
<b>CO-3:</b>	Apply various Analysis and design techniques	-	-	3	-	-	-	-	-	-	-	-	-		2	-
<b>CO-4:</b>	Use object-oriented implementation concepts to produce quality software	-	2	3	-											3
<b>CO-5:</b>	Relate the Object-oriented testing and maintenance concepts while doing testing and maintenance of software	2	-	3	-	-	-	-	-	-	-	-	-	-	-	3

**Unit-1 - Introduction** 9 Hour  
 Introduction to Software Engineering, Object orientation, Object oriented methodologies, Object oriented modeling, Terminologies used in object-oriented development, Object oriented Software life cycle models, Selection of software development life cycle models

**Unit-2 - Software Requirements and Estimation** 9 Hour  
 Software requirements, Software Requirement Elicitation techniques, Initial Requirement Document, Use case Approach, Characteristics of good requirements, Software Requirement specification document, Object oriented software Estimation: Lorenz and Kidd Estimation method, Use case points method, Object oriented function point, Case Study: For the given application apply use case approach to Elicit the requirements and validate and document the specifications

**Unit-3 - Object Oriented Analysis and Design** 9 Hour  
 Object oriented Analysis-Structured Analysis and object-oriented analysis-Identification of class-Identification of relationships – Identifying state and behavior. Object oriented design:- Interaction diagrams-sequence and collaboration diagrams-Refinement of use case descriptions, refinement of class, Creation of software design document, Generating test cases from use cases, Object oriented design Principles. Case study. For the given application do Analysis and Design

**Unit-4 - Object Oriented Design to Implementation** 9 Hour  
 Activity Diagram, State chart diagram, storing persistent data in database, Implementing the class, Software quality metrics. Case study: For the given application create Activity diagram, State chart diagram

**Unit-5 - Object Oriented Software Testing and Maintenance** 9 Hour  
 Software Testing, Software verification Techniques, Functional Testing, Structural Testing, Class testing, Levels of testing, Testing Tools, Software maintenance, Categories of Software maintenance, Challenges of Software maintenance, Maintenance of object-oriented software, Software Rejuvenation.

<b>Learning Resources</b>	1. Yogesh Singh, Ruchika Malhotra," Object Oriented Software Engineering", PHI Learning Private Ltd.,Eastern Economy Edition, 2012 2. Stephen R. Schach," Object-Oriented and Classical Software Engineering" Eighth Edition, y McGraw-Hill,2011	3. Gerardus Blokdyk, Object oriented Software Engineering: A complete Guide, ISBN-10 : 1867300230, 2020
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	40%	-	30%	-	30%	-		
Level 2	Understand	40%	-	30%	-	30%	-		
Level 3	Apply	20%	-	40%	-	40%	-		
Level 4	Analyze	-	-	-	-	-	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Joseph Thankarajan, CTS, Chennai	1. Dr. John T.Mesiah Dhas, Associate Professor, T.John Institute of Technology, Bangalore	1. Dr.T.S.Shiny Angel, SRMIST

<b>Course Code</b>	21CSE392T	<b>Course Name</b>	PYTHON FOR SOFTWARE ENGINEERING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand Software Engineering and Python												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Familiarize about Software Development and Data structures in Python															
<b>CLR-3:</b>	Learn GUI programming and Poplar Python packages															
<b>CLR-4:</b>	Design patterns in Python															
<b>CLR-5:</b>	Apply Software Testing using Pytest															
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>															
<b>CO-1:</b>	Gain knowledge on the basics of Software Engineering and Python programming language												1	1	1	
<b>CO-2:</b>	Acquire knowledge on software design and development using Python												1	2		
<b>CO-3:</b>	Familiarize working with database, GUIs, and get introduced to popular packages in Python												1	3		
<b>CO-4:</b>	Recognize different types of design patterns and study popular patterns												2	3		
<b>CO-5:</b>	Comprehend the use of Pytest to perform software testing												1	-	-	

<b>Unit-1 - Introduction</b>	<b>9 Hour</b>
Introduction to Software Engineering and Programming - Software Development Life Cycles - Introduction to Python - Python Setup - Download and install Python - PyCharm IDE - Create Python project in PyCharm - Variables in Programming - Writing Programs in Python - Variables, expressions, and statements - Functions - Conditionals and recursion - Iteration	
<b>Unit-2 - Software Development Using Python</b>	<b>9 Hour</b>
Software Development using Python - Modules - PIP - Try Except Blocks - Date time - Random numbers - Strings - Lists - Tuples - Dictionaries - Linked lists - Stacks - Queues - Trees - Files and exceptions - Classes and objects - Classes and functions - Classes and methods - Inheritance – Case study application	
<b>Unit-3 - Database Operations and GUI Programming in Python</b>	
Crud operation Python using MySQL – Linting - GUI in Python - Tkinter Programming - Tkinter Widgets - Standard attributes - Python Tkinter Geometry - Data Visualization in Python - Creating line graph - Pie chart - Bar Graph - Python Packages – GUI and Database operations case study	
<b>Unit-4 - Design Patterns in Python</b>	<b>9 Hour</b>
Pattern Types - Creational Patterns: Singleton - Factory Method - Constructor/Builder - Structural patterns: Adapter - Decorator - Facade - Behavioral Patterns: Observer - Chain of Responsibility - State - Strategy	
<b>Unit-5 - Software Testing Using Pytest</b>	
Pytest - Use pytest Using Python - pytest Fixtures - Assertions In pytest - Parametrization In pytest - Decorators In pytest - Run Specific Tests - Example Real world Program	

<b>Learning Resources</b>	1. David M. Beazley, "Python Distilled", Addison-Wesley Professional (2021) 2. Allen B. Downey, "Python for Software Design: How to Think Like a Computer Scientist", Cambridge University Press (2009) 3. Alan D. Moore, "Python GUI Programming with Tkinter: Design and build functional and user-friendly GUI applications", 2nd Edition (2021)	4. Sean Bradley, "Design Patterns in Python: Common GOF (Gang of Four) Design Patterns implemented in Python", (2022) 5. Brian Okken, "Python Testing with pytest-Simple, Rapid, Effective, and Scalable", Second Edition (2022) 6. <a href="http://www.python.org">www.python.org</a>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>	
<i>Bloom's Level of Thinking</i>	<i>Formative CLA-1 Average of unit test (50%)</i>	<i>Life-Long Learning CLA-2 (10%)</i>					
		<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>
Level 1	Remember	40%	-	30%	-	20%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	20%	-	30%	-	40%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

#### Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mrs. S. Gokularani, L&T Infotech, Chennai	1. Dr.P.Shanthi Bala, CS, Pondicherry University, Puducherry	1. Dr. M Vimaladevi, SRMIST

<b>Course Code</b>	21CSE393T	<b>Course Name</b>	ANALYSIS OF SOFTWARE ARTIFACTS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Infer software quality metrics												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Articulate Software Analysis and vulnerabilities															
<b>CLR-3:</b>	Examine software testing and tools															
<b>CLR-4:</b>	Attribute Automated test generation															
<b>CLR-5:</b>	Deduce Software Maintenance concepts															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	<b>Program Specific outcomes</b>		
<b>CO-1:</b>	Summarize the knowledge of software quality metrics												-	PSO-1	PSO-2	PSO-3
<b>CO-2:</b>	Determine procedures of software analysis												-	-	-	3
<b>CO-3:</b>	Articulate software testing strategies and tools												-	-	-	3
<b>CO-4:</b>	Analyse the approaches to Automated test generation												-	-	-	1
<b>CO-5:</b>	Examine software maintenance models												-	-	-	3

<b>Unit-1 - Software Quality Metrics</b>	9 Hour
Measurement basics, Analyzing the metric data, Metrics for measuring size and structure, Object-oriented metrics, Software Quality models	
<b>Unit-2 - Software Analysis</b>	9 Hour
Introduction to Static analysis - Static analyzer for finding dynamic programming errors-data flow testing – a procedure to apply data flow testing- examples performance analysis and verification- Security analysis and verification – Software vulnerabilities and exploitation	
<b>Unit-3 - Software Testing</b>	9 Hour
Software verification testing, Functional testing, Structural testing, State-based testing, Mutation testing, and Software testing tools, Case study with Software Testing	
<b>Unit-4 - Automated Test Generation</b>	9 Hour
Approaches to testing data generation, Test data generation using genetic algorithms, and Test data generation tools	
<b>Unit-5 - Software Maintenance</b>	9 Hour
Categories of Software Maintenance, Challenges of Software Maintenance, Maintenance of Object-Oriented Software, Case study: Estimation of Maintenance Effort - Belady and Lehman Model, Boehm Model	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>Yogesh Singh &amp; Ruchika Malhotra, Object-Oriented Software Engineering, PHI Learning Private Limited, 2019</li> <li>Yogesh Singh, Software Testing, Cambridge University Press, 2020</li> <li>Kshirasagar Naik and Priyadarshi Tripathy "Software Testing and Quality Assurance: theory and practice, edited by copyright John Wiley &amp; sons Inc, 2008.</li> <li>Tyson R. Browning, "Applying the design structure matrix to system decomposition and integration problems", A review and new directions IEEE Transactions on Engineering Management, Vol. 48, No.3, August 2001.</li> <li>Neeraj sangal and Frank Waldman "Dependency models to manage software Architecture: Journal of Defense software engineering, November 2005. Online at <a href="http://www.stsc.hill.af.mil">www.stsc.hill.af.mil</a></li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>	
<i>Bloom's Level of Thinking</i>	<i>Formative CLA-1 Average of unit test (50%)</i>	<i>Life-Long Learning CLA-2 (10%)</i>					
		<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>
Level 1	Remember	40%	-	30%	-	30%	-
Level 2	Understand	40%	-	30%	-	30%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	-	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

#### Course Designers

##### Experts from Industry

1. Ruhina Abideen, Assistant Consultant.TCS, [ruhina.abideen@tcs.com](mailto:ruhina.abideen@tcs.com)

##### Experts from Higher Technical Institutions

1. C Ramesh, Associate professor, CVR College of Engineering, Hyderabad

##### Internal Experts

2. Dr.G. Senthil Kumar SRMIST

<b>Course Code</b>	21CSE396T	<b>Course Name</b>	DESIGN PRINCIPLES OF SMART SPACE MANAGEMENT	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand Space fundamentals and IoT Architecture												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Learn different Protocols for IoT Design															
<b>CLR-3:</b>	Familiarize the Concepts of smart space design															
<b>CLR-4:</b>	Build IoT with Raspberry Pi and Arduino for smart space															
<b>CLR-5:</b>	understand the role of psychology in space making and applying IoT in space design															
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Distinguish IoT applications in different domains												3	1	-	
<b>CO-2:</b>	Apply various protocols for design of IoT systems												3	2	-	
<b>CO-3:</b>	Illustrate the techniques for smart spaces												3	2	-	
<b>CO-4:</b>	Deploy an IoT application using Raspberry Pi/Ardiuno												3	2	-	
<b>CO-5:</b>	Analyze applications of IoT in Real time scenario												3	2	-	

**Unit-1 - Introduction to Space Design and IoT** 9 Hour  
 Introduction to spatial design, Characteristics of space design aspects, Spatial Requirements, User & function, Standards & Requirements in spatial Design, Introduction to Internet of Things - Characteristics of IoT, IoT Network Architecture and Design, Drivers Behind New Network Architectures, Comparing IoT Architectures – The oneM2M IoT Standardized Architecture, The IoT World Forum (IoTWF) Standardized Architecture, A Simplified IoT Architecture, The Core IOT Functional Stack, IoT Data Management and Compute Stack Hierarchy of Ede, Fog and Cloud, Smart Objects: Things in IOT, Sensors, Actuators, Micro-Electro-Mechanical Systems (MEMS) and Smart objects, Sensor Networks, Wireless Sensor Networks (WSNs)

**Unit-2 - IoT Protocols** 9 Hour  
 Protocol Standardization for IoT, M2M and WSN Protocols, SCADA and RFID Protocols, Unified Data Standards, WPAN Technologies for IoT, Protocols – IEEE 802.15.4, Zigbee Architecture, Wireless HART, Near-field communication (NFC), Z-Wave, Bluetooth Low Energy (BLE), BACnet, Modbus IP Based Protocols for IoT, Network layer – 6LowPAN, CoAP, Edge connectivity and protocols, Cloud Platforms for IOT

**Unit-3 - Smart Space Design** 9 Hour  
 introduction to smart spaces, Need and Significance of smart space, Example projects for smart space, Presentation, Factors considered for smart space design, Need User profile, Factors considered for smart space design Activity Efficiency required, Application of smart concepts in space Lighting, Application of smart concepts in space Automation Signage, Exercise and Discussion (essential factors and applications)

**Unit-4 - IoT Development Boards** 9 Hour  
 IoT Development Boards: Arduino IDE and Board Types, Building IOT with Raspberry Pi, IoT Systems - Logical Design using Python, IoT Physical Devices & Endpoints, IoT Device -Building blocks - Raspberry Pi -Board-,Linux on Raspberry Pi, Raspberry Pi Interfaces, Programming Raspberry Pi with Python, Other IoT Platforms – Arduino, Interfacing Relay Driver with Arduino Uno, Programming Logic to Control Electrical Devices via Bluetooth using Arduino, Control Electrical Devices via Bluetooth Communication, Check Electrical Device status over Internet, Implementation of Home Automation using Arduino.

**Unit-5 - Psychology and Future Trends** 9 Hour  
 Role of user experience in spatial design, Introduction to Psychology in space making – smart spaces, Impact of Psychology in space making – IQ, Impact of Psychology in space making – EQ, Impact of Psychology in space making – SQ, Applications in smart spatial Design, Examples for Current research and Future trends in smart spatial design, Case Study: Smart Home Automation, Case Study: Smart Lighting.

<b>Learning Resources</b>	<p>1. David Hanes, Gonzalo Salgueiro, Rob Barton , "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things" , Cisco Press, 2017</p> <p>13. Arshdeep Bahga, Vijay Madisetti, —Internet of Things – A hands-on approach!, Universities Press, 2015</p> <p>14. Hakima Chaouchi, — “The Internet of Things Connecting Objects to the Web” ISBN : 978-1-84821-140-7, Wiley Publications</p> <p>15. Olivier Hersistent, David Boswarthick, and Omar Elloumi, — “The Internet of Things: Key Applications and Protocols”, Wiley Publications</p> <p>16. Juan Carlos Augusto, Chris D Nugent, “Designing Smart Homes”, Springer</p> <p>17. Tom Hargreaves, Charlie Wilson, “Smart Homes and their users”, Springer</p> <p>18. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), —Architecting the Internet of Things!, Springer, 2011.</p> <p>19. <a href="https://in.pc当地.com/simplisafe-home-security-system/129484/how-to-set-up-your-smart-home-a-beginners-guide">https://in.pc当地.com/simplisafe-home-security-system/129484/how-to-set-up-your-smart-home-a-beginners-guide</a></p> <p>20. <a href="https://www.homebuilding.co.uk/advice/how-to-design-a-smart-home">https://www.homebuilding.co.uk/advice/how-to-design-a-smart-home</a></p> <p>21. <a href="https://www.archdaily.com/936027/psychology-of-space-how-interiors-impact-our-behavior">https://www.archdaily.com/936027/psychology-of-space-how-interiors-impact-our-behavior</a></p> <p>22. <a href="https://sushantuniversity.edu.in/blog/do-you-know-how-psychology-of-space-is-impacting-interior-designing/">https://sushantuniversity.edu.in/blog/do-you-know-how-psychology-of-space-is-impacting-interior-designing/</a></p> <p>23. <a href="https://www.ylighting.com/blog/smart-home-lighting-guide/">https://www.ylighting.com/blog/smart-home-lighting-guide/</a></p>
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<b>Learning Assessment</b>						
<i>Bloom's Level of Thinking</i>	Continuous Learning Assessment (CLA)				<i>Summative Final Examination (40% weightage)</i>	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	20%	-	20%
Level 2	Understand	40%	-	40%	-	40%
Level 3	Apply	30%	-	40%	-	40%
Level 4	Analyze	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-
Level 6	Create	-	-	-	-	-
	Total	100 %		100 %		100 %

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
3. Ar.Apsaran Raja,Kaaloo, NID, Chennai	2. Prof. Premkumar, NIT Trichy	5. Dr.R.Annie Uthra,SRMIST 6. Dr.M.Ferni Ukrat, SRMIST 7. Mrs.Sri Vallaba, Architecture and Interior Design, SRMIST 8. Dr.A.Alice Nithya, SRMIST

<b>Course Code</b>	21CSE421T	<b>Course Name</b>	BUSINESS INTELLIGENCE AND ANALYTICS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>			
1	2	3	4	5	6	7	8	9	10	11	12						
<b>CLR-1 :</b>	Familiarize with Business Intelligence, Analytics and Decision Support																
<b>CLR-2 :</b>	Understand the technologies for Decision making																
<b>CLR-3 :</b>	Familiarize with predictive modeling techniques																
<b>CLR-4 :</b>	Familiarize with sentiment analysis techniques																
<b>CLR-5 :</b>	Understand about Decision making systems																
<b>Course Outcomes (CO):</b>		<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Gain knowledge on Business Intelligence, Analytics and Decision Support	-	-	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSC-1	PSC-2	PSC-3
<b>CO-2:</b>	Understand the technologies for Decision making	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
<b>CO-3:</b>	Apply predictive modeling techniques	-	-	-	-	-	-	-	3	-	3	-	-	-	2	-	-
<b>CO-4:</b>	Apply sentiment analysis techniques	-	-	-	-	-	-	-	3	-	3	-	-	-	-	-	2
<b>CO-5:</b>	Gain knowledge on Decision making systems	-	-	-	-	-	-	-	3	-	3	-	-	-	1	1	

#### **Unit-1 - Introduction: Business Intelligence, Analytics and Decision Support** 9 Hour

Information Systems Support for Decision Making - An Early Framework for Computerized Decision Support - The Concept of Decision Support Systems - A Framework for Business Intelligence - Business Analytics Overview - Brief Introduction to Big Data Analytics - Clickstream Analysis – Metrics - Clickstream Analysis - Practical Solutions - Competitive Intelligence Analysis

T1: Introduction to Power BI and SSMS

T2: Installing Power BI and SSMS

T3: Prepare data in Power BI Desktop

#### **Unit-2 - Decision Making** 9 Hour

Decision Making - Introduction and Definitions - Phases of the Decision - Making Process - The Intelligence Phase - Design Phase - Choice Phase - Implementation Phase - Decision Support Systems Capabilities - Decision Support Systems Classification - Decision Support Systems Components

T4: Load data in Power BI Desktop

T5: Model data in Power BI Desktop part-1

T6: Model data in Power BI Desktop part-2

#### **Unit-3 - Predictive modeling and sentiment analysis** 9 Hour

Basic Concepts of Neural Networks - Developing Neural Network - Based Systems - Illuminating the Black Box of ANN with Sensitivity - Support Vector Machines - A Process Based Approach to the Use of SVM - Nearest Neighbor Method for Prediction -Sentiment Analysis Overview - Sentiment Analysis Applications - Sentiment Analysis Process - Sentiment Analysis - Speech Analytics

T7: Implement data model using SQL in Power BI

T8: Create DAX calculations in Power BI Desktop part-1

T9: Create DAX calculations in Power BI Desktop part-2

<b>Unit-4 - Multi-criteria Decision making systems</b>	<b>9 Hour</b>
Decision Support Systems modeling - Structure of mathematical models for decision support - Decision making under certainty - Uncertainty and Risk - Decision modeling with spreadsheets - Mathematical programming optimization - Decision analysis introduction - Decision tables - Decision Trees - Multi-criteria decision making - Pairwise comparisons	
T10: Design a report in Power BI Desktop part-1	
T11: Design a report in Power BI Desktop part-2	
T12: Create a Power BI dashboard	
<b>Unit-5 - Automated Decision Systems</b>	<b>9 Hour</b>
Automated Decision Systems - The Artificial Intelligence field - Basic concepts of Expert Systems - Applications of Expert Systems - Structure of Expert Systems - Knowledge Engineering - Development of Expert Systems - Location based Analytics - Cloud Computing - Business Intelligence	
T13: Create a Power BI paginated report	
T14: Perform data analysis in Power BI Desktop	
T15: Enforce Row-level security	

<b>Learning Resources</b>	4. Ramesh Sharda, Dursun Delen, EfraimTurban, J.E.Aronson,Ting-Peng Liang, David King, "Business Intelligence and Analytics: System for Decision Support", 10 <sup>th</sup> Edition, Pearson Global Edition, 2013. 5. Brett Powell, "Mastering Microsoft Power Bi: Expert techniques for effective data analytics and business intelligence", 2018	6. Alberto Ferrari Marco Russo, "Definitive Guide to DAX, The: Business intelligence for Microsoft Power BI, SQL Server Analysis Services, and Excel", Second Edition, By Pearson, 2020
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<b>Learning Assessment</b>						
Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%
Level 2	Understand	25%	-	20%	-	25%
Level 3	Apply	30%	-	25%	-	30%
Level 4	Analyze	30%	-	25%	-	30%
Level 5	Evaluate	-	-	10%	-	-
Level 6	Create	-	-	5%	-	-
	Total	100 %		100 %		100 %

<b>Course Designers</b>	<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
	2. Mr.V.Selvakumar,Hexaware Technologies, selvakumarp@hexaware.com	2. Dr. T. Veerakumar, Professor, NIT Goa	2. Dr. T. Karthick, DSBS, SRMIST

<b>Course Code</b>	21CSE493T	<b>Course Name</b>	SOFTWARE SECURITY	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Comprehend the need for Software Security and the threats to software security												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Realize Secure software architecture design and coding															
<b>CLR-3:</b>	Gain basic knowledge on web security principles															
<b>CLR-4:</b>	Acquire risk management and mitigation of risk in software development															
<b>CLR-5:</b>	Learn testing types and strategies for secure software															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12			
<b>CO-1:</b>	Identify security threats and issues in software												-	PSO-1	PSO-2	PSO-3
<b>CO-2:</b>	Prepare software by incorporating security principles												-	-	-	3
<b>CO-3:</b>	Predict the issues in web and database security												-	-	-	1
<b>CO-4:</b>	Apply risk management strategies and risk mitigation strategies in software development												-	-	-	3
<b>CO-5:</b>	Use testing strategies for secure software development												-	-	-	3

**Unit-1 - Introduction** 9 Hour  
 Introduction to software Security- Software assurance and software security - Threats to Software security - Sources of Software Insecurity - Benefits of detecting software security defects early - Managing Secure software development - Risk Management framework for Software security - Software security practices in the development lifecycle - Properties of secure software - Influencing security properties of software - Building a security assurance case - Incorporating assurance cases into SDLC -Security Requirements Engineering

**Unit-2 - Secure Software Architecture and Design** 9 Hour  
 Software security practices for architecture and design - Software security knowledge for architecture and design - Software characterization - Threat analysis - Architectural vulnerability assessment - Risk likelihood determination - Risk Impact Determination - Risk Mitigation Planning - Security principles - Security guidelines and attack patterns - Secure coding and testing - Code analysis - common software code vulnerabilities - Source code review - Coding practices - Best practices for secure coding

**Unit-3 - Client and Server-Side Security** 9 Hour  
 Browser Security Principles - Defining the same-origin policy - Client-side vs. server-side - Exceptions to the same origin policy- Cross-site scripting- XSS defense- Cross-site request forgery - CSRF defense - Prevent XSS -SQL Injection - SQL Injection effects - Blind SQL Injection - Setting Database Permissions - Stored Procedure Security - SQL Injection in stored procedures, Case study: Application with Client-side Security, Application with server side security.

**Unit-4 - Risk Management** 9 Hour  
 Risk Management framework - Five stages of activity- Applying the RMF- Understanding the business context - Gathering the artifacts, conducting project research, Identifying the business and technical risk, Developing risk questionnaires, interviewing the target project team, Analyzing the research and interview data - Uncovering technical risks - Analyzing software artifacts - Synthesizing and ranking the risk - Reviewing the risk data - Conducting the business and technical peer review - Defining the risk mitigation strategy - Risk Management is a framework for Software security

**Unit-5 - Software Security Testing****9 Hour**

About Software Security testing - Contrasting software testing and software security testing - Functional testing - Risk-based testing - Penetration Testing - Security testing consideration throughout the SDLC - Unit testing - Testing Libraries - Testing Executable files- Integration testing - System Testing - Security Failures - Categories of Errors - Attacker Behaviour - Functional and attacker perspectives for Security Analysis -Identity Management and Software development, Case study on Software security Testing.

<b>Learning Resources</b>	1. Gary McGraw, "Software Security-A guide for Project Managers", Addison-Wesley Professional,2008,ISBN-13:978-0321509178 2. Andrew Homan, " Web Application Security Exploitation and Countermeasures for Modern Web Applications", O'Reilly Media, Inc, First edition,2020	3. JamesM.Helfrich, "Security for Software Engineers", CRC Press, Taylor and Francis Group, 2019 4. James Ransome, Anmo IMisra," Core Software Security", CRC Press, Taylor, and Francis Group, 2014.
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**Learning Assessment**

Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1 <i>Remember</i>	30%	-	20%	-	20%	-
Level 2 <i>Understand</i>	40%	-	40%	-	40%	-
Level 3 <i>Apply</i>	30%	-	40%	-	40%	-
Level 4 <i>Analyze</i>	-	-	-	-	-	-
Level 5 <i>Evaluate</i>	-	-	-	-	-	-
Level 6 <i>Create</i>	-	-	-	-	-	-
Total	100 %		100 %		100 %	

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Joseph Thankarajan, TCS Chennai	1. Dr. John T.Mesiah Dhas, Associate Professor, T.John Institute of Technology, Bangalore	1. Dr.T.S.Shiny Angel, SRMIST

<b>Course Code</b>	21CSE495T	<b>Course Name</b>	ARTIFICIAL INTELLIGENCE IN AGILE SYSTEMS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Introduce a broad understanding of basic concepts of Artificial Intelligence and Agile systems												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Illustrate the Software design patterns for implementing Agile systems in real world applications															
<b>CLR-3:</b>	Demonstrate the Various Agile AI process and outcomes															
<b>CLR-4:</b>	Analyze the Various Agile design principles in various applications															
<b>CLR-5:</b>	Discuss the Knowledge in Applications of Artificial intelligence and Agile systems in Industry															
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Familiarize the concepts of Artificial Intelligence inn Agile systems and planning methods															
<b>CO-2:</b>	Understand the various software design patterns for appropriate scenarios															
<b>CO-3:</b>	Acquire the knowledge in Agile AI process and outcomes															
<b>CO-4:</b>	Gain knowledge on various agile design principles in real world industry															
<b>CO-5:</b>	Categorize the applications of Artificial Intelligence in Agile systems in designing applications															

**Unit-1 - Introduction to AI and Agile Techniques** 9 Hour  
 Intelligent Agents, Problem Solving with AI, Intelligent Agents, Structure of Agents, Agile Alliance, Principles of Agile Practices, Practices of Extreme Programming, Planning –Initial Exploration, Release Planning, Iteration planning , Task planning, Challenges in Traditional Systems, Real time applications of AI in Agile systems, Test driven development, Acceptance Test, Serendipitous Architecture, Serendipitous decoupling

**Unit-2 – Design Patterns and Applications** 9 Hour  
 Symptoms of poor design, Principles of a good design, Types of design patterns, Strategy design Pattern, Real time Applications of Strategy design Pattern, Mediator design pattern, Real time Applications of Mediator design pattern, Singleton design pattern, Real time Applications of Singleton design pattern, Factory design pattern, Real time Applications of Factory design pattern  
 Façade design Pattern

**Unit-3 – Agile AI Process** 9 Hour  
 Agile Approach, AI process for business today, Agile design Example, Agile approach in AI, Organizing Agile for AI Data Scientist, Organizing Agile for AI Data Engineers, Organizing Agile for AI Business Analysts, Need for Agile in AI, Contrasting Machine Learning and AI, Advantages of Agile AI, Agile Framework for AI Projects, Case study: Identify which pattern is applicable for the given case study and justify, Case Study : Prediction of disease patterns and proactive care

**Unit-4 – Agile Design Principles** 9 Hour  
 Liskov Substitution Principle, Example of a violation of LSP, Real Example of Liskov Substitution Principle, Factoring Instead of Deriving, Heuristics and Conventions Dependency inversion principle, Layering, Dynamic Vs static polymorphism, Interface Segregation principle, Backward force applied by clients on Interfaces, Class interfaces vs Object Interfaces, Case study: Identify which pattern is applicable for the given case study and justify, Case Study : Credit card and loans fraud patterns and utilization

**Unit-5 – Agile in Healthcare** 9 Hour

*Learning from Real-Time, Big Data Applications of AI in health care, Realizing the Potential of AI in Healthcare, Evolution of Data and Its Analytics, Real time Challenges of Big Data, Impact of Data in Future, Ethics of Artificial Intelligence and Machine Learning, Prediction Ethics, Preventing Algorithms from Becoming Immoral, Real time applications of Agile systems, AI and Agile systems in health care, Future of Health care, Industrial Impact of Artificial Intelligence in health care, Industrial Impact of Artificial Intelligence in Agile System, Case Study : Designing a Document Editor : Design Problems, Document Structure, Case Study : Customer experience: Chat bot to substitute patient/member engagement*

<b>Learning Resources</b>	1. Stuart J. Russell, Peter Norwig , Artificial Intelligence –A Modern approach, 3rd PearsonEducation, 2016 2. Arjun Panesar, Machine Learning andAI for HealthcareBig Data for Improved HealthOutcomes, Apress ,2019 3. Carlo Appugliese, Paco Nathan, William Roberts, Agile AI, O'Reilly Media, Inc.2020	4. Robert C. Martin, Agile Software Development, Principles, Patterns, and Practices, Pearson Education, 2002 5. Bernhard Rumpe , Agile Modeling with UML Code Generation, Testing, Refactoring, Springer 2017 6. Andrew Stellman& Jennifer Greene, Head First Agile, A Brain-Friendly guide, Orelly ,2017
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<b>Learning Assessment</b>						
Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	20%	-	20%
Level 2	Understand	40%	-	40%	-	40%
Level 3	Apply	30%	-	40%	-	40%
Level 4	Analyze	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-
Level 6	Create	-	-	-	-	-
	Total	100 %		100 %		100 %

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr.S.Ravikumar , Director , Agile Practise, TEK System, Chennai		1. Dr T R Saravanan , SRMIST 2. Dr.G.Maragatham , SRMIST

<b>Course Code</b>	21CSE496T	<b>Course Name</b>	DEEP LEARNING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>												
<b>CLR-1:</b>	Understand the mathematical building blocks of Deep learning												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>											
<b>CLR-2:</b>	Get familiar with tuning of Deep Neural Network and layered approach																									
<b>CLR-3:</b>	Understand different architectures of Deep Networks																									
<b>CLR-4:</b>	Design and implement CNN for computer vision application using TensorFlow/ Keras																									
<b>CLR-5:</b>	Design and implement RNN for text and sequence processing application using TensorFlow/ Keras																									
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	
<b>CO-1:</b>	Understand the mathematical building blocks of Neural networks													3	1	-						-	-	1	-	-
<b>CO-2:</b>	Learn the foundations of Neural network and training them													3	1	3	-	-	-	-	-	-	-	-	2	-
<b>CO-3:</b>	Understand Architectural principles of neural network and major architectures of Deep Networks													2	2	3	-	3	-	-	-	-	-	-	2	-
<b>CO-4:</b>	Implement CNN model for computer vision application using TensorFlow/ Keras													2	2	3	-	3	-	-	-	-	-	-	3	2
<b>CO-5:</b>	Implement RNN model for text and sequence processing application using TensorFlow/ Keras													2	2	3	-	3	-	-	-	-	-	-	3	2

<b>Unit-1 - Introduction to Deep Learning</b>	<b>9 Hour</b>
Artificial intelligence - Machine learning - Learning representations from data - Understanding how deep learning works - mathematical building blocks of neural networks - Data representations for neural networks - Scalars - Vectors - Matrices - 3D tensors and higher-dimensional tensors - Key attributes - Vector data - The gears of neural networks: tensor operations - Element-wise operations - Tensor dot	
<b>Unit-2 - Foundations of Neural Network and Deep Learning</b>	
<b>9 Hour</b>	
Neural Networks – The Biological Neuron – The Perceptron – Multilayer feed forward networks – Training neural networks – Backpropagation Learning – Activation functions – Linear – Sigmoid – Tanh -SoftMax – Loss Functions - Hyperparameters – Learning rate – Regularization – Momentum - Sparsity	
<b>Unit-3 - Fundamentals of Deep Networks</b>	
<b>9 Hour</b>	
Architectural principles of Deep Networks – Parameters – Layers – Activation functions – Loss functions – Optimization algorithms – Hyperparameters – Building blocks of Deep Networks – RBMs – Autoencoders – Variational Autoencoders – Major architectures of Deep Networks – Deep belief Networks – Generative Adversarial Networks – Convolution Neural Networks – Recursive Neural Networks	
<b>Unit-4 - Deep learning for Computer Vision</b>	
<b>9 Hour</b>	
Introduction to convnets -The convolution operation - The max-pooling operation-Training a convnet from scratch on a small dataset -The relevance of deep learning for small-data problems - Downloading the data - Building your network - Data preprocessing - Using data augmentation - Using a pre trained convnet - Feature extraction - Fine Tuning - Visualizing what convnets learn - Visualizing intermediate activations - Visualizing convnet filters - Visualizing heatmaps of class activation	

**Unit-5 - Deep Learning for Text And Sequences** 9 Hour

Working with text data - One-hot encoding of words and characters - Using word embeddings - Putting it all together: from raw text to word embeddings - Understanding recurrent neural networks - A recurrent layer in Keras - Understanding the LSTM and GRU layers - A concrete LSTM example in Keras - Advanced use of recurrent neural networks - A temperature-forecasting problem - Preparing the data - first recurrent baseline - Using recurrent dropout contents to fight overfitting - Stacking recurrent layers - Using bidirectional RNNs - Sequence processing with convnets - Understanding 1D convolution for sequence data -1D pooling for sequence data - Implementing a 1D convnet - Combining CNNs and RNNs to process long sequences

**Case Studies:**

1. Develop a framework to classify facial expression using Convolutional Neural Network. Consider six basic emotional categories of anger, disgust, fear, happiness, sadness, and surprise and classify them without any complex pre-processes
2. NLP models can be used for text classification in order to detect spam-related words, sentences, and sentiment in emails, text messages, and social media messaging applications. Implement an NLP system to classify spam messages

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Deep Learning A Practitioner's Approach, Josh Patterson &amp; Adam Gibson, published by O'Reilly Media, Inc, First Edition, 2017</li> <li>2. Deep Learning with Python, FRANÇOIS CHOLLET, published by Manning Publications Co, 2018</li> <li>3. Better Deep Learning Train Faster, Reduce Overfitting and Make Better Predictions, Jason Brownlee, Machine Learning Mastery, 2019.</li> </ol>	<ol style="list-style-type: none"> <li>4. Deep Learning for Beginners: A Beginner's Guide to Getting Up and Running with Deep Learning from Scratch Using Python. Dr. Pablo Rivas and Laura Montoya, published by Packt publishing, 2020</li> </ol>
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Learning Assessment						
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)		
		Theory	Practice	Theory	Practice	Theory
Level 1	Remember	30%	-	30%	-	20%
Level 2	Understand	40%	-	40%	-	40%
Level 3	Apply	30%	-	30%	-	40%
Level 4	Analyze	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-
Level 6	Create	-	-	-	-	-
	Total	100 %		100 %		100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.A.Vasantha, Senior Consultant, Slalom · Sydney, New South Wales, Australia	1. Dr.A.Punitha, Associate Professor, Annamalai University	1. Dr.A.Revathi, SRMIST

<b>Course Code</b>	21CSE497T	<b>Course Name</b>	GAMING AND VIRTUAL REALITY	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the fundamentals of Virtual Reality												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Understand the basics of perception and human vision															
<b>CLR-3:</b>	Introduce the concepts of motion and tracking in VR tools															
<b>CLR-4:</b>	Understand the basic concepts of game design															
<b>CLR-5:</b>	Develop a game using Unity															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12			
<b>CO-1:</b>	Summarize the concepts of Geometry of Virtual Reality												3	-	-	-
<b>CO-2:</b>	Explain the basics of visual perception and rendering												3	-	2	-
<b>CO-3:</b>	Apply the concepts of motion and tracking in VR												3	-	3	-
<b>CO-4:</b>	Learn the concepts of game designing												3	-	2	-
<b>CO-5:</b>	Apply the concepts of game designing to develop a game using Unity												3	-	3	-

<b>Unit-1 - Introduction to Virtual Reality</b>	<b>9 Hour</b>
Defining Virtual Reality, History of VR, Scientific landmarks Computer Graphics, Basics of Geometric Models, Degree of freedom, Changing the position and Orientation, Introduction to Axis-Angle Representations of Rotation-, Basics of Transformations-Representation of the Virtual World, Virtual environments, Visual Displays, Auditory Displays, Haptic Displays.	
<b>Unit-2 - Visual Perception &amp; Rendering</b>	
Human Physiology and Perception, Human Eye, eye movements, Perception of Depth, Perception of Motion, Perception of Color, World Environment, VR Environment, Key Elements of Virtual Reality Experience, Interface to the Virtual World-Input & output, Combining Sources of Information Visual Rendering-Ray Tracing and Shading Models, Rasterization, Correcting Optical Distortions, Improving Latency and Frame Rates	
<b>Unit-3 - VR Tools, Motion &amp; Tracking:</b>	
R database, VR toolkits, Software for VR, Tessellated Data, Lights and Camera, Scripts, Graphical User Interface, Motion in Real and Virtual Worlds- Velocities and Accelerations, The Vestibular System, Physics in the Virtual World Mismatched Motion and Vector Tracking- Tracking 2D & 3D Orientation, Tracking Position and Orientation, Tracking Attached Bodies	
<b>Unit-4 - Introduction to Game Design</b>	
Game Design and Paper Prototyping - Game Analysis Frameworks - Inscribed Layer, Dynamic Layer - Cultural Layer, Design Goals - Paper Prototyping, Puzzle Design - The Digital Game Industry, Digital Prototyping - Introducing Development Environment: Unity - Thinking in Digital Systems - Introducing C# - Variables and Components - Boolean Operations and Conditionals - Functions and Parameters	
<b>Unit-5 - Basics of Game Development</b>	
Basics of Game Development - Scenes, Game Objects, Components - Working with Unity 2D & 3D - 2D graphics, Camera - Sprites a Texture Atlases – Animation – Scrolling - Overview of vector math - Physics principles - 3D math primer Basics of 3D World, 3D rendering Essentials - Using Unity for 3D development	

<b>Learning Resources</b>	1. Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016 2. Virtual and Augmented Reality: An Educational Handbook, Zeynep Tacgin , Cambridge Scholars Publishing, 2020 3. Jeremy Gibson, "Introduction to Game Design, Prototyping, and Development: From Concept to Playable Game with Unity and C#" ISBN-10:0321933168. 2014 4. Sanjay Madhav, "Game Programming Algorithms and techniques", Addison-Wesley, 2013 5. Jonathon Manning, Paris Buttfield-Addison, "Mobile Game Development with Unity: Build Once, Deploy Anywhere", O'Reilly Media Inc., 2017 6. Steve Aukstakalnis , "Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR" 2016, Publisher(s): Addison-Wesley Professional 7. <a href="https://nptel.ac.in/courses/106/106/106106138/">https://nptel.ac.in/courses/106/106/106106138/</a>
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	30%	-	20%	-	20%	-		
Level 2	Understand	40%	-	40%	-	40%	-		
Level 3	Apply	30%	-	40%	-	40%	-		
Level 4	Analyze	-	-	-	-	-	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Tejas Gowda, Co-Founder & Chief Data Scientist, TenzAI	1. Dr. T. Senthilkumar, Associate Professor, Amrita School of Engineering, Amrita Vishwa Vidyapeetham	1. Dr. A. Alice Nithya, SRMIST

<b>Course Code</b>	21CSE498T	<b>Course Name</b>	SMART PHONE COMPUTING AND ITS APPLICATIONS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 3	T 0	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Introduce the basic terminologies of mobile computing, fundamental concepts of mobile programming environment												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Understand about smartphone energy management, localization techniques, location privacy issues															
<b>CLR-3:</b>	Expertise to Mobile Social Networking															
<b>CLR-4:</b>	Learn about context-awareness and gesture recognition methodologies															
<b>CLR-5:</b>	Exposure to Advanced Mobile Applications															

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Understand Networking basics and Different MPE	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
<b>CO-2:</b>	Gain Knowledge of Wireless energy and localization	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
<b>CO-3:</b>	Introduce State of Art research in mobile computing technologies	3	-	-	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2
<b>CO-4:</b>	Gain knowledge in recognition methodologies	3	-	-	-	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
<b>CO-5:</b>	Understand Advanced Mobile Applications	3	-	-	2	3	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2

**Unit-1 - Networking Basics** 9 Hour  
 Wireless LAN, Bluetooth, WIFI Direct, NFC Programming platforms: Overview of different mobile programming environments, Difference with the classical programming practices, Introduction to mobile operating systems, iOS, Android, Windows, Mobile application development. Introduction to IoT: Definition, trend, IoT components, Data cleaning and processing, Social-IoT

**Unit-2 - Wireless Energy Management** 9 Hour  
 Measurement of energy consumption, WiFi Power Save Mode (PSM), Constant Awake Mode (CAM), Different Sleep States, WiFi Energy management Localization: User location and tracking system, Cell tower localization, Spot localization, Logical location, Ambience fingerprinting, War-driving, Localization without war-driving, Indoor localization, Crowdsourcing for localization. Context Sensing: Context-Aware system, Automatic Image Tagging, Safety critical applications Energy-efficient Context Sensing, Contextual Ads and Mobile Apps.

**Unit-3 - Mobility** 9 Hour  
 Overview of Mobility models, Automatic Transit Tracking, Mapping, Arrival Time Prediction, Augmenting Mobile 3G with WiFi, Vehicular WiFi Hotspots, Code Offload Privacy and Security: Authentication on Mobile Phones, Activity based Password, Finger Taps usage as Fingerprints, Location Privacy

**Unit-4 - Mobile Affective Computing** 9 Hour  
 Human Activity and Emotion Sensing, Health Apps Activity and Gesture Recognition: Machine Recognition of Human Activities, Mobile Phones to Write in Air, Crowdsensing based activity recognition, Personalized Gesture Recognition, Content Rating, Recognizing Human without Face Recognition, Phone-to-Phone Action Games, Interface design issues, Touchscreen, Gesture-based Input.

**Unit-5 - Case Studies** 9 Hour  
 Smartphone App game, Determining driver phone use, Smart phone Configuration I Tourism, Network Monitoring using smart phone.

<b>Learning Resources</b>	1. "Smart Phone and Next Generation Mobile Computing" Morgan Kaufmann Series in Networking, PeiZheng, Lionel Ni 1 <sup>st</sup> Edition ELSEVIER 2005 2. ." Principles Of Mobile Computing", Hansmann, LotharMerk, Martin Niclous, Stober, reamtech Press 2006 2 <sup>nd</sup> Edition	3. <a href="https://ieeexplore.ieee.org/search/searchresult.jsp?newsearch=true&amp;queryText=determining%20driver%20phone%20use">https://ieeexplore.ieee.org/search/searchresult.jsp?newsearch=true&amp;queryText=determining%20driver%20phone%20use</a> 4. <a href="Https://link.springer.com/book/10.1007/b102605">Https://link.springer.com/book/10.1007/b102605</a> 5. <a href="https://ieeexplore.ieee.org/document/7152220">https://ieeexplore.ieee.org/document/7152220</a> .
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<b>Learning Assessment</b>		<b>Continuous Learning Assessment (CLA)</b>				<b>Summative Final Examination (40% weightage)</b>			
	<b>Bloom's Level of Thinking</b>	<b>Formative CLA-1 Average of unit test (50%)</b>		<b>Life-Long Learning CLA-2 (10%)</b>					
		<b>Theory</b>	<b>Practice</b>	<b>Theory</b>	<b>Practice</b>				
Level 1	<i>Remember</i>	30%	-	20%	-	20%	-		
Level 2	<i>Understand</i>	40%	-	40%	-	40%	-		
Level 3	<i>Apply</i>	30%	-	40%	-	40%	-		
Level 4	<i>Analyze</i>	-	-	-	-	-	-		
Level 5	<i>Evaluate</i>	-	-	-	-	-	-		
Level 6	<i>Create</i>	-	-	-	-	-	-		
	<b>Total</b>	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Dr.R.Jaya,Data Scientist, Great Learning ,Bangalore.	1. Dr.R. Senthilkumar, Associate professor, Dept of CSE, New Horizon college of Engineering, Bangalore. 2. Dr.N. Thillai Arasu, Associate Professor, School of CSE &IT, Reva University, Bangalore	1. Dr.Dinesh G, SRMIST

**ACADEMIC CURRICULA**

**UNDERGRADUATE/ INTEGRATED POST  
GRADUATE DEGREE PROGRAMMES**

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume – 11D

(Syllabi for Computer Science and Engineering w/s in  
Cloud Computing Programme Courses)



**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

# ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021



**SRM**

INSTITUTE OF SCIENCE & TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

<b>Course Code</b>	21CSC316J	<b>Course Name</b>	CLOUD ARCHITECTURE AND PROTOCOLS	<b>Course Category</b>	C	PROFESSIONAL CORE	L 2	T 0	P 2	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Explore cloud computing models and infrastructure for various networks.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Identify policies, mechanisms and scheduling for resource management, virtualization, and optimization of networks.															
<b>CLR-3:</b>	Compare multiple approaches to cloud system design and solve real world problems															
<b>CLR-4:</b>	Illustrate storage concept and self-organizing capability for different cloud systems															
<b>CLR-5:</b>	Relate Cloud architecture into business models															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CO-1:</b>	Explore the concepts of cloud infrastructure, for different cloud models												3	2	1	
<b>CO-2:</b>	Monitor the scalability issues and its performance in a distributed environment												3	2	2	
<b>CO-3:</b>	Apply the principle of virtualization, storage, and data management for resource utilization												3	-	3	
<b>CO-4:</b>	Create application by utilizing cloud platforms												3	-	3	
<b>CO-5:</b>	Relate Cloud architecture with maximization of service delivery												3	2	2	

**Unit-1 - Introduction** 12 Hour  
Vision of Cloud Computing, defining a Cloud, Cloud Computing Reference Model, Characteristics and Benefits, Historical Developments, Building Cloud Computing Environments, Computing Platforms and Technologies, Eras of Computing, Parallel vs. Distributed Computing, Elements of Parallel Computing

**Unit-2 – Virtualization Techniques** 12Hour  
Virtualization and Cloud Architecture, Characteristics of Virtualized Environments, Taxonomy of Virtualization Techniques, Virtualization and Cloud Computing, Pros and Cons of Virtualization, Technology Examples, Xen, VMware, Microsoft Hyper-V, Cloud Reference Model and Architecture, Infrastructure as a Service, Platform as a Service, Software as a Service, Types of Clouds, Economics of the Cloud, Open Challenges in Clouds, Aneka Architecture, Building Private Clouds using Aneka, Cloud Management

**Unit-3 – Application Programming** 12 Hour  
Cloud Application Programming, Concurrent Computing and Thread Programming, Multithreading with Aneka, Programming Applications with Aneka Threads; High-Throughput Computing and Task Programming, Task-based Application Models, Aneka Task-Based Programming, Task Programming Model, and Developing Applications with the Task Model; Data Intensive Computing: Map-Reduce Programming

**Unit-4 - Applications** 12 Hour  
Public Cloud Infrastructures and Applications, Amazon Web Services - Compute, Storage, and Communication Services; Google AppEngine – Architecture, Application Life-Cycle, Cost Model; and Microsoft Azure. Scientific Applications - ECG Data Analysis on Cloud, Protein Structure Prediction, Satellite Image Processing; Business and Consumer Applications – CRM, Social Networks, Media Applications, and Multiplayer Online Gaming.

**Unit-5 – Energy Aware Techniques** 12 Hour

Advanced Topics in Cloud Computing, Energy efficiency in clouds, Energy-efficient and green cloud computing architecture, Market-based management of clouds, Market-oriented cloud computing, A reference model for MOCC, 3 Technologies and initiatives supporting MOCC, Observations, Federated clouds/Inter Cloud, Characterization and definition, Cloud federation stack, Technologies for cloud federations, Third-party cloud services such as Meta CDN.

**Lab Experiments**

- |   |   |
|---|---|
| <ol style="list-style-type: none"> <li>1. Installation of Cloud Simulation</li> <li>2. Create a datacenter with one host and run one cloudlet on it.</li> <li>3. Create a datacenter with one host and run two cloudlets on it. The cloudlets run in VMs with the same MIPS requirements. The cloudlets will take the same time to complete the execution.</li> <li>4. Create a datacenter with two hosts and run two cloudlets on it. The cloudlets run in VMs with different MIPS requirements. The cloudlets will take different time to complete the execution depending on the requested VM performance.</li> <li>5. Create two datacenters with one host each and run two cloudlets on them.</li> <li>6. Create two datacenters with one host each and run cloudlets of two users on them.</li> <li>7. Create scalable simulations</li> </ol> | <ol style="list-style-type: none"> <li>8. EC2 Instance Window virtual machine launch and access using RDP Client from any network/specify network using private keypair</li> <li>9. AWS Platform: Dashboard Services Study Experiments</li> <li>10. EC2 Instance Linux virtual machine launch and access using putty application/SSH Client from any network/specify network by private keypair</li> <li>11. Configure Virtual Private Cloud with single public subnet and launch any virtual machine within the subnet.</li> <li>12. Configure public Virtual Private Cloud with one public subnet and one private subnet then launch &amp; access any virtual machine within the private subnet</li> <li>13. Create a Lambda function with the console in AWS Platform</li> <li>14. Creating a server less application with continuous delivery in the Lambda console<br/>Create Application Load Balancer Using AWS Lambda function</li> </ol> |
|---|---|

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Rajkumar Buyya, Christian Vecchiola, and ThamaraiSelvi, <i>Mastering Cloud Computing</i>, McGraw Hill, New Delhi, India, 2013, ISBN-13: 978-1-25-902995-0.</li> <li>2. Dan C Marinescu: <i>Cloud Computing Theory and Practice</i>. Elsevier (MK), 1<sup>st</sup> edition, 2013, ISBN: 9780124046276.</li> <li>3. Kai Hwang, GeofferyC.Fox, Jack J Dongarra: <i>Distributed Computing and Cloud Computing, from parallel processing to internet of things</i>. Elsevier (MK), 1<sup>st</sup> edition, 2012, ISBN: 978-0-12-385880-1</li> <li>4. John W Rittinghouse, James F Ransome: <i>Cloud Computing Implementation, Management and Security</i>, CRC Press, 1<sup>st</sup> Edition, 2013, ISBN: 978-1-4398-0680-7.</li> <li>5. Gautam Shroff, "Enterprise Cloud Computing Technology Architecture Applications", Cambridge University Press; 1 edition, [ISBN: 978-0521137355], 2010.</li> </ol>
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<b>Learning Assessment</b>						
Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%
Level 2	Understand	20%	-	-	20%	20%
Level 3	Apply	20%	-	-	20%	20%
Level 4	Analyze	15%	-	-	15%	15%
Level 5	Evaluate	15%	-	-	15%	15%
Level 6	Create	15%	-	-	15%	15%
	Total	100 %		100 %		100 %

<b>Course Designers</b>		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Sudhakar E P Development Project Leader at American Megatrends International India (P) Ltd	1. Dr. Rajkumar Buyya University of Melbourne, Australia	1. Dr.M.Saravanan, SRMIST,

<b>Course Code</b>	21CSC314P	<b>Course Name</b>	BIG DATA ESSENTIALS	<b>Course Category</b>	C	PROFESSIONAL CORE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Identify the basics of big data and hadoop												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	Demonstrate the tools and techniques in big data												-	-	-										
<b>CLR-3:</b>	Inspect the query language based on big data application												-	-	-										
<b>CLR-4:</b>	Interpret classification and clustering in big data application												-	-	-										
<b>CLR-5:</b>	Experiment the Big data Visualization tools												-	-	-										
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Acquire knowledge on the basics of big data												2	-	-	3	-	-	-	-	-	-	-	2	
<b>CO-2:</b>	Examine the tools and techniques using Hadoop, HDFS, and Map Reduce												-	-	-	3	3	-	-	-	-	-	-	3	
<b>CO-3:</b>	Build any database for the application in big data												2	-	-	3	-	-	-	-	-	-	-	3	
<b>CO-4:</b>	Apply different classification and clustering algorithms using data sets in an application												-	-	-	3	-	-	-	-	-	-	-	3	
<b>CO-5:</b>	Analyze the Visualization techniques in big data												2	-	-	3	3	-	-	-	-	-	-	-	3

<b>Unit-1 - Introduction</b>	<b>9 Hour</b>
Introduction to Big Data, Impact of Big Data, Parallel Processing, and Data Parallelism, Tools of Big Data, Introduction to the Hadoop Ecosystem, Introduction to MapReduce, The Hadoop Ecosystem/Common components: Introducing HDFS, Hive, HBase, and Spark, other modules, Installing Hadoop	
<b>Unit-2 - Hadoop Distributed File System</b>	
Features of HDFS, HDFS Commands, Retrieving file data from HDFS using Python Snakebite, Deleting files in HDFS using Python Snakebite, Map Reduce and Spark RDD Big Data, Working with HDFS, Working with HBase, Difference between HDFS and HBase, Hadoop Word Count using Map Reduce, Matrix Multiplication using Map Reduce	
<b>Unit-3 - Pig Programming</b>	
Introduction to Pig, Parallel processing using Pig, Pig Latin-Input and output, Hive: Introduction, data types and file formats, QL-data definition, data manipulation, QL views, indexes, Hive queries with partitioning.	
<b>Unit-4 - Spark Framework</b>	
GPU Computing, CUDA Programming model, Multiplication in CUDA, CUDA Memory model, Shared memory matrix multiplication Writing Spark application, Spark programming in R, Scala, Python, Java, Streaming application, Classification and Clustering in Big data, K-Means clustering, Decision Tree Classification, Naive Bayes Classification.	
<b>Unit-5 – Big Data Visualization</b>	
Introduction to big data visualization, Tree Maps, Maps, Gauge, Sunburst, Different visualization tools, Creating Visualization in Tableau, Different visualization methods in Tableau	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Sima Acharya, Subhashini Chellappan," BIG Data and Analytics" Wiley Publication, 2020.</li> <li>2. Michael Minelli,Michele Chambers, AmbigaDhiraj, "BigData, BigAnalytics - Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley Publication, 2018.</li> <li>3. Thomas Erl, "Big Data Fundamentals-Concepts, Drivers and Techniques", Pearson publication, 2016.</li> <li>4. Kyle Banker, PeterBakkum, Shaun Verch," MongoDB in Action" Dream tech Press publication 2016.</li> <li>5. Achari, Shiva "Hadoop Essentials" Birmingham, UK: Packt Publishing. 2015.</li> <li>6. Tom White, "HADOOP: The Definitive Guide", O Reilly 2012.</li> </ol>					
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<b>Learning Assessment</b>								
Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						<b>Final Examination (0% weightage)</b>	
	Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20%)			
	Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	15%	-	-	15%	-	15%	-
Level 2	Understand	25%	-	-	20%	-	20%	-
Level 3	Apply	30%	-	-	25%	-	25%	-
Level 4	Analyze	30%	-	-	25%	-	25%	-
Level 5	Evaluate	-	-	-	10%	-	10%	-
Level 6	Create	-	-	-	5%	-	5%	-
	Total	100 %		100%		100%		-

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Kumanan P, Project Manager, CTS, Chennai	1. Dr.V.Vijayarajan, Associate Professor/HOD, Vellore Institute of Technology, Vellore	1. Mrs.V.Vijayalakshmi, SRMIST

# ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021



**SRM**  
INSTITUTE OF SCIENCE & TECHNOLOGY  
(Deemed to be University u/s 3 of UGC Act, 1956)

**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

**(Deemed to be University u/s 3 of UGC Act, 1956)**

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

<b>Course Code</b>	21CSE261T	<b>Course Name</b>	FUNDAMENTALS OF CLOUD COMPUTING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>	<i>The purpose of learning this course is to:</i>	Program Outcomes (PO)												<b>Program Specific outcomes</b>		
		1	2	3	4	5	6	7	8	9	10	11	12			
<b>CLR-1:</b>	Review the fundamental ideas behind Cloud Computing, the evolution of the paradigm, its applicability, benefits, as well as current and future challenges															
<b>CLR-2:</b>	Discover cloud-enabling technologies and get exposure to advanced clouds															
<b>CLR-3:</b>	Employ distributed file system and cloud storage technologies															
<b>CLR-4:</b>	Identify the cloud security threats and protective mechanisms for cloud computing															
<b>CLR-5:</b>	Compare various architectural styles and cloud development models															
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
<b>CO-1:</b>	Describe the fundamentals of cloud computing and its applications, benefits, and Challenges	3	-	-	2	-	-	-	-	-	-	-	-	3	-	-
<b>CO-2:</b>	Illustrate concepts in cloud infrastructures to understand the cloud system	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-
<b>CO-3:</b>	Demonstrate the usage in storage system in cloud	3	-	-	3	-	-	-	-	-	-	-	-	3	-	-
<b>CO-4:</b>	Investigate security issues related to cloud computing	-	2	-	2	-	-	-	-	-	-	-	-	3	-	-
<b>CO-5:</b>	Categorize cloud programming models and apply to solve problems on the cloud.	3	-	-	2	2	-	-	-	-	-	-	-	-	-	3

**Unit-1 - Introduction to Cloud Computing** 9 Hour  
Network-Centric Computing - Origin of Cloud Computing-Evolution of cloud computing - Basic Concepts and Terminology - Goals and Benefits - Risks and Challenges -Roles and Boundaries - Cloud Characteristics - Cloud Deployment Models - Cloud Service Models - Cloud Service Providers and the Cloud Ecosystem -SLA Management in Cloud Computing: A Service Providers Perspective – Overview of Amazon Web Services (AWS)- Tutorial: Creating an account on AWS

**Unit-2 - Cloud enabling technologies** 9 Hour  
Broadband networks and Internet architecture - Data Center Technology - Web Technology - Multitenant Technology - Service Technology -Virtualization Technology - Virtual Machines - Hypervisors -Full Virtualization and Para-virtualization - Hardware Support for Virtualization - Kernel-Based Virtual Machine– Tutorial: Creating AWS EC2 Instances.

**Unit-3 - Introduction to Cloud Data Storage** 9 Hour  
The evaluation of storage technology - Storage Models - File Systems and databases - Cloud Object Storage (Amazon S3) - Data Storage for Online Transaction Processing Systems- Disk Locality versus Data Locality in Computer Clouds- Tutorial: Creating a S3 bucket in AWS

**Unit-4 - Fundamental Cloud Security** 9 Hour  
Basic Terms and Concepts - Threat Agents, Cloud Security Threats - Cloud Security Mechanisms - Encryption – Hashing - Digital Signature - Public Key Infrastructure - Identity and Access Management - Single Sign-On: Kerberos authentication - One-time password, Basic cloud data - security mechanisms - Virtual Machine Security - Security of Virtualization - A Trusted Hypervisor - Mobile Devices and Cloud Security - Tutorial: Creating an IAM in AWS

**Unit-5 - Cloud Application Development and Architectural Styles**

**9 Hour**

MapReduce Programming Model - Case Study: The Grep – TheWeb Application - Hadoop: Yarn and Tez - SQL on Hadoop: Pig, Hive, and Impala - Current Cloud Applications and New Opportunities - Design approaches with Case Study - Design methodology for IaaS Service Model - Google API, More on AWS EC2 Instances.

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Dan C. Marinescu, "Cloud Computing Theory and Practice", Second Edition Copyright © 2018 Elsevier Inc. All. <a href="https://www.sciencedirect.com/book/9780128128107/cloud-computing">https://www.sciencedirect.com/book/9780128128107/cloud-computing</a></li> <li>2. Rajkumar Buyya, James Broberg, AndrzejGoscinski, Cloud Computing Principles and Paradigms, Wiley Publications, 2017.</li> <li>3. Thomas Erl, ZaighamMahmood, and RicardoPuttini, "Cloud Computing: Concepts, Technology &amp; Architecture", Prentice Hall/PearsonPTR, Fourth Printing, 2014, ISBN: 978013338752.</li> <li>4. Arshdeep Bahga, Vijay Madisetti, "Cloud Computing: A Hands-On Approach", University Press, 2016, ISBN13: 978-0996025508.</li> <li>5. K. Chandrasekaran, "Essentials of Cloud Computing", Chapman and Hall/CRC Press, 2014, ISBN 9781482205435</li> </ol>
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<b>Learning Assessment</b>		<b>Continuous Learning Assessment (CLA)</b>				<b>Summative Final Examination (40% weightage)</b>			
<b>Bloom's Level of Thinking</b>		<b>Formative CLA-1 Average of unit test (50%)</b>		<b>Life-Long Learning CLA-2 (10%)</b>					
		<b>Theory</b>	<b>Practice</b>	<b>Theory</b>	<b>Practice</b>				
Level 1	Remember	20%	-	20%	-	20%	-		
Level 2	Understand	30%	-	30%	-	30%	-		
Level 3	Apply	20%	-	20%	-	20%	-		
Level 4	Analyze	20%	-	20%	-	20%	-		
Level 5	Evaluate	10%	-	10%	-	10%	-		
Level 6	Create	-	-	-	-	-	-		
<b>Total</b>		100 %		100 %		100 %			

**Course Designers**

<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr.Mohit Kumar, Senior Data Scientist, Verizon,Bangalore,Karnataka,India	1. Dr. K.R. Jothi Associate Professorship of Computational Intelligence, School of Computer Science and Engineering, Department of Information Technology, Vellore Institute of Technology, Vellore	1. Ms.V.Lavanya, SRMIST, KTR

<b>Course Code</b>	21CSE262T	<b>Course Name</b>	COMMUNICATION SYSTEMS ENGINEERING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Illustrate the principles of Communication systems engineering												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	Discuss the Knowledge on Communication systems components																								
<b>CLR-3:</b>	Apply encoding and decoding techniques																								
<b>CLR-4:</b>	Sketch the fundamentals of Fibre Optic Communication																								
<b>CLR-5:</b>	Outline the basics of Satellite Communication																								
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Outline the basic ideas about Communication and its types												3	-	-	-	-	-	-	-	-	-	3	-	-
<b>CO-2:</b>	Identify the applications of Communication systems, information sources and source coding algorithms												3	-	-	-	-	-	-	-	-	-	3	-	-
<b>CO-3:</b>	Articulate the concepts of coding for reliable Communication												3	-	-	-	-	-	-	-	-	-	3	-	-
<b>CO-4:</b>	Utilize the skills learned during the design and integration of the fiber optic mode of Communication in any system under development												3	-	-	3	-	-	-	-	-	-	2	-	-
<b>CO-5:</b>	Demonstrate the design and integration of the satellite mode of Communication in any system under development												3	-	-	-	-	-	-	-	-	-	2	-	-

<b>Unit-1 – Introduction to Communication System</b>	<b>9 Hour</b>
Introduction – Significance of human Communication, Communication systems, Communication channel, Types of electronic Communication, simplex, Full duplex, half duplex, Analog and Digital signals, Modulation and multiplexing, Baseband transmission, Broadband transmission, Multiplexing, Electromagnetic spectrum, Frequency and wavelength, Optical spectrum, Bandwidth, Channel Bandwidth, Effect of Noise on Analog Communication systems	

<b>Unit-2 – Information Coding</b>	<b>9 Hour</b>
Introduction to information sources and source coding, Modelling of information sources, Source Coding Theorem, Source Coding Algorithms: Huffman source coding algorithm, Lempel-Ziv source coding algorithm, Rate distortion theory: Mutual information, Differential Entropy, Rate distortion function - Quantization, Waveform Coding: PCM, DPCM, Delta modulation, Digital audio transmission and digital audio recording, Digital audio in telephone transmission systems, Digital audio recording	

<b>Unit-3 – Coding for Reliable Communication</b>	<b>9 Hour</b>
Tight bound on error probability of orthogonal signals, The promise of coding, Linear Block Codes, Theorem on Linear code, Hamming Codes, Decoding and performance of linear block codes, Soft decision decoding, Hard decision decoding, Error detection and Error correction, Burst error correcting codes, Cyclic codes, The structure of cyclic codes, The generator matrix, Encoding of cyclic Coupling Losses Equivalent Noise codes, BCH Codes, Reed-Solomon Codes, Convolutional Codes, Basic properties of convolutional codes, Encoding, The transfer function, Catastrophic codes, Optimum decoding of convolutional codes - The Viterbi algorithm.	

**Unit-4 - Fibre Optic Communication****9 Hour**

Introduction Through Optical Fiber, Electromagnetic Spectrum, Types of Optical Fibres, Propagation of Light, Single Mode Fibre, Multimode Fibre, Losses Within an Optical Fiber: Attenuation Loss, Absorption Loss, Radiation Loss, Dispersion Loss, Rayleigh Scattering Loss, Modal Dispersion Loss, Coupling Losses, Optical Point-to-point Communication Systems: Single Channel System Amplified Single Channel System, Wavelength Division Multiplexing (WDM) Systems

**Unit-5 - Satellite Communication****9 Hour**

Introduction, Basic Satellite Transponder Kepler's Laws, Kepler's First Law Kepler's Second Law Kepler's Third Law, Satellite Orbits: Low Earth Orbit Satellite Medium Earth Orbit Satellite, Satellite Orbital Patterns Inclined Orbits Equatorial Orbit, Polar Orbits, Geostationary Satellites, Geosynchronous Satellite, Power Systems, Altitude Control: Spin Stabilized, Spun/de-spun Stabilization Method, Three-axis Stabilized Method, Altitude Control Components: Sensors, Actuators, Satellite System Parameters, Equivalent Noise, Temperature Carrier-to-Noise Density Ratio, Energy of Bit-to-Noise Density Ratio, Satellite System Link Models, Satellite System Link Equation 636 Uplink Power Budget Calculation, Satellite Radio Navigation

<b>Learning Resources</b>	1. Louis E. Frenzel, <i>Principles of Electronic Communication Systems</i> , 4th Edition, Tata McGraw Hill Education, 2019. (Unit -I) 2. Ohn G. Proakis, Masoud Salehi, <i>Communication Systems Engineering</i> , 2nd edition, Pearson Education International, 2015. (Unit - II & Unit -III)	3. <i>Communication Systems</i> , V. Chandra Sekar, Oxford University Press, 2015(Unit - IV &Unit-V)
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**Learning Assessment**

Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%
Level 2	Understand	30%	-	30%	-	30%
Level 3	Apply	20%	-	20%	-	20%
Level 4	Analyze	30%	-	30%	-	30%
Level 5	Evaluate	-	-	-	-	-
Level 6	Create	-	-	-	-	-
	Total	100 %		100 %		100 %

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. J.Dayanithi, Senior Consultant, Verizon Data Services Private Ltd.	1. Dr.V.Vijayarajan, Associate Professor, Vellore Institute of Technology, Vellore	1. Mrs. V.Vijayalakshmi, SRMIST

<b>Course Code</b>	21CSE263T	<b>Course Name</b>	DIGITAL COMMUNICATION SYSTEMS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Outline the framework of digital communication systems												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Discover and correlate the digital coding techniques															
<b>CLR-3:</b>	Illustrate and prioritize the various digital modulation schemes															
<b>CLR-4:</b>	Adapt and validate with error control coding methods															
<b>CLR-5:</b>	Assess and classify the significance of multiplexing and multiple access															
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>															
<b>CO-1:</b>	Recognize the essentials of digital communication system												2	-		
<b>CO-2:</b>	Interpret the concepts on sampling, Quantization, encoding and Signal Compression												2	3	-	
<b>CO-3:</b>	Identify the various digital modulation techniques for various signals												2	3	-	
<b>CO-4:</b>	Examine the error Detection and Correction codes												2	3	-	
<b>CO-5:</b>	Analyze the multiplexing and multiple access techniques												2	-	-	

<b>Unit-1 - Introduction Digital Communication System</b>	<b>9 Hour</b>
Advantages of Digital Communication-Regeneration of Digital Signals, Power Efficiency of Digital Modulators Bandwidth Compression, - Multimedia: Unification of Signals Performance, Technology - Time and Frequency Representation - Fourier Series, Fourier Transform - Discrete Fourier Transform - Convolution - Correlation - Hilbert Transform - Low-pass and Band-pass Representations - Signals and Systems: Analytic Signals, Low-pass Equivalent Signals - Signal Space Representations: Vector Space	

<b>Unit-2 – Digital Coding Techniques</b>	<b>9 Hour</b>
Digitizing Analog Signals - Sampling - Quantization - Encoding - Signal Compression, Signal Statistics and Redundancy - Companded PCM - Predictive Coding - Transform Coding - Parametric Coding - Perceptual Coding - Application of Digital Coding- Digital Speech - Adaptive Delta Modulation Codec- Pulse Code modulation Codec - Digital Audio: MP3 Coding - Digital Video: Run Length Coding, variable Length Coding - MPEG1	

<b>Unit-3 - Digital Modulation Techniques</b>	<b>9 Hour</b>
Baseband Modulation - Pulse Modulation Systems - Baseband Signalling - Correlative Coding: Duo-Binary Coding, Modified Duo-Binary Coding- Digital Phase Modulation(Phase Shift Keying): Bi-phase shift keying modulation - Quadrature and Offset Quadrature phase shift keying - Digital Frequency Modulation(Frequency Shift Keying), Minimum Shift Keying, Gaussian Minimum Shift Keying, - Continuous Phase Modulation, Baseband Signals, Band-pass Signals - Comparison of Basic Modulations Orthogonal Frequency Division Multiplexing	

<b>Unit-4 – Error Coding and Decoding</b>	<b>9 Hour</b>
Introduction-Types and Measure of Error- Shannon-Hartley Capacity Theorem - Methods of Error Control-Classification of Error-Correcting Codes - Linear Block Codes-Hamming Distance, Weight, Error Detection, Correction - Linear Block Codes-Generator Matrix, Systematic codes, Parity Check Matrix Standard Array - Implementing the decoder Cyclic Codes-Generator Polynomial for cyclic code - Systematic Cyclic code - Polynomial Multiplication and division - Importance of Block Codes-Hamming Codes, Golay-Reed Solomon Codes, Convolutional codes, Convolutional Encoder - Convolutional Decoding, Maximum like hood Decoding, Viterbi algorithm, Sequential Decoding and Fano Algorithm, Practical Applications of Error Correcting codes, Deep Space Communication, Satellite Communication	
<b>Unit-5 – Multiplexing Techniques</b>	<b>9 Hour</b>
Introduction to Multiplexing-Types - Frequency Division Multiplexing, Time Division Multiplexing - Frame Synchronization - Primary Multiplexing in Digital Telephony - Higher Order Multiplexing - Multiple Access-Frequency Division Multiple Access, Time Division Multiple Access, Code Division Multiple Access, Random Access, Carrier Sense Multiple access/Collision Detection, Fixed Assignment Multiple Access, Demand Assignment Multiple Access - Introduction to Pseudo-Noise Sequence - Properties of PN Sequences - Spread Spectrum: Direct Sequence Spread Spectrum(DSSS), Frequency Hopping Spread Spectrum(FHSS), Spread Spectrum Applications	

<b>Learning Resources</b>	1. R.N. Mutagi, <i>Digital Communication – Theory, Techniques and Applications</i> , 2nd Edition, Oxford University Press, 2014.	6. Simon Haykin, "Communication Systems", John Wiley & Sons, 4th Edition, 2008.
	2. John R. Barry, Edward A. Lee, David G. Messerschmitt, <i>Digital Communication</i> , 3rd Edition, Springer International Edition, Springer, 2011	7. Bernard Sklar, "Digital Communication, Fundamentals and Application", Pearson Education Asia, 2nd Edition, 2001
	3. John G. Proakis, Masoud Salehi, <i>Digital Communications</i> , 5th Edition, McGrawHill Education, 2015	8. Taub & Schilling, "Principle of Communication Systems", McGraw Hill Inc, 2nd Edition, 2003.
	4. Simon Haykin and Michael Moher, "Communication Systems," 5th edition, John Wiley & Sons, 2013	9. B.P. Lathi, "Modern Digital and Analog Communication System", Oxford University Press, 3rd Edition, 2005.
	5. Singh. R. P & Sapre. S. D, "Communication Systems: Analog & Digital," 3rd edition, McGraw-Hill Education, Seventh Reprint, 2016.	10. Shu Lin, Daniel Costello, "Error control coding – Fundamentals and Applications", Prentice Hall, Upper Saddle River, NJ, 2nd Edition, 2004.

<b>Learning Assessment</b>							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice		
Level 1	Remember	20%	-	20%	-	20%	
Level 2	Understand	30%	-	30%	-	30%	
Level 3	Apply	20%	-	20%	-	20%	
Level 4	Analyze	30%	-	30%	-	30%	
Level 5	Evaluate	-	-	-	-	-	
Level 6	Create	-	-	-	-	-	
	Total	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Dr. V. Lingasamy, ME, PhD, Sr. Technical Lead at Sterlite Technologies Limited, Chennai	1. Dr.K.R. Jothi Associate Professorship of Computational Intelligence, School of Computer Science and Engineering, Department of Information Technology, Vellore Institute of Technology, Vellore	1. Mr.H.Karthikeyan, SRMIST, KTR – NWC

<b>Course Code</b>	21CSE330T	<b>Course Name</b>	CLOUD ARCHITECTURE	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Review the fundamentals of cloud architecture	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
<b>CLR-2:</b>	Infer the technologies used with cloud platforms	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
<b>CLR-3:</b>	Discover the advance cloud architecture and storage structures	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
<b>CLR-4:</b>	Classify the importance of cloud architecture design	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
<b>CLR-5:</b>	Examine virtualization architecture and future trends in cloud structures	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3

  

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CO-1:</b>	Persist the concept of basic cloud computing paradigms	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
<b>CO-2:</b>	Interpret the concepts of Cloud service structures	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
<b>CO-3:</b>	Analyze the components of cloud computing and about business agility in an organization	3	-	-	2	-	-	-	-	-	-	-	-	-	-	3
<b>CO-4:</b>	Relate with the market service providers in cloud	3	-	-	2	-	-	-	-	-	-	-	-	-	-	3
<b>CO-5:</b>	Evaluate data center technologies and cloud architecture patterns	3	-	-	2	-	-	-	-	-	-	-	-	-	-	3

<b>Unit-1 - Introduction</b>	<b>9 Hour</b>
Introduction to cloud computing fundamental, Cloud Computing definition, Cloud deployment models, Private, Public, Hybrid, community cloud, Cloud services: IaaS, PaaS, SaaS, Enabling technologies of cloud computing, Benefits and challenges of cloud computing, Business Agility: Benefits and challenges to Cloud, architecture. Cloud Applications, Application availability, Performance, Various types of disaster in cloud environment.	

<b>Unit-2 - Service Oriented Architecture</b>	<b>9 Hour</b>
REST, Systems of Systems, Web Services, Publish-Subscribe Model, Basics of Virtualization, Types of Virtualizations, Implementation Levels of Virtualization, Virtualization Structures- Advantages and Disadvantages, Tools and Mechanisms, Virtualization of CPU Memory, I/O Devices, Virtualization Support and Disaster Recovery, Server Virtualization, Parallel Processing, Vector Processing, Symmetric Multiprocessing Systems, Massively Parallel Processing Systems.	

<b>Unit-3 - Cloud Storage Infrastructures</b>	<b>9 Hour</b>
Introduction to cloud storage infrastructures, Concept, planning and Design, Business continuity ,Basic concepts of information security, Managing VDC and cloud environments and infrastructures, Securing storage in virtualized and cloud environments, Monitoring and management, Security auditing and SIEM, Storage Network Design, Architecture of storage, analysis and planning, Storage network design considerations, NAS and FC SANs, Hybrid storage networking technologies, iSCSI, FCIP, FCoE, Design for storage virtualization in cloud computing, Host system design considerations, Cloud Applications, Technologies and the processes required for deploying web services.	

<b>Unit-4 – Resource Provisioning</b>	<b>9 Hour</b>
Management of Cloud Services, Reliability, availability and security of services deployed from the cloud, Performance and scalability of services, Tools and technologies used to manage cloud services deployment, Cloud Economics, Cloud Computing infrastructures available for implementing cloud based services, Economics of choosing a Cloud platform for an organization, Runtime Support Services Resource Provisioning and Platform Deployment- Provisioning of Compute Resources (VMs),Resource Provisioning Methods, NIST Cloud Computing Reference Architecture, Demand-Driven, Event-Driven Resource Provisioning, Popularity-Driven Resource Provisioning, Dynamic Resource Deployment Storage-as-a-Service, Advantages of Cloud Storage - Global Exchange of Cloud Resources Application Development. Service creation environments to develop cloud-based applications	
<b>Unit-5 – Data Center Design</b>	<b>9 Hour</b>
Introduction to Cloud Architecture patterns, Horizontally Scaling Compute Pattern- Cloud Significance, Queue-Centric Workflow Pattern Auto-Scaling Pattern, Eventual Consistency Prime, MapReduce Pattern, Database Sharding Pattern, Node Failure Pattern, Network Latency Primer CDN Pattern, Multisite Deployment Pattern, Network connectivity optimization evolution: Top of rack (TOR), end of rack (EOR), connectivity, Stand-alone, blades, stateless, clustering, scaling optimization, virtualization, Limitation of traditional server deployments, Case studies	

<b>Learning Resources</b>	1. Gautam Shroff, "Enterprise Cloud Computing Technology Architecture Applications", Cambridge University Press; 1 edition, [ISBN: 978-0521137355], 2010.	6. Klaus Schmidt, "High Availability and Disaster Recovery" Springer; edition [ISBN: 978-3540244608], 2006.
	2. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach" McGraw-Hill Osborne Media; 1 edition [ISBN:0071626948], 2009	7. Kai Hwang, Geoffrey C. Fox, Jack G. Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
	3. Greg Schulz, "Cloud and Virtual Data Storage Networking", Auerbach Publications [ISBN: 978-1439851739], 2011	8. Rittinghouse, John W., and James F. Ransome, —Cloud Computing: Implementation, Management and Security, CRC Press, 2017.
	4. EMC, "Information Storage and Management" Wiley; 2ndedition [ISBN: 978-0470294215], 2012.	9. Silvano Gai, Claudio DeSanti, "I/O Consolidation in the Data Center" Cisco Press; 1stedition [ISBN: 9781587058882], 2009.
	5. Volker Herminghaus, Albrecht Scriba, "Storage Management in Data Centers" Springer; edition [ISBN: 978- 3540850229], 2009.	10. Bill wilder, Cloud Architecturepatterns,2012

Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice		
Level 1	Remember	20%	-	20%	-	20%	
Level 2	Understand	20%	-	20%	-	20%	
Level 3	Apply	30%	-	30%	-	30%	
Level 4	Analyze	30%	-	30%	-	30%	
Level 5	Evaluate	-	-	-	-	-	
Level 6	Create	-	-	-	-	-	
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.PartheepanRudrapathi, CEO, KXE	1. Dr.V.Arulkumar, Associate Professor, SSN College of Engineering	1. Dr.M. Shobana, Assistant Prof., SRMIST

<b>Course Code</b>	21CSE329T	<b>Course Name</b>	SERVICE ORIENTED ARCHITECTURE AND MICROSERVICES	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	State the fundamentals XML and AWS												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Develop an application based on XML and XSL															
<b>CLR-3:</b>	Explore the key principles behind SOA															
<b>CLR-4:</b>	Illustrate the web services technology elements for realizing SOA															
<b>CLR-5:</b>	Compare the various web service standards															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12			
<b>CO-1:</b>	Explain the fundamentals of XML and AWS												2	-	-	-
<b>CO-2:</b>	Test the applications based on XML												2	3	-	-
<b>CO-3:</b>	Illustrate the key principles behind SOA												2	-	2	-
<b>CO-4:</b>	Implement the web services using technology elements												2	3	-	-
<b>CO-5:</b>	Apply the various web service standards to solve real world problems												2	3	2	-

**Unit-1 - XML** **9 Hour**  
 Introduction to XML, Amazon Web Services, XML in Context, Fundamentals of XML, XML Document Structure, XML Content Models, Rules of XML, Structure - Well-formed and valid documents, Linking XML Documents Together, Namespaces, Identifying the Scope of Namespaces, DTD, Structure of a Document, Type Definition, XML Schema, X-Files, Getting started with AWS, AWS Compute, Storage, Networking, Amazon EC2

**Unit-2 – Dynamic Modeling** **9 Hour**  
 Parsing XML – using DOM, DOM Traversal and Range, SAX, Working with SAX-Handling Errors, XML, Transformation and XSL, XSLT for Document Publishing, XSL for Business-to-Business (B2B) Communication, XSL Formatting, Modeling Databases in XML, Developing a Data Access Object (DAO), Developing a Servlet for HTTP Access– Testing the Application- Converting the XML Data to HTML with XSLT, Converting the XML Data to HTML, Converting the XML Data to HTML with XSLT, Java Architecture for XML Binding (JAXB), Data Binding

**Unit-3 – Service Oriented Architecture** **9 Hour**  
 Service-Oriented Architecture Concepts, SOA Processes, Principles and Tools, SOA Governance Policies and Processes, SOA Principles and Guidelines, Line of Business Services, Reusable Technical Services, Roots of SOA, Characteristics of SOA, Comparing SOA with Client-Server, Distributed architectures, Benefits of SOA, Technical Benefits, Business Benefits-Increased Business Agility, Better Business Alignment, Principles of Service orientation, Service layers

**Unit-4 – Web Service Description Language** **9 Hour**  
 Service descriptions –WSDL– Basic WSD, Syntax, SOAP Binding-Messaging with SOAP –Service discovery, UDDI- Introduction to UDDI, Structure of UDDI Message Exchange Patterns, Orchestration – Choreography –WS Transaction, B- WS-Atomic Transaction – WS – Business Activity, WS-Coordination Framework, WS-Transaction Management

**Unit-5 – Web Service Security** 9 Hour

Service Oriented Analysis and Design, – Service Modeling –Design standards, guidelines, Composition, WS-BPEL, WS-Coordination, WS-Policy, WS-Security –WS Trust, WS-Secure Conversation, WS-Federation-Security Assertion Markup Language (SAML), Data-Level Security XML Encryption-XML Signature, SOA support in J2EE

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Ron Schmelzer et al. "XML and Web Services", Pearson Education, 2002.</li> <li>2. Thomas Erl, "Service Oriented Architecture: Concepts, Technology, and Design", Pearson Education, 2005.</li> <li>3. Frank P. Coyle, "XML, Web Services and the Data Revolution", Pearson Education, 2002.</li> <li>4. Eric Newcomer, Greg Lomow, "Understanding SOA with Web Services", Pearson Education, 2005.</li> <li>5. Sandeep Chatterjee and James Webber, "Developing Enterprise Web Services: An Architect's Guide", Prentice Hall, 2004</li> <li>6. James McGovern, Sameer Tyagi, Michael E. Stevens, Sunil Mathew, "Java Web Services Architecture", Morgan Kaufmann Publishers, 2003</li> <li>7. <a href="https://docs.aws.amazon.com/whitepapers/latest/aws-overview/compute-services.htm#amazon-ec2">https://docs.aws.amazon.com/whitepapers/latest/aws-overview/compute-services.htm#amazon-ec2</a></li> </ol>
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Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	20%	-	20%	-	20%	-		
Level 2	Understand	30%	-	30%	-	30%	-		
Level 3	Apply	30%	-	30%	-	30%	-		
Level 4	Analyze	20%	-	20%	-	20%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
Total		100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. T.Ananadharaman ,Project Manager, TCS, Chennai	1. Dr.T.Sudalaimuthu, Professor, Hindustan Institute of Science and Technology, Chennai	1. Dr.N.Senthamarai, SRMIST

<b>Course Code</b>	21CSE363T	<b>Course Name</b>	CLOUD SERVICES SOLUTION ARCHITECT	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Discuss the concepts of Computing instances and database service in AWS platform												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	Articulate of logical, secured Networking groups and applying Cloud Content Delivery in AWS																								
<b>CLR-3:</b>	Apply Security measures to protect the resources and understands compliance management in AWS																								
<b>CLR-4:</b>	Demonstrate Management and Governance services at cloud deployment model																								
<b>CLR-5:</b>	Categorize the different migration service systems and different application integration services																								
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Demonstrate on Computing instances and database service in AWS	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3			
<b>CO-2:</b>	Implement Networking and Cloud front Content Delivery in AWS	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3			
<b>CO-3:</b>	Examine Security measures and compliance in AWS	2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3			
<b>CO-4:</b>	Interpret management and governance services	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3			
<b>CO-5:</b>	Compare different migration services and application integration services in AWS	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3			

<b>Unit-1 – Introduction to AWS</b>	<b>9 Hour</b>
Compute: Amazon EC2, AWS Elastic Beanstalk, Amazon Elastic Container Service (Amazon ECS), Amazon Elastic Kubernetes Service (Amazon EKS), Elastic Load Balancing, AWS Fargate, AWS Lambda. AWS Billing and Cost Management: AWS Budgets and Cost Explorer. Database: Amazon Aurora, Amazon DynamoDB, Amazon DynamoDB Accelerator (DAX).	
<b>Unit-2 – AWS Gateway Services</b>	
Networking and Content Delivery: Amazon API Gateway, Amazon CloudFront, AWS Direct Connect, AWS Global Accelerator, Amazon Route 53, AWS Transit Gateway, Amazon VPC (and associated features)	
<b>Unit-3 – Identity and Access Management</b>	
AWS Identity and Access Management (IAM), AWS Key Management Service (AWS KMS), AWS Shield, AWS Single Sign-On, AWS WAF	
<b>Unit-4 - Management and Governance</b>	
AWS Auto Scaling, AWS Backup, AWS CloudFormation, AWS CloudTrail, Amazon CloudWatch, AWS Config. AWS Organizations, AWS Resource Access Manager, AWS Systems Manager, AWS Trusted Advisor	
<b>Unit-5 - Migration and Transfer</b>	
AWS Database Migration Service (AWS DMS), AWS Server Migration Service (AWS SMS), AWS Snowball, AWS Transfer Family. Application Integration: Amazon SNS and SQS	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>Piper, B., &amp; Clinton, D. (2020). AWS Certified Solutions Architect Study Guide: Associate SAA-C02 Exam. John Wiley &amp; Sons.</li> <li>Sequeira, A. (2019). AWS Certified Solutions Architect-associate (SAA-C01) Cert Guide. Pearson IT Certification.</li> </ol>	<ol style="list-style-type: none"> <li><a href="https://docs.aws.amazon.com/">https://docs.aws.amazon.com/</a></li> </ol>
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	20%	-	15%	-	15%	-		
Level 2	Understand	20%	-	15%	-	15%	-		
Level 3	Apply	20%	-	20%	-	20%	-		
Level 4	Analyze	20%	-	20%	-	20%	-		
Level 5	Evaluate	10%	-	15%	-	15%	-		
Level 6	Create	10%	-	15%	-	15%	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Mohit Kumar, Senior Data Scientist, Verizon,Bangalore,Karnataka,India		1. Dr.M.Saravanan, SRMIST
		2. Ms.V.Lavanya, ,SRMIST

<b>Course Code</b>	21CSE364T	<b>Course Name</b>	DATA CENTRIC NETWORKING AND SYSTEM DESIGN	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Describe various data centric Networking Concepts												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Gain knowledge on the data center architectures & network connectivity.															
<b>CLR-3:</b>	Articulate networking caching policies															
<b>CLR-4:</b>	Understand the security issues in data centric networks.															
<b>CLR-5:</b>	Learn the application of IoT in ICN.															
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>															
<b>CO-1:</b>	Identify various data centric networking concepts.												-	-	-	
<b>CO-2:</b>	Distinguish different data center architectures & core network connectivity issues.												-	-	-	
<b>CO-3:</b>	Design the caching policies in DCN.												-	-	-	
<b>CO-4:</b>	Protect the Data centric networks from different attacks.												-	-	-	
<b>CO-5:</b>	Make use of IoT and ML techniques in Data centric networks for more efficient.												-	-	-	

**Unit-1 - Introduction** 9 Hour  
 Introduction to Information-Centric Networks, Data-centric networking from different perspectives, Requirements for modern data centers, Internet architecture, Content Distribution Networks (CDN), Content-Centric Communication, Characteristics of ICN, Design Principles, and Assumptions, Design Principles, Key Building Blocks of ICN and Design Challenges, TRIAD Architecture, DONA Architecture.

**Unit-2 – Data Center Design** 9 Hour  
 Network Information (NetInf) Architecture, Top of rack (TOR)network connectivity, End of rack (EOR) network connectivity, NDN Architecture, Comparative Analysis of ICN Architectures, Software-Defined Networking in ICN, Data Routing Schemes, Realization of Routing in ICN, Stateful Forwarding Paradigm for NDN, OSPF-Based Routing for NDN- NLSR.

**Unit-3 – Computing Architecture** 9 Hour  
 Introduction to server Architectures, clustering in server architectures, Redundant Layer 2 designs, Redundant Layer 3 design, Network Caching, Issues in ICN Caching, Leave Copy Everywhere (LCE), Leave Copy Down, SDN Based Caching, Analysis of Various Caching Methods, Caching policies, Caching with Amazon Elasti Cache.

**Unit-4 – Data Centric Networking Protocols** 9 Hour  
 RSTP protocol, PVST protocol, Monitoring Your Applications and Infrastructure - Working with AWS CloudTrail, MSTP protocol, TRILL protocols Security in DCN, Key Security & Privacy Concerns in ICN Architectures, Attacks in ICN, Naming, routing related attacks, ICN Attributes Leading to Security Threats, Optimization in ICN, Application of ML in Communication Networks, ML in caching, naming, Routing

**Unit-5 – Data Centric Services** 9 Hour  
 State-of-the-Art Work in SDN-Based ICN, CORNET architecture, Recent Trends in ICN Applications, Data-Centric Networks in Internet of Things, Adaptation of Information-Centric Networks for Internet of Things (IoT): Challenges and Opportunities, Design Issues of IoT over ICN, Information-Centric Networks in Wireless, Sensor Networks, ICN-based VANETs, Locator Identifier Separation Protocol (LISP)

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>Zhi-Li Zhang, "Information Centric Networks (ICN), Nitul Dutta · Hiren Kumar Deva Sarma, Rajendrasinh Jadeja · Krishna Delvadia, Gheorghita Ghinea, Architecture &amp; Current Trends, 2021</li> <li>Mouricio Arregoces, "Data Centre Fundamentals", CiscoPress, 2003</li> <li>Silvano Gai, Claudio DeSanti, "I/O Consolidation in the Data Center" Cisco Press; 1st edition [ISBN: 9781587058882], 2009.</li> <li>Kevin Corbin, Ron Fuller, David Jansen, "NX-OS and Cisco Nexus Switching: Next-Generation Data Center Architectures" CiscoPress; 1 edition [ISBN: 9781587058929], 2010.</li> <li>Silvano Gai, Tommi Salli, Roger Andersson, "Cisco Unified Computing System" CiscoPress; 1st edition, [ISBN: 9781587141935], 2010.</li> <li>Information Centric Networks: A New Paradigm for the Internet by Released May 2013 Publisher(s): Wiley ISBN: 9781848214491</li> <li>Robert W. Kembel, Roger Cummings (Introduction), "The Fibre Channel Consultant" Northwest Learning Assoc; 3rd edition, [ISBN: 0931836840], 1998.</li> <li>Robert W. Kembel "Fiber Channel/Switched Fabric" Northwest Learning Associates, inc. [ISBN: 0931836719], 2009.</li> <li>John L. Hufford, "iSCSI", Addison-Wesley Boston [ISBN: 978-0201784190], 2003.</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)	Life-Long Learning CLA-2 (10%)							
		Theory	Practice	Theory	Practice				
		20%	-	20%	-	20%	-		
Level 1	Remember	20%	-	20%	-	20%	-		
Level 2	Understand	30%	-	30%	-	30%	-		
Level 3	Apply	20%	-	20%	-	20%	-		
Level 4	Analyze	30%	-	30%	-	30%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. N. Vijaya Sankar Associate Tech Lead MST Solutions	1. Dr. Soundarajan Program Chair, Associate Professor, in the Department of Computer Science and Engineering, Amrita School of Engineering, Amrita Vishwa Vidyapeetham, Chennai.s_sountharajan@ch.amrita.edu	1. Dr. V. Pandimurugan SRM IST

<b>Course Code</b>	21CSE461T	<b>Course Name</b>	CLOUD SECURITY	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Identify the concept of cloud security												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	Compute the issues related to virtualized infrastructure security												-	-	-										
<b>CLR-3:</b>	Predict and Gain knowledge on the various issue in cloud security												-	-	-										
<b>CLR-4:</b>	Contrast the methods to improve virtualization security and technologies in security												-	-	-										
<b>CLR-5:</b>	Design the cloud contracting Model and case study of commercial cloud												-	-	-										
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Demonstrate the main concepts of cloud security												3	-	-	-	-	-	-	-	-	-	-	3	
<b>CO-2:</b>	Illustrate the architecture design of cloud storage												3	-	-	-	-	-	-	-	-	-	-	3	
<b>CO-3:</b>	Classify the cloud security key management Schemes												3	2	-	-	-	-	-	-	-	-	-	3	
<b>CO-4:</b>	Categorize the types of attacks and phases of malware												3	-	-	-	-	-	-	-	-	-	-	3	
<b>CO-5:</b>	Summarize the security design for cloud Models												1	-	3	-	-	-	-	-	-	-	-	2	

**Unit-1 - Introduction** **9 Hour**  
Cloud Security Fundamentals- Infrastructure Security- Network level security- Host level security- Application-level security- Data security and Storage- Data privacy and security Issues- Jurisdictional issues raised by Data location- Identity & Access Management- Access Control- Trust, Reputation- Risk.

**Unit-2 - Information Gathering and Footprinting** **9 Hour**  
Layered Cloud Architecture Design- NIST cloud computing Reference Architecture-Public, Private and Hybrid Cloud- IaaS, PaaS, SaaS - Architectural design Challenges- Cloud Storage- Storage-as-a-service- Advantages of Cloud storage- Cloud storage Provider- Storage Provider-S3

**Unit-3 - Web and Database Attacks** **9 Hour**  
Confidentiality, privacy, integrity, authentication, - non-repudiation, availability, access control, defense in depth, least privilege- Cryptographic Systems- Symmetric cryptography- stream ciphers, block ciphers, modes of operation- Public-key cryptography, hashing- digital signatures, public-key infrastructures- key management for IaaS, PaaS, SaaS - Cryptographic key Management Issues and challenges in cloud services.

**Unit-4 - Attacks and Malware Lifecycle** **9 Hour**  
Multi-tenancy software and its issues- IBM security virtual server protection- virtualization-based sandboxing- Cloud Storage- Security- HIDPS- log management- Data Loss Prevention- Security Governance- Cloud security Challenges- Virtual Machine Security- ESX, ESX File system Security Storage considerations- ESIX security- Security Management Standards- SaaS, PaaS, and IaaS Availability management.

**Unit-5 - Wireless Security Technologies** **9 Hour**  
Authentication in cloud computing- Client access in cloud- Cloud contracting Model- Commercial and business considerations- Case Study on Open Source & Commercial Clouds- X.509 certificates, OpenSSL- Eucalyptus- Microsoft Azure- Amazon EC2- Legal and Compliance Issues in Cloud Computing- Examination of modern security standards.

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Rittinghouse, John W., and James F. Ransome, –Cloud Computing: Implementation, Management and Security, CRC Press, 2017.</li> <li>2. Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.</li> <li>3. Ronald L. Krutz, Russell Dean Vines, "Cloud Security" [ISBN: 0470589876], 2010.</li> <li>4. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing – A Practical Approach, Tata McGraw Hill, 2009.</li> <li>5. Tim Mather, SubraKumaraswamy, ShahedLatif, "Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance" O'Reilly Media; 1<sup>st</sup> edition [ISBN: 0596802765], 2009.</li> <li>6. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice), O'Reilly, 2009</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>	
<b>Bloom's Level of Thinking</b>	<b>Formative CLA-1 Average of unit test (50%)</b>	<b>Life-Long Learning CLA-2 (10%)</b>					
		<b>Theory</b>	<b>Practice</b>	<b>Theory</b>	<b>Practice</b>	<b>Theory</b>	<b>Practice</b>
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	30%	-	30%	-	30%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr.T. Madhan, Team Leader, Tata Consultancy Services, siruseri Campus, Chennai, madhan.tk@gmail.com	1. Dr. S. Janakiraman, Associate Professor, Pondicherry University, sj.dbt@pondiuni.edu.in	1. Dr. R. Naresh, SRMIST
2. Mrs.K.Saranya, IT Analyst, Tata Consultancy Services, siruseri Campus, Chennai, saranya.k6@gmail.com	2. Dr. R.Shyamala, Associate Professor, Anna University College of Engineering Tindivanam, vasuchaaru@gmail.com	2. Dr. C.N.S. Vinoth Kumar, SRMIST

<b>Course Code</b>	21CSE463T	<b>Course Name</b>	CLOUD STRATEGY PLANNING AND MANAGEMENT	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Learn the concepts and technological advances fueling the rapid adoption of cloud computing today.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Apply the skills and knowledge required to plan and manage a Cloud Computing strategy within an organization.															
<b>CLR-3:</b>	Interpret the strategic value of Cloud Computing using IT Governance and Compliance															
<b>CLR-4:</b>	Illustrate the Service Oriented Architecture Services, Databases and Applications															
<b>CLR-5:</b>	Explore about IT Governance benefits and services along with Asset Management															

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		<b>Program Outcomes (PO)</b>													
<b>CO-1:</b>	Demonstrate how cloud computing enables IT Transformation and business value in an organization.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>
<b>CO-2:</b>	Examine the role that cloud computing can play in the business process.														
<b>CO-3:</b>	Appraise how the incorporation of cloud computing in an IT strategy can deliver on strategic business objectives														
<b>CO-4:</b>	Criticize how cloud computing and Service Oriented Architecture (SOA) can deliver business agility.														
<b>CO-5:</b>	Implement IT governance to manage business realization from cloud IT services.														

<b>Unit-1 - Introduction</b>	<b>9 Hour</b>
The four pillars of cloud computing - Cloud applications and platforms providing the cloud infrastructure - Cloud computing - Spectral efficiency - Sensors and perspiration - Strategic inflection points in information Technology - Cloud computing and its slogans -User centered solution and cloud computing - For cloud vendors inflection point Is risk and opportunity - Potential customers of cloud technology - The cloud interests Small and Medium enterprises - Virtual companies and the cloud - Virtual networked objects - Consumer technologies and the cloud - Social networks and multimedia messaging	

<b>Unit-2 – Infra Structure Design</b>	<b>9 Hour</b>
Moving to a cloud architecture and strategy to achieve business value - BPM, IS, Porter's Value chain model and BPR as a means of delivering business value - Developing Business Strategy: Investigate business strategy models to gain competitive advantage for organizations - SWOT/PEST, Economies of scale, Porter's 3 Strategies and 5 Competitive Forces, D'Aveni's hyper competition models - Emphasize the roles of the strategic IS/IT leaders such as Chief Information Officer (CIO) - The Chief Technology Officer (CTO) in planning and managing IT Strategic development in the organization - Budgeting for cloud computing - Service level agreements - Outsourcing, Infrastructural inter dependencies, and the cloud - Human resources at the CIO level - The transition from legacy to competitive system	

<b>Unit-3 – Design Strategies</b>	<b>9 Hour</b>
Develop an IT strategy to deliver on strategic business objectives in the business strategy - IT Project planning in the areas of IaaS is essential in delivering a successful strategic IT Plan - IT Project planning in the areas of SaaS is essential in delivering a successful strategic IT Plan - IT Project planning in the areas of PaaS is essential in delivering a successful strategic IT Plan - IT Project planning in the areas of IaaS is essential in delivering a successful strategic IT Plan - Searching for an open architecture - Infrastructure as a Utility - Cloud System Architecture and its primitives - The User Organizations Business Architecture - Financial Services Applications Architecture	

**Unit-4 – Cloud Service Management****9 Hour**

Shared services delivered by a Service Oriented Architecture (SOA) in a Private or Public Cloud - Services, Databases and Applications on demand - The effect on Enterprise Architecture and its traditional frameworks such as Zachman).- The Open Group Architecture Framework (TOGAF) - Customer Relationship Management - Enterprise Resource Planning - Just-in-Time Inventories - Machine-to-Machine and RFID Communications - Challenges Presented by Organization - Challenges Presented by Commercial vision

**Unit-5 – Governance and Asset Management****9 Hour**

Benefit Realization and IT Governance - Managing resources (people, process, technology), to realize benefit from Private/Public Cloud IT services - Gartner's 5 pillars of benefit realization - IT governance as a service in measuring the delivery of IT Strategy from Cloud IT Services using Sarbanes Oxley (CobiT) and other commonly-used approaches - High Technology for private banking and Asset Management - Cloud Software for Private Banking - Leadership is based on Fundamentals - Cloud Software For Asset Management - Cloud Technology can Improve Fund Management - Criteria of Success in Asset Management Technology

<b>Learning Resources</b>	1. Dimitris N. Chorafas: <i>Cloud Computing Strategies</i> , CRC Press,2011. 2. Arnold J Cummins, "Easiest Ever Guide to Strategic IT Planning" <a href="http://strategicitplanningguide.com/">http://strategicitplanningguide.com/</a> .	3. David S. Linthicum, "Cloud Computing and SOA Convergence in Your Enterprise", Addison Wesley [ISBN: 0136009220],2009. 4. Charles Babcock, "Management Strategies for the Cloud Revolution", 1st Ed., Tata McGrawHill [ISBN:0071740759],2010.
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**Learning Assessment**

Bloom's Level of Thinking	Continuous Learning Assessment (CLA)					Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)				
	Theory	Practice	Theory	Practice	Theory		
Level 1 <i>Remember</i>	20%	-	20%	-	20%	-	
Level 2 <i>Understand</i>	30%	-	30%	-	30%	-	
Level 3 <i>Apply</i>	20%	-	20%	-	20%	-	
Level 4 <i>Analyze</i>	30%	-	30%	-	30%	-	
Level 5 <i>Evaluate</i>	-	-	-	-	-	-	
Level 6 <i>Create</i>	-	-	-	-	-	-	
Total	100 %		100 %		100 %		

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Sudhakar E P Development Project Leader at American Megatrends International India (P) Ltd	1. Dr.Khanna Nehemiah H, Professor, Ramanujan Computing Centre, Anna University	1. Mrs.V.Lavanya, SRMIST

<b>Course Code</b>	21CSE464T	<b>Course Name</b>	FOG COMPUTING ANALYTICS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Annotate the concepts of fog and edge computing												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	Relate simulation tools of fog computing																								
<b>CLR-3:</b>	Understand the component, architecture and working model																								
<b>CLR-4:</b>	Examine different security methods and use cases																								
<b>CLR-5:</b>	Utilize big data analytics for fog computing																								
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Express the knowledge on the concepts of fog and edge computing												3	-	-	-	-	-	-	-	-	-	-	3	
<b>CO-2:</b>	Infer simulation tools of fog computing												3	-	-	-	3	-	-	-	-	-	-	3	
<b>CO-3:</b>	Interpret the component, architecture and working model												2	-	-	-	3	-	-	-	-	-	-	3	
<b>CO-4:</b>	Correlate different security methods and use cases												3	-	-	-	-	-	-	-	-	-	-	3	
<b>CO-5:</b>	Identify the role of big data analytics in fog computing												3	-	-	-	-	-	-	-	-	-	-	3	

**Unit-1 - Edge and Fog Computing Techniques** 9 Hour  
 Introduction to Edge Computing, Infrastructure of edge computing, Benefits of Edge computing, Edge devices and Edge Services, Applications of Edge technology AWS IoT, AWS Outposts, Introduction to Fog Computing, Characteristics of fog Computing, Reason for fog Computing, Challenges, Advantages and disadvantages, Fog services, Application scenarios –Health care, Sensors and Fog nodes, Difference between edge and fog computing, AWS Local zones, AWS Wavelength

**Unit-2 - Modeling and Simulation Tools** 9 Hour  
 Working procedure of fog computing, Software Systems, Components of fog computing, Modeling and Simulation, Simulation tools, Ifogsim, Characteristics of ifogsim, Working of ifogsim, Contiki – Characteristics, MAC protocol, Routing protocol simulation in contiki, Working procedure, MobFogsim – Protocols, Implementation of MobFogsim, AWS Infrastructure and services, Comparison of different simulator, AWS Device defender, AWS Device management IoT Events, AWS IoT Events

**Unit-3 - Fog Data Analytics for IoT** 9 Hour  
 Fog Protocol, JSON based protocol, Fog interfaces with IoT, Fog interfaces with Cloud, Fog Networking, SDN, NFV, Other fog networking, Protocol Optimization, Fog kit, Fog kit-framework, Fog hardware framework, Fog software framework, Proximity Detection protocols, DDS/RTPS computing protocols, AWS IoT Greengrass, Amazon EC2

**Unit-4 - Fog Data Analytics: Security and Privacy** 9 Hour  
 Quality of Service (QoS) and Management, Computation Offloading, Resource Provisioning, Security and Privacy, Security attacks on fog computing, Trust and authentication, Network security, Secure and Private Data Computation, Intrusion Detection, Multimedia fog computing, Case study, Smart Traffic Light System, Wearable Sensing devices, Smart Home, Security services on AWS, Resource allocation in AWS, Compare cloud and Fog resource allocation – AWS

<b>Unit-5 - Fog Computing for Big Data Analytics</b>	<b>9 Hour</b>
Big Data analytics, Benefits of Big data analytics, A Typical Big Data Analytics Infrastructure, Big Data Analytics in the Cloud, Data Analytics in the Fog, Fog analytics, Smart management of Big Data in Fog, System Architecture, Fog engine, Data analytics using Fog engine, Architecture of Fog-engine, Challenges and issues, Fog-engine prototype, Configuration of fog engine, AWS IoT Analytics, Comparison of Fog-engine and cloud data analytics, Application of Big Data, Amazon kinesis data analytics	

<b>Learning Resources</b>	1. Fog and Edge Computing: Principles and Paradigms. United Kingdom: Wiley, 2019. 2. Fog Data Analytics for IoT Applications: Next Generation Process Model with State of the Art Technologies. Germany: Springer Singapore, 2020.	3. Fog Computing: Theory and Practice, Assad Abbas, Samee U. Khan, Albert Y. Zomaya, Wiley, 2020 4. <a href="https://staff.cdms.westernsydney.edu.au/~bjavadi/papers/Chapter11_javadi.pdf">https://staff.cdms.westernsydney.edu.au/~bjavadi/papers/Chapter11_javadi.pdf</a>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	20%	-	20%	-	20%	-		
Level 2	Understand	30%	-	30%	-	30%	-		
Level 3	Apply	20%	-	20%	-	20%	-		
Level 4	Analyze	30%	-	30%	-	30%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. PratheepanRudrapati, CEO, Knowledge Xchange Community	1. Dr. S.Venkatesan, Associate Professor, Department of Information Technology, IIIT Allahabad	1. Dr. Savaridassan.P, SRM IST

<b>Course Code</b>	21CSE465T	<b>Course Name</b>	CLOUD APPLICATION DEVELOPMENT	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Explore different cloud services												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	Compare different security aspects in cloud deployment models																								
<b>CLR-3:</b>	Describe different virtualization techniques in cloud deployment models																								
<b>CLR-4:</b>	Articulate cloud applications in various platform																								
<b>CLR-5:</b>	Design real-time cloud applications using cloud services																								
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Summarize the different cloud services and deployment platforms												3	-	-	-	-	-	-	-	-	-	-	3	
<b>CO-2:</b>	Appraise different cloud security services in deployment models												-	-	2	-	-	-	-	-	-	-	-	3	
<b>CO-3:</b>	Interpret different virtualization platforms												-	-	-	-	2	-	-	-	-	-	-	3	
<b>CO-4:</b>	Categorize different cloud services.												-	-	3	-	-	-	-	-	-	-	-	3	
<b>CO-5:</b>	Develop and deploy cloud applications using cloud services												-	-	3	-	-	-	-	-	-	-	-	3	

<b>Unit-1 - Cloud computing concepts and Services</b>	<b>9 Hour</b>
Introduction to cloud computing – Cloud deployment models – Business drivers for cloud computing – Cloud computing Delivery Models – Cloud computing Services – Challenges of cloud computing – Cloud infrastructure: Cloud storage and cloud Compute in Amazon – HP Cloud System Matrix – Microsoft Windows Azure – Microsoft Windows Azure services - Google App Engine, cloud platform as a service – Apache Hadoop, Mashups – CRM as a service – Social Computing Services – Document Services – Scalable Data Storage Techniques – Map Reduce Revisited – Rich Internet Applications.	
<b>Unit-2 - Challenges, Security and Managing Cloud</b>	
Addressing the cloud challenges – Scaling Computation – Scaling Storage – Multi-Tenancy – Availability – Design cloud security – Cloud security requirements and Best practices – Security Design Patterns- Security Architecture standards – Managing the cloud – IaaS, PaaS, SaaS – Cloud Scale Management Systems – Open Source Private cloud software – Amazon cloud formation – Windows Azure Active Directory	
<b>Unit-3 - Virtualization</b>	
Server Virtualization – Hypervisor-based Virtualization – Techniques for Hypervisor – Hardware support for virtualization – VMware virtualization software – XenServer virtual machine monitor – Storage virtualization – File virtualization – Example – Block virtualization – Examples – Grid Computing – Grid Technologies – Comparing Grid and Cloud – Cloud-related technologies – Creating sample hello world application in Open Shift Example	
<b>Unit-4 - Application Development</b>	
Amazon Web Services: EC2 Instances – Connecting Clients to Cloud Instances through Firewalls – Security Rules for Application Layer & Transport Layer protocols in EC2 – How to launch an EC2 Linux Instance and connect to it – S3 in Java – Manage SQS Services in C# - Install the simple notification service on ubuntu – Example – Creating an EC2 Placement Group –Use MPI – Hadoop Ecosystem – Install Hadoop on Eclipse on a Windows System – Cloud Based Simulation of a Distributed Trust Algorithm – A cloud service for adaptive data streaming – cloud-based optimal FPGA synthesis	

**Unit-5 - Applications****9 Hour**

Cloud Application Design – Design considerations for cloud applications – Reference architectures for cloud applications – Cloud applications design methodologies – Data storage approaches – Web application framework – Django – RESTful Web API – Cloud Application Development, Design Approaches – Design methodology for IaaS & PaaS model – Image Processing App – Big Data Analytics – Recommendation systems – Multimedia cloud – Live video streaming app – Streaming protocols – Video Transcoding app

<b>Learning Resources</b>	1. Dinkar Sitaram, Geetha Manjunath, <i>Moving To The Cloud: Developing Apps in the New World of Cloud Computing</i> , Syngress, 2013. 2. Arshdeep Bahga, Vijay Madisetti, <i>“Cloud Computing A Hands-on Approach”</i> , 2014 3. Edward Hughes, John Hiley, Keith Brown, Ian McKenzie Smith, <i>Hughes Electrical and Electronics Technology</i> , Pearson Education, 12th ed., 2016 4. Scott Adkins, John Belamaric, Vincent Giersch, <i>“OpenStack Cloud Application Development”</i> , Wiley publisher, 2016	5. David E.Y. Sarna, <i>“Implementing and Developing Cloud Applications”</i> , CRC Press 2011 6. Dan C.Marinescu, <i>“Cloud Computing: Theory and Practice”</i> , Morgan Kaufman, 2013 7. Michael P. McGrath, <i>Understanding PaaS: Unleash the Power of Cloud Computing</i> , O'Reilly Media, 2012, Charles Alexander, Matthew Sadiku, <i>Fundamentals of electrical circuits</i> , McGraw-Hill Education; 5th ed., 2012 8. Richard Rodger, <i>“Beginning Mobile Application Development in the Cloud”</i> , John Wiley & Sons Inc., 2012.
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**Learning Assessment**

Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%
Level 2	Understand	25%	-	20%	-	25%
Level 3	Apply	30%	-	25%	-	30%
Level 4	Analyze	30%	-	25%	-	30%
Level 5	Evaluate	-	-	10%	-	-
Level 6	Create	-	-	5%	-	-
	Total	100 %		100 %		100 %

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.Nagaveer, CEO, Campus Corporate Connect, nagaveer@campuscorporateconnect.com	1. Dr. Srinivasa Rao Bakshi, IITM, Chennai, sbakshi@iitm.ac.in	1. Dr.S.Thenmalar, SRMIST

<b>Course Code</b>	21CSE466T	<b>Course Name</b>	NETWORK DESIGN AND MANAGEMENT	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
CLR-1:	Grasp knowledge on the types of Networks and the Network Management basics												PSO-1	PSO-2	PSO-3										
CLR-2:	Understand the Network Management Standards																								
CLR-3:	Familiarize with the working of Simple Network Management Protocol and its various versions																								
CLR-4:	Discern on the working of Remote Monitoring Systems																								
CLR-5:	Deduce on various Network Management Applications																								
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
CO-1:	Acquire knowledge on networks and network management	2	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	
CO-2:	Interpret Information on various Network Protocols	2	-	-	3	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	
CO-3:	Gain knowledge on the working of SNMP protocol and its various applications	2	-	-	3	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	
CO-4:	Examine the network management tools and gather information from the network	2	-	-	3	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	
CO-5:	Familiarize with the working of various management applications	2	3	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	

**Unit-1 – Introduction to Network Management** 9 Hour  
 Telephone Network Management, Distributed Computing Environment, TCP/IP Based Networks, Communication Protocols and Standards, Protocol Layer and Services, Challenges of IT Managers, Network Management, Network and System Management, Network Management System Platform, Current status and future of Network Management, Network Management Standards, Network Management Model - Organizational model, Information Model, Management Information Trees, Communication Model, ASN.1, Terminology, Symbols and Conventions, Functional Model

**Unit-2 – Network Protocols** 9 Hour  
 Introduction to SNMP, SNMP v1 model, Organization Model, System overview, SNMP v1 Information model, Structure of Management Information, Managed Objects, MIB-Object Group, System Group, Interfaces Group, Address Translation group, IP Group, ICMP Group, TCP Group, UDP Group, SNMP, MIB, User-Based Security Model, Access Control

**Unit-3 – Network Monitoring Tools** 9 Hour  
 Remote Monitoring, RMON SMI and MIB, RMON1, RMON2, System Utilities for Management Tool, Network Statistics Measurement Systems, Traffic Load, Protocol Statistics, Data and Error Statistics, Network Management System, Components, Requirements, System Management, Network Management Applications, Configuration Management, Inventory Management, Performance Management Tools

**Unit-4 – Configuration Management** 9 Hour  
 Network Management Applications, Fault Management -Architecture, Fault location, Fault isolation Algorithm, Self-healing, avoiding failures, Configuration setting, Configuration discovery and Change Control, Configuration Management Applications, Patch Management, Approaches for Performance Management, Performance Monitoring and Reporting, Performance trouble shooting, Capacity Planning, Account Management, Report Management System and User Reports, Policy Management, Service Level Management

**Unit-5 - Network Design and Planning** **9 Hour**

Network Design for Enterprise Network, Network Design Process, Data Collection, Data Generation, Traffic Generators, Cost Generators, Topology, Architecture, Graph, Link, Algorithms, Network Design Techniques, Performance Analysis, Queuing Essentials, Loss and Delay, Reliability, Network Cost

<b>Learning Resources</b>	1. Greg Tomsho, Ed Tittel, David Johnson, "Guide to Network Essentials", Eighth Edition, Cengage Learning, 2019 2. Teresa C.Piliouras , "Network Design Management and Technical Perspectives", Second Edition 2015	3. Mani Subramanian "Network Management Principles and Practice", Second Edition, Pearson Publication, 2012. 4. Dinesh Chandra Verma, "Principles of Computer Systems and Network Management", Springer, 2009.
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)	Life-Long Learning CLA-2 (10%)							
		Theory	Practice	Theory	Practice				
Level 1	Remember	20%	-	20%	-	20%	-		
Level 2	Understand	30%	-	30%	-	30%	-		
Level 3	Apply	30%	-	30%	-	30%	-		
Level 4	Analyze	20%	-	20%	-	20%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr.Vijay Aravind .S Manager, Accenture, Bengaluru Email:vijayaravin@gmail.com	1. Dr. Zayaraz Godandapani, Professor, Dept. of CSE, Pondicherry Engineering College	1. Dr.A.Vijay Vasantha, SRM IST

**ACADEMIC CURRICULA**  
**UNDERGRADUATE/ INTEGRATED POST  
GRADUATE DEGREE PROGRAMMES**  
(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume - 11E

(Syllabi for Computer Science and Engineering w/s in  
Computer Networking Programme Courses)



**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**  
(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

# ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021



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**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

<b>Course Code</b>	21CSC311J	<b>Course Name</b>	WIRELESS NETWORKS	<b>Course Category</b>	C	PROFESSIONAL CORE	L 2	T 0	P 2	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Identify the concepts of modulation and transmitters in analog communication												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Relate frequency modulation and amplitude modulation in digital communication															
<b>CLR-3:</b>	Transfer knowledge on wireless communication and its parameters															
<b>CLR-4:</b>	Relate various wireless network topologies and its operations															
<b>CLR-5:</b>	Appraise the concepts of information on GPRS applications															
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>															
<b>CO-1:</b>	Recognize the concepts of modulation and transmitters in analog communication												3	-	2	1
<b>CO-2:</b>	Correlate the information on frequency modulation and amplitude modulation in digital communication												3	-	-	2
<b>CO-3:</b>	Articulate knowledge on wireless communication and its parameters												3	-	-	2
<b>CO-4:</b>	Devise wireless network topologies and its operations												3	-	2	1
<b>CO-5:</b>	Defend the concepts of information on GPRS applications												3	-	2	1

<b>Unit-1 - Analog Communication</b>	<b>12 Hour</b>
Introduction to communication system, Need for modulation. - classification- - Amplitude Modulation, Definition, Time domain and frequency domain description, . Square law Modulator, Square law detector, Envelope detector. Radio Transmitters-Classification of Transmitters.	
<b>Unit-2 - Digital Communication</b>	<b>12 Hour</b>
Frequency Modulation: Narrow band FM, Wide band FM, FM Wave -Comparison of FM & AM - Detection of FM Waves: Phase locked loop, Foster Seeley Discriminator.	
<b>Unit-3 - Wireless Communication</b>	
An Introduction to the Wireless Channel – Noise, Multipath Propagation Large scale path loss – Small scale fading- Parameters of mobile multipath channels – Time dispersion parameters-Coherence bandwidth – Doppler spread & Coherence time, Classification of fading.	
<b>Unit-4 - Wireless Network Planning and Operation</b>	
Wireless networks topologies, cellular topology, cell fundamentals signal to interference ratio calculation, capacity expansion techniques, cell splitting, cell sectoring, micro cell method, overload cells, channel borrowing techniques, DCA, mobility management, radio resources and power management securities in wireless networks.	
<b>Unit-5 - Wireless LAN</b>	
Mechanism to support a mobile environment, IS-95 CDMA forward channel, IS – 95 GPRS and higher data rates, Historical overviews of the LAN industry, evolution of the WLAN industry, wireless home networking, IEEE 802.11. The PHY Layer, MAC Layer-Wireless Network Application-Case Study.	

<b>Lab Experiments</b>	
1. Implement Amplitude modulation and demodulation. 2. Implement Frequency modulation and demodulation. 3. Design TDM and FDM 4. Design PAM and PPM 5. Implement Propagation Path loss Models (Indoor & Outdoor) 6. Design Spread Spectrum – DSSS Modulation & Demodulation 7. Study CSMA/CD protocol and its performance	8. Design Global System for Mobile Communication (GSM) 9. Configuration of simple network with point-to-point link 10. Design Star topology 11. Study of cell splitting and cell sectoring. 12. Study Token bus protocol and the performance 13. Study Token ring protocol and the performance. 14. Study Zigbee and Blue-tooth technologies 15. Study WiFi and LiFi technologies.

<b>Learning Resources</b>	1. Rappaport.T.S. "Wireless Communications: Principles and Practice", 2nd Edition, Pearson, 2011. 2. John D Kraus, Ronald J Marhefka, Ahmed S Khan "Antenna and Wave Propagation", 4th Edition, Tata McGraw Hill, 2010 3. Constantine Balanis. A, "Antenna Theory: Analysis and Design", 3rd Edition, John Wiley, 2012. 4. Andreas.F. Molisch., "Wireless Communications", Wiley, 2nd Edition-2005, Reprint-2014	5. Andrea Goldsmith, "Wireless Communications", Cambridge University Press, Aug 2005 6. Schiller, "Mobile Communications", Pearson Education Asia Ltd., Reprint 2012 7. Lee W.C.Y., " Mobile Communications Engineering: Theory and Applications", McGraw Hill, New York, 2nd Edition, 1998
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Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	-	15%	15%	-		
Level 2	Understand	25%	-	-	20%	25%	-		
Level 3	Apply	30%	-	-	25%	30%	-		
Level 4	Analyze	30%	-	-	30%	30%	-		
Level 5	Evaluate	-	-	-	10%	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. J Dr.Madan Lakshmanan, Senior Scientist, CEERI, CSIR, Chennai (R&D Industry)	1. Dr. K.Selvakumar, Professor & Head, Annamalai University, Chidambaram, Tamilnadu, India	1. Dr.P.Visalakshi, SRMIST
2. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anuj@gmail.com	2. Prof. Subra Ganesan, Professor, Electrical and Computer Engineering, Oakland University, USA	2. Arun.A, SRMIST
3. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	3. Dr.M.D. Selvaraj, Professor, Head of the Department, ECE, IITM, Kancheepuram, Technology, Chennai	3. Dr.K.Kalimuthu, SRMIST

<b>Course Code</b>	21CSC312J	<b>Course Name</b>	MOBILE ADHOC NETWORKS	<b>Course Category</b>	C	PROFESSIONAL CORE	L 2	T 0	P 2	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the design issues in ad hoc and sensor networks												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Relate the architecture and protocols of wireless sensor networks															
<b>CLR-3:</b>	Categorize the different types of MAC protocols															
<b>CLR-4:</b>	Examine the different types of adhoc routing protocols															
<b>CLR-5:</b>	Correlate the QoS issues in adhoc networks															
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>															
<b>CO-1:</b>	Understand the use of network devices in data Communication												3	-	-	
<b>CO-2:</b>	Practice various MAC protocols in Adhoc Wireless Networks												3	-	-	
<b>CO-3:</b>	Categorize the routing protocols used in Adhoc and Wireless sensor networks												-	-	-	
<b>CO-4:</b>	Relate the transport layer design and network security issues and the various prevention techniques												3	-	-	
<b>CO-5:</b>	Sketch the QoS design in Adhoc and Wireless sensor networks												3	-	-	

**Unit-1 - Introduction to MANET and WSN** 12 Hour  
Origin of packet radio networks, Components of packet radio networks, Mobile Ad hoc Networks (MANETs) and wireless sensor networks (WSNs): concepts and architectures, Issues in adhoc network, Design Challenges in Ad hoc and Sensor Networks, Applications of Ad Hoc and Sensor networks.

**Unit-2 - MAC Protocol** 12 Hour  
Ad Hoc Wireless Networks: Introduction, Cellular and Ad Hoc wireless Networks, Ad Hoc Wireless Internet, MAC Protocols for Ad Hoc Wireless, Design Goals of MAC protocol, Classification of MAC Protocols, MAC Protocols for Wireless Sensor Networks, Schedule based protocols – LEACH, IEEE 802.15.4, BLUETOOTH, ZIGBEE.

**Unit-3 - Network Routing Protocol** 12 Hour  
Design issues, goals, and classification. Proactive Vs reactive routing, Link State Routing Protocol, Distance Vector Multicast Routing Protocol, Overview of hybrid routing protocol, energy aware routing algorithm, hierarchical routing, QoS aware routing.

**Unit-4 - Transport Layer Protocol & Network Security** 12 Hour  
Issues in designing transport layer protocol, Design goals of a transport layer protocol, Classification of transport layer solutions, TCP over adhoc networks, Security in mobile adhoc network, Network security requirement, Issues and challenges in security provisioning, Network security attack, Key management, Secure routing in adhoc network.

**Unit-5 - Cross Layer Design & Quality of Service** 12 Hour  
Cross layer Design: Need for cross layer design, Cross layer optimization, Parameter optimization, Cross layer cautionary perspective. Integration of adhoc with Mobile IP networks, Issues, and challenges in providing QoS in adhoc network, Characteristics of QoS solutions, Qos Model, QoS resource reservation signaling, SWAN.

<b>Lab Experiments</b>	
Lab1: Study on Sample wireless topology Lab2: Design of simple Mobile Ad-hoc networks Lab3: Create simple sensor networks using NS-2 Lab4: Study on various MAC protocols, Lab5: Implement LEACH protocol, Lab6: Implement ZIGBEE, RFID protocol. Lab7: Implement unicast routing protocol	Lab8: implement multicast routing protocol Lab9: implement QoS aware routing protocol Lab10: Implement transport layer protocol Lab11: Implement TCP, Other transport layer protocols Lab12: Study on User Datagram Protocol Lab13: Implement cross layer optimization Lab14: Study on integration of adhoc with Mobile IP network Lab15: Implement QoS model in MAC layer

<b>Learning Resources</b>	1. C. Siva Ram Murthy, and B. S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols ", Prentice Hall Professional Technical Reference, 2008. 2. Dargie, Waltenebus, and Christian Poellabauer. Fundamentals of wireless sensor networks: theory and practice. John Wiley & Sons, 2010. 3. Kazem Sohraby, Daniel Minoli, & TaiebZnati, "Wireless Sensor Networks Technology, Protocols, and Applications", John Wiley, 2007. 4. Anna Hac, "Wireless Sensor Network Designs", John Wiley, I Edition, 2003. 5. Savo G. Glisic, "Advanced Wireless Networks: Technology and Business Models", John Wiley, I Edition, 2016
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
Bloom's Level of Thinking	Formative CLA-1 Average of unit test (45%)	Life-Long Learning CLA-2 (15%)							
		Theory	Practice	Theory	Practice				
		15%	-	-	15%	15%	-		
Level 1	Remember	15%	-	-	15%	15%	-		
Level 2	Understand	25%	-	-	25%	25%	-		
Level 3	Apply	30%	-	-	25%	30%	-		
Level 4	Analyze	30%	-	-	25%	30%	-		
Level 5	Evaluate	-	-	-	10%	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. J. Aravind Kumar, Senior Architect, JDA Solutions, Bangalore 2. Dr.R. Lenin Babu, Conversight.Ai, Indiana, United States of America	1. Dr. K. Selvakumar, Professor & Head, Annamalai University, Chidambaram, Tamilnadu, India 2. Dr. K. G. Srinivasa, Professor, Department of Data Science and Artificial Intelligence, IIIT- Naya Raipur, Raipur, Chhattisgarh, India	1. Dr.N. Krishnaraj, SRMIST 2. Dr. Praveena Akki, SRMIST

# ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021



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**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

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Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

<b>Course Code</b>	21CSE273T	<b>Course Name</b>	DISTRIBUTED OPERATING SYSTEMS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Recognize the essential concepts of distributed system												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Relate the communication systems that takes place in Distributed systems															
<b>CLR-3:</b>	Discover the necessity of synchronization, consistency, and Fault tolerance in a Distributed System															
<b>CLR-4:</b>	Categorize different processors and process management approaches															
<b>CLR-5:</b>	Use distributed shared memory schemes to access data in the distributed systems.															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
<b>CO-1:</b>	Characterize the fundamental hardware and software concepts of distributed systems												2	-	3	-
<b>CO-2:</b>	Categorize layered protocols and comprehend the communications in distributed systems												2	-	3	-
<b>CO-3:</b>	Implement synchronization of distributed systems using various algorithms.												2	-	3	-
<b>CO-4:</b>	Demonstrate process scheduling and fault tolerance of distributed systems.												2	-	3	-
<b>CO-5:</b>	Illustrate the concepts of distributed shared memory systems.												2	-	3	-

**Unit-1 - Introduction to Distributed System** 9 Hour  
Distributed Systems- Goals of Distributed Systems, Hardware Concepts- Bus-based Multiprocessors- Switched Multiprocessors, - Bus-based Multicomputers- Switched Multicomputers, Software Concepts-Network Operating System - True Distributed Systems- Multiprocessors- Time Sharing Systems- Design Issues-Distributed Systems. Case Study: Mach OS System Architecture

**Unit-2 - Fundamentals of Communication systems** 9 Hour  
Layered Protocols, ATM networks, Client Server model - Blocking Primitives, Non-Blocking Primitives, Buffered Primitives, Unbuffered Primitives, Reliable primitives, Unreliable primitives, Message passing and its related issues, Remote Procedure Call and its related issues, Case Studies: Communication in Mach OS.

**Unit-3 - Synchronization in Distributed Systems** 9 Hour  
Fundamentals of Clock Synchronization, Logical clock, Physical clock, Algorithms for Clock synchronization, Mutual Exclusion-Centralized Algorithm, Distributed Algorithm, Token Ring Algorithm, Comparison of all three algorithms, Importance of Election Algorithm, Bully Algorithm, Ring Algorithm, Atomic Transaction- Introduction Transaction Model, Concurrency Control, Deadlock in Distributed Systems, Distributed Deadlock Detection. Synchronization in Mach OS.

**Unit-4 - Processes and Processors in Distributed Operating Systems** 9 Hour  
Threads, Design issues of Threads package, Workstation Model, System Model – Introduction, Using Idle Workstations, Processor Pool Model, Hybrid Model, Processor Allocation – Allocation Model, Design issues for processor Allocation Algorithms, Example of processor Allocation Algorithms, Scheduling in Distributed Systems, Load Balancing and Sharing Approach, Fault Tolerance- Fault tolerance Using Active Replication, Primary-backup, Real Time Distributed Systems- Communication, Real Time Scheduling. Case study - Process Management in Mach OS

<b>Unit-5 - Distributed Shared memory</b>	<b>9 Hour</b>
Introduction, Bus-Based Multiprocessors, Switched Multiprocessors, Ring-based Multiprocessors, Numa Multiprocessors, Consistency Models – Strict Consistency, Casual Consistency, PRAM Consistency, Weak Consistency, Release Consistency, Entry Consistency, Page Based Distributed Shared Memory – Replication, granularity, Finding the Owner, Finding the Copies, Page Replacement, Synchronization, Shared – Variable Distributed Shared memory, Object Based Distributed Shared memory, Case Study – Memory Management in Mach OS	

<b>Learning Resources</b>	1. Andrew S. Tanenbaum, <i>Distributed Operating Systems</i> , Pearson Education, 2011. 2. Pradeep K. Sinha, <i>Distributed Operating Systems Concepts and Design</i> , PHI, 2012.	3. Mukesh Singhal, Niranjan G Shivratri, <i>Advanced concepts in Operating Systems</i> , Mc Graw Hill International, 2017. 4. Erciyes, Kayhan, <i>Distributed real-time systems: theory and practice</i> , Springer, 2019. 5. <a href="http://www.cs.iit.edu/~sun/cs550.html">http://www.cs.iit.edu/~sun/cs550.html</a>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Uma Parvathy S, Associate Consultant TCS. <a href="mailto:umaparvathy.s@tcs.com">umaparvathy.s@tcs.com</a>	1. Dr. S. Geetha, Assistant Professor, Pondicherry University, <a href="mailto:geethareddy@pondiuni.ac.in">geethareddy@pondiuni.ac.in</a>	1. Dr. K. Deepa Thilak, SRMIST

<b>Course Code</b>	21CSE274T	<b>Course Name</b>	PERVASIVE COMPUTING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understanding the basics of pervasive computing and its application												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Categorize the fundamental elements of pervasive computing.															
<b>CLR-3:</b>	Connect voice enabling technology with pervasive computing															
<b>CLR-4:</b>	Relate the design process Human–Computer Interface															
<b>CLR-5:</b>	Illustrate Pervasive Mobile Transaction															
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>															
<b>CO-1:</b>	Understand the fundamental elements of pervasive computing and its solutions												2	-	-	
<b>CO-2:</b>	Relate hardware, software and implementing security aspects involved in pervasive computing												3	-	-	
<b>CO-3:</b>	Voice Technology connection in Pervasive Computing												3	-	-	3
<b>CO-4:</b>	Discover the functionalities and components of Human–Computer Interface												2	-	-	3
<b>CO-5:</b>	Demonstrate about Pervasive Mobile Transaction												3	-	-	3

<b>Unit-1 - Pervasive Computing</b>	<b>9 Hour</b>
Past, Present and Future Pervasive computing, Pervasive Computing Market, m-Business, Application examples: Retail, Application examples: Airline check-in and booking, Healthcare, Tracking, Car information system, Sales Force Automation, Email access via WAP and voice, A Pervasive System for Volcano Monitoring, A Pervasive Computing Platform for Individualized Higher Education, Device Technology, Hardware, Human machine interface, Biometrics, Operating systems, Java for pervasive devices	
<b>Unit-2 - Device connectivity</b>	
Protocols, Security, Device management, WAP and beyond: Components of the WAP architecture, WAP infrastructure, WAP security issues, Wireless Markup language, WAP Push, Products	
<b>Unit-3 - Voice Technology</b>	
Basic of speech recognition, Voice Standard, Speech application, Speech and pervasive computing, Security, Personal digital assistants: Device categories, Personal digital assistant operating systems, Device characteristics, Software components Standards Mobile application Personal digital assistant browser	
<b>Unit-4 - Human–Computer Interface (HCI) in Pervasive Environments</b>	
HCI interface in Pervasive Environments: HCI Service and Interaction Migration, Context-Driven HCI Service Selection, Scenario Study: Video Calls at a Smart Office, A Web Service– Based HCI Migration Framework	
<b>Unit-5 - Pervasive Mobile Transaction</b>	
Mobile Transaction Framework, Context-Aware Pervasive Transaction Model, Dynamic Transaction Management, Formal Transaction Verification, Evaluations. Case Studies: iCampus Prototype, IPSpace: An IPv6-Enabled Intelligent Space.	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. JochenBurkhardt, Horst Henn, Stefan Hepper, Thomas Schaech &amp; Klaus Rindtorff, –Pervasive Computing, Technology and Architecture of Mobile Internet Applications  , Pearson Education, 2012.ISBN-13: 978-0201722154, 2012</li> <li>2. S. Poslad, –Ubiquitous Computing: Smart Devices, Environments, and Interactions,    Wiley, 2009</li> <li>3. Gupta, Deepak, and Aditya Khamparia, eds. Fog, Edge, and Pervasive Computing in Intelligent IoT Driven Applications. John Wiley &amp; Sons, 2020.</li> <li>4. Bhargava, Deepshikha &amp; Vyas, Dr Sonali. (2019). Pervasive Computing: A Networking Perspective and Future Directions. 10.1007/978-981-13-3462-7.</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. Charan Ramaswamy Senior Administrator, Wipro Technologies Australia Pty Ltd	1. Dr. N.Kumaratharan Professor, Electronics & Communication Engineering Sri Venkateswara College of Engineering Pennalur, Sriperumbudur - 602 117 Tamil Nadu, INDIA.	1. Dr. Rajaram V, SRM IST

<b>Course Code</b>	21CSE347T	<b>Course Name</b>	NETWORK PROTOCOLS AND PROGRAMMING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Describe the importance of various network and transport layer protocols												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Demonstrate the basics of different socket programming concepts and functions															
<b>CLR-3:</b>	Examination of application layer protocols and Multicasting protocols with its characteristics															
<b>CLR-4:</b>	Summarizes the latest IPV6 technology and addressing schemes															
<b>CLR-5:</b>	Appraise the WAN protocols and MPLS protocols															

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Determining the basics of different types of network and transport layer protocols	-	-	2	-	3	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	3	
<b>CO-2:</b>	Experimenting network connections through socket programming and summarizing application layer protocols	-	-	2	-	3	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	3	
<b>CO-3:</b>	Demonstrate the Application layer protocols, Multicasting Protocols and its characteristics	-	-	2	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	
<b>CO-4:</b>	Experimenting the latest IPV6 address in real time.	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	
<b>CO-5:</b>	Categorizing WAN Protocols with MPLS technology.	-	-	2	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	

<b>Unit-1 - Network and Transport Layer Protocols</b>	<b>9 Hour</b>
OSI Model, IP Header, ARP, RARP, ICMP, UDP Data gram and its characteristics, TCP Header & Connection Establishment Process, IP Fragmentation, ARP, RARP, ICMP, UDP Data gram and its characteristics, TCP Header & Connection Establishment Process	
<b>Unit-2 - Socket Programming</b>	<b>9 Hour</b>
Byte Ordering Conversion Functions, man page, System Calls used with sockets, Iterative and Concurrent Server, Socket Interface, Remote Procedure Call, TCP Client Server Program, UDP Client Server Program	
<b>Unit-3 - Application Layer Protocols</b>	<b>9 Hour</b>
DNS, TELNET, FTP, HTTP, WWW, DHCP, SMTP, POP3 Multicasting Protocols BGMP, IGMP, MBGP, MOSPF, PGM, PIM-DM PIM-SM	
<b>Unit-4 - Ipv6 Protocol</b>	<b>9 Hour</b>
IPV6 Features, IPv6 Header, IPv6 Address Types, IPv6 Routing Protocols, IPv4 to IPv6 Tunneling and Translation Techniques	
<b>Unit-5 - WAN Protocols</b>	<b>9 Hour</b>
DSL and Cable technology, Frame Relay, ATM, PPP, HDLC, MPLS, CR-LDP, LDP, RSVP-TE	

<b>Learning Resources</b>	1. Forouzan, Behrouz A. TCP/IP protocol suite. McGraw-Hill Higher Education, 2002. 2. Beej's Guide to Network Programming Using Internet Sockets Brian "Beej Jorgensen" Hall v3.1.9, Copyright © November 16, 2022. 3. Stevens, W. Richard, Andrew M. Rudoff, and Bill Fenner. Unix network programming volume 1: the sockets networking API. Vol. 3. Boston: Addison-Wesley Professional, 2003.	4. Dong, Jielin. "Network Protocol Handbook." (2007). <a href="https://people.scs.carleton.ca/~lanthier/teaching/COMP1406/Notes/COMP1406_Ch12_NetworkProgramming.pdf">https://people.scs.carleton.ca/~lanthier/teaching/COMP1406/Notes/COMP1406_Ch12_NetworkProgramming.pdf</a> . 5. <a href="https://www.geeksforgeeks.org/types-of-network-protocols-and-their-uses/">https://www.geeksforgeeks.org/types-of-network-protocols-and-their-uses/</a> 6. <a href="https://internalpointers.com/post/network-programming-beginners-overview">https://internalpointers.com/post/network-programming-beginners-overview</a> 7. <a href="https://people.scs.carleton.ca/~lanthier/teaching/COMP1406/Notes/COMP1406_Ch12_NetworkProgramming.pdf">https://people.scs.carleton.ca/~lanthier/teaching/COMP1406/Notes/COMP1406_Ch12_NetworkProgramming.pdf</a> .
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<b>Learning Assessment</b>		<b>Continuous Learning Assessment (CLA)</b>				<b>Summative Final Examination (40% weightage)</b>	
<i>Bloom's Level of Thinking</i>	<i>Formative CLA-1 Average of unit test (50%)</i>	<i>Life-Long Learning CLA-2 (10%)</i>				<i>Theory</i>	<i>Practice</i>
		<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>		
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Dr.S.Venkata prasad, TCS, chennai-venkataprasad.s@tcs.com. 2. Mr. J. Hariprasam, HCL Technologies, Chennai.hariprasad@hcl.com	1. Dr. T Veera kumar, NIT, Goatveerakumar@nitgoa.ac.in 2. Dr. Bhavana Rudhra, NIT, Karnataka.bhawanarudra@nitk.edu.in	1. Dr S Murugaanandam, SRMIST .

<b>Course Code</b>	21CSE348T	<b>Course Name</b>	NETWORK ROUTING ALGORITHMS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Understand the basics about Routing in Networks												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	Relate the categories of Routing Algorithms																								
<b>CLR-3:</b>	Explore the Routing Protocols																								
<b>CLR-4:</b>	Explore the Distance Vector Routing Family																								
<b>CLR-5:</b>	Explore the Router Architecture and Design																								
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Identify and define Network categories and corresponding Routing Schema												-	-	3	-	-	-	-	-	-	-	3		
<b>CO-2:</b>	Examine the categories of Routing Algorithms												-	-	2	-	-	-	-	-	-	-	3		
<b>CO-3:</b>	Analyze the Routing Protocols												-	-	2	-	3	-	-	-	-	-	3		
<b>CO-4:</b>	Analyze the Distance Vector Routing Family												-	-	2	-	-	-	-	-	-	-	3		
<b>CO-5:</b>	Analyze the Router Architecture and Design												-	-	2	-	2	-	-	-	-	-	3		

**Unit-1 - Routing Foundations** 9 Hour  
 Introduction to Networking and Network Routing - IPV4 Addressing, Protocol Stack Architecture - Router Architecture - Network Topology Architecture - Network Management Architecture - Global Telephone Network - Communication Technologies - Standards Committees.

**Unit-2 - Routing Algorithms: Shortest Path, Widest Path, and Spanning Tree** 9 Hour  
 Bellman-Ford Algorithm: Centralized View - A Distance Vector Approach: Distributed View – Dijkstra's Algorithm: Centralized Approach – Dijkstra's Algorithm: Distributed Approach – Widest Path Algorithm: Dijkstra-Based Approach - Widest Path Algorithm: Distance Vector-Based Approach – Spanning Tree: Breadth First Search and Depth First Search - Minimum Spanning Tree - Steiner Tree Algorithms - k-Shorest Paths Algorithm

**Unit-3 - Routing Protocols: Framework and Principles** 9 Hour  
 Routing Protocol, Routing Algorithm, and Routing Table – Routing Information Representation and Protocol Messages – Distance Vector Routing Protocol: Illustration – Distance Vector Routing Protocol: Times – Babel Routing Protocol – Link State Protocol: In-Band Hop-by-Hop Dissemination – Link State Protocol: In-Band Based on End-to-End Session – Path Vector Routing Protocol - Link Cost

**Unit-4 - IP Routing and Distance Vector Protocol Family** 9 Hour  
 Routers, Networks, and Routing Information – Routing Table – Communication of Routing Information – Static Routes – Routing Information Protocol, Version 1 (RIPv1) : Communication and Message Format–RIPv1 General Operation – Routing Information Protocol, Version 2 (RIPv2) - Interior Gateway Routing Protocol (IGRP) - Enhanced Interior Gateway Routing Protocol (EIGRP)

**Unit-5 - Router Architecture and Design** 9 Hour  
 Router Architectures – Functions of a Router - Types of Routers – Elements of a Router – Packet Flow – Packet Processing: Fast Path Versus Slow Path - Router Architectures, Impact of Addressing on Lookup - Longest Prefix Matching

<b>Learning Resources</b>	1. Deepankar Medhi, Karthik Ramasamy, <i>Network Routing Algorithms, Protocols, and Architectures</i> Morgan Kaufmann Publishers, Second Edition, 2017. 2. James Aweya, <i>IP Routing Protocols</i> , CRC Press, First Edition, 2021.	3. Yoram Orzach, Deepanshu Khanna, <i>Network Protocols for Security Professionals</i> , Packt Publishers, First Edition, 2022. 4. James H. Baxter, <i>Wireshark Essentials</i> , Packt Publishers, First Edition, 2017
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.R.Lenin Babu, Conversight.Ai, USA, leninbabur@conversight.ai	1. Dr.K.Selvakumar, Professor, Annamalai University, kskaucse@gmail.com	1. Dr.C. Rajesh Babu, SRMIST
2. Mr.U.Aravind Kumar, JPA Solutions, Bangalore, uaravinda@gmail.com	2. Dr.K.G.Srinivasa, Professor, NITTR Chandigarh, kg.srinivasa@nittrchd.ac.in	

<b>Course Code</b>	21CSE349T	<b>Course Name</b>	OPTICAL NETWORKS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand a basic foundation of Optical Networks												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Relate the details about propagation and Dispersion of light															
<b>CLR-3:</b>	Correlate the different Components of Optical Networks															
<b>CLR-4:</b>	Analyze the Optical Network															
<b>CLR-5:</b>	Appraise about the Optical Network Management Techniques															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
<b>CO-1:</b>	Acquire the basic knowledge Multiplexing and Fiber characteristics												-	3	-	-
<b>CO-2:</b>	Illustrate the effects of Light energy												-	3	-	-
<b>CO-3:</b>	Categorize the Various Components of Optical Networks												-	3	-	-
<b>CO-4:</b>	Articulate about SONET and WDM												-	3	-	-
<b>CO-5:</b>	Appraise the Network management functions and Access Networks												-	3	-	-

<b>Unit-1 - Introduction to Optical Networks</b>	<b>9 Hour</b>
Introduction: Network Architecture - Services, Circuit Switching, Packet Switching - First- and second-generation optical networks – Optical Layer - Transmission basics: Wavelength, Frequencies, Channel Spacing - Network evolution: Single Mode Fiber, Multi-Mode Fiber.	
<b>Unit-2 - Propagation of Light</b>	
Propagation of light energy in optical fibers: Loss and Bandwidth windows – Intermodal dispersion: Geometrical Optics Approach, Bit Rate–Distance Limitation - Chromatic dispersion: Chirped Gaussian Pulses, Controlling the Dispersion - nonlinear effects: Stimulated Brillouin Scattering, Stimulated Raman Scattering, Self-Phase Modulation, Cross-Phase Modulation	
<b>Unit-3 - Network Components</b>	
Couplers, Isolators and Circulators, Multiplexers and Filters: Fiber gratings – Fabry Perot Filters – MZ interferometers – Arrayed waveguide grating – optical amplifiers: SOA, EDFA and Raman Amplifier – switches.	
<b>Unit-4 - Optical Networks</b>	
SONET/ SDH, Architecture of Optical transport networks (OTNs), Generic Framing Procedure, Optical Transport Network, Ethernet, IP, Multiprotocol Label Switching, Resilient Packet Ring, Storage-Area Networks -WDM: Terminals, Amplifiers, Multiplexers, Cross connects	
<b>Unit-5 - Network Management</b>	
Network Management functions: Management Framework, Information Model, Management Protocols - Optical Layer services and Interfacing - Performance and fault management - Configuration Management - optical safety	

<b>Learning Resources</b>	1. Partha Parthim Sahu, "Fundamentals of Optical Networks and Components" CRC Publications, 2020 2. Rajiv Ramaswamy, Kumar N. Sivarajan and Galen H. Sasaki, "Optical Networks – A practical perspective", 3rd edition, Elsevier, 2010			3. Ulysses Black, "Optical Networks – Third generation transport systems", 1st edition, Pearson, 2002 4. C. Siva Ram Murthy and Mohan Gurusamy, "WDM Optical Networks: Concepts Design, and Algorithms", PHI, EEE, 2001	
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>			
	<i>Bloom's Level of Thinking</i>	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr.M.Vivekanandan,Nokia 2. Mr.Santhosh Kumar,CTS	1. Mr.Karthikeyan.C.M.T,Govt College of Engg,Bangur 2. Dr.Syedthouheed,Reva University, Bangalore	1. Ms.G.Parimala, SRMIST 2. Dr.S.Thanga Revathi, SRMIST

<b>Course Code</b>	21CSE350T	<b>Course Name</b>	PRINCIPLES OF CLOUD COMPUTING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the fundamental ideas behind Cloud Computing, the evolution of the paradigm, its applicability; benefits, as well as current and future challenges												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Articulate cloud enabling technologies and get exposure to advanced clouds															
<b>CLR-3:</b>	Correlate cloud storage technologies and relevant distributed file systems, NoSQL databases and object storage															
<b>CLR-4:</b>	Appraise the cloud security threats and protective mechanism for cloud computing															
<b>CLR-5:</b>	Participate in team-based peer reviews to analyze the security development life cycle and mitigate risks and vulnerabilities															

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>
<b>CO-1:</b>	Explain the fundamentals of cloud computing and its applications, benefits, and Challenges	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>CO-2:</b>	Apply fundamental concepts in cloud infrastructures to understand the cloud system, network and virtualization and outline their role in enabling the cloud computing system model.	-	-	-	2	-	-	-	-	-	-	-	-	3	-	-
<b>CO-3:</b>	Analyze the fundamental concepts of cloud storage and demonstrate their use in storage systems	-	-	-	-	2	-	-	-	-	-	-	-	3	-	-
<b>CO-4:</b>	Appraise the security issues related to cloud computing and handle the security threats and construct different cloud delivery design models.	-	-	-	2	-	-	-	-	-	-	-	-	3	-	-
<b>CO-5:</b>	Analyze various cloud programming models and apply them to solve problems on the cloud.	-	-	-	2	-	-	-	-	-	-	-	-	3	-	-

<b>Unit-1 - Introduction to Cloud Computing</b>	<b>9 Hour</b>
Introduction - Evolution of cloud computing- Network-Centric Computing - Network-Centric Content -Origin of Cloud Computing -Basic Concepts and Terminology - Goals and Benefits - Risks and Challenges -Roles and Boundaries - Cloud Characteristics - Cloud Deployment Models - Cloud Service Models - Cloud Service Providers and the Cloud Ecosystem -SLA Management in Cloud Computing: A Service Providers Perspective.	

<b>Unit-2 - Cloud Technologies</b>	<b>9 Hour</b>
Cloud enabling technologies-Broadband networks and Internet architecture - Data Center Technology - Web Technology - Multitenant Technology - Service Technology -Virtualization Technology - Virtual Machines - Full Virtualization and Para-virtualization - Hardware Support for Virtualization - Kernel-Based Virtual Machine - Hypervisors.	

<b>Unit-3 - Cloud Data Storage</b>	<b>9 Hour</b>
Introduction to Cloud Data Storage - The evaluation of storage technology - Storage Models - File Systems and databases - Cloud Object Storage (Amazon S3) - Data Storage for Online Transaction Processing Systems - Disk Locality versus Data Locality in Computer Clouds.	

<b>Unit-4 - Cloud Security</b>	<b>9 Hour</b>
Fundamental Cloud Security - Basic Terms and Concepts - Threat Agents, Cloud Security Threats - Cloud Security Mechanisms - Encryption – Hashing - Digital Signature - Public Key Infrastructure - Identity and Access Management - Single Sign-On: Kerberos authentication - One-time password, Basic cloud data - security mechanisms - Virtual Machine Security - Security of Virtualization - A Trusted Hypervisor - Mobile Devices and Cloud Security.	
<b>Unit-5 - Cloud Application Development</b>	<b>9 Hour</b>
Cloud Application Development and Architectural Styles - MapReduce Programming Model - Case Study: The Grep The Web Application - Hadoop: Yarn and Tez - SQL on Hadoop: Pig, Hive, and Impala - Current Cloud Applications and New Opportunities - Design approaches with Case Study - Design methodology for IaaS Service Model - Google API, More on AWS EC2 Instances.	

<b>Learning Resources</b>	1. Dan C. Marinescu, "Cloud Computing Theory and Practicell, Second Edition" Elsevier Inc. 2018	4. K. Chandrasekaran, "Essentials of Cloud Computing", Chapman and Hall/CRC Press, 2014, ISBN 9781482205435
	2. Rajkumar Buyya, James Broberg, AndrzejGoscinski, "Cloud Computing Principles and Paradigms", Wiley Publications, 2017.	5. Arshdeep Bahga, Vijay Madisetti, "Cloud Computing: A Hands-On Approach", University Press, 2016, ISBN13: 978-0996025508.
	3. Thomas Erl, ZaighamMahmood, and RichardoPuttini, "Cloud Computing: Concepts, Technology & Architecture", Prentice Hall/PearsonPTR, Fourth Printing, 2014, ISBN: 978013338752.	

Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	-	-	-	-		
Total		100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. SuriyadeepanRamamoorthy Research Engineer at Saama Technology Puducherry, Puducherry, India Information Technology and Services.	1. Dr.E. Ilavarasan Professor, CSE Pondicherry Engineering College.	1. Dr. Manickam.M, SRMIST 2. Ms.V.Lavanya, SRMIST

<b>Course Code</b>	21CSE450T	<b>Course Name</b>	NETWORK SECURITY	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the basic concepts of networking devices												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Appraise knowledge on the working of IP security															
<b>CLR-3:</b>	Categorize various methods and protocols to maintain E-mail security															
<b>CLR-4:</b>	Validate the knowledge on the various methods and protocols to maintain web security															
<b>CLR-5:</b>	Assess various security measures for wireless and cell phone Communications															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
<b>CO-1:</b>	Acquire the knowledge of network devices used in data Communication												-	-	-	3
<b>CO-2:</b>	Examine the working of IP security and acquire the ability to identify IP security attack												-	-	-	3
<b>CO-3:</b>	Appraise Email security and use the knowledge to detect the attacks in e-mail												-	3	-	3
<b>CO-4:</b>	Grade the knowledge to prevent against Web security attack												-	-	-	3
<b>CO-5:</b>	Assess wireless network security issues and the various prevention techniques												-	-	-	3

**Unit-1 – Introduction to Network Security** 9 Hour  
 Networking Devices (Layer1,2), Networking Devices (Layer 3), Different types of network layer attacks, Firewall- ACL, Packet Filtering, DMZ, Alerts, Audit Trials, IDS, Advantages and Disadvantages of IDS (Need of IPS), Advantages of IPS over IDS, IPS, IPS Types- Signature based, Anomaly based, Policy based, IPS Types - Honey pot based, Applications, Malicious Software

**Unit-2 - Overview of IPSEC** 9 Hour  
 Security Associations, Security Policy databases, AH and ESP, Tunnel and Transport mode, IP header Protection, IP and IPv6, IPV4 and IPV6 header, Authentication Header, Mutable, Immutable and Mutable but predictable, Encapsulation Security Payload (ESP), Internet Key Exchange, Phases of IKE, Phase I IKE- Modes and key types, Phase II IKE Protocols, Phase III IKE, ISAKMP/IKE Encoding

**Unit-3 - Security Services** 9 Hour  
 Security Services for E-mail, Establishing keys, Establishing Public and secret keys, Privacy, End-to end Privacy, Privacy with distribution List Exploders, Authentication of the source, Based on public key technology and secret keys and with distribution list, Message Integrity, Non-repudiation, Introduction and Overview of PGP, Efficient Encoding, Certificate and key revocation, Signature types, Private key, Anomalies, Object Format,S/MIME

**Unit-4 – Transport Layer Security** 9 Hour  
 SSL/TLS Basic Protocol, computing the keys, client authentication, PKI as deployed by SSL, SSL Attacks fixed in v3, Exportability, Encoding, Encrypted Record, Handshake messages, Change cipher spec and Alerts, SET

**Unit-5 – Application Layer Security** 9 Hour  
 Wireless Security: IEEE 802.11 Wireless LAN, Authentication, Authentication and Confidentiality, Cellphone Security,GSM(2G)Security,Security in UMTS(3G),Wireless LAN Vulnerabilities, Phishing, Buffer Overflow,Format String Attacks,Cross-site Scripting (XSS),SQL Injection,Case Studies:Secure Inter-branch Payment Transactions,Virtual Elections

<b>Learning Resources</b>	1. William Stallings, "Cryptography and Network Security - Principles and Practice", 8 <sup>th</sup> edition, Pearson Publication, 2017 2. Bernard Menezes, "Network Security and Cryptography", Cengage Learning, 2nd edition, 2012 3. Charlie Kaufman, Radia Perlman, Mike Speciner, "Network Security, Prentice Hall of India", 2nd edition, 2002. 4. Atul Kahate, "Cryptography and network security", Tata McGraw-Hill Education, 4 <sup>th</sup> edition, 2019		
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<b>Learning Assessment</b>		<b>Continuous Learning Assessment (CLA)</b>				<b>Summative Final Examination (40% weightage)</b>	
	<i>Bloom's Level of Thinking</i>	<i>Formative CLA-1 Average of unit test (50%)</i>		<i>Life-Long Learning CLA-2 (10%)</i>			
		<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>
Level 1	<i>Remember</i>	15%	-	15%	-	15%	-
Level 2	<i>Understand</i>	25%	-	25%	-	25%	-
Level 3	<i>Apply</i>	30%	-	25%	-	30%	-
Level 4	<i>Analyze</i>	30%	-	25%	-	30%	-
Level 5	<i>Evaluate</i>	-	-	10%	-	-	-
Level 6	<i>Create</i>	-	-	-	-	-	-
	<i>Total</i>	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr.M.Vivekanandan,Nokia 2. Mr.Santhosh Kumar,CTS	1. Mr.Karthikeyan.C.M.T,Govt College of Engg,Bangur 2. Dr.Syedthouheed,Reva University, Bangalore	1. Ms.D.Saveetha, SRMIST

<b>Course Code</b>	21CSE466T	<b>Course Name</b>	NETWORK DESIGN AND MANAGEMENT	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Grasp knowledge on the types of Networks and the Network Management basics												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Understand the Network Management Standards															
<b>CLR-3:</b>	Familiarize with the working of Simple Network Management Protocol and its various versions															
<b>CLR-4:</b>	Discern on the working of Remote Monitoring Systems															
<b>CLR-5:</b>	Deduce on various Network Management Applications															
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>															
<b>CO-1:</b>	Acquire knowledge on networks and network management												2	-	-	
<b>CO-2:</b>	Interpret Information on various Network Protocols												2	-	-	
<b>CO-3:</b>	Gain knowledge on the working of SNMP protocol and its various applications												2	-	-	
<b>CO-4:</b>	Examine the network management tools and gather information from the network												2	-	-	
<b>CO-5:</b>	Familiarize with the working of various management applications												2	3	-	

**Unit-1 – Telecommunication Network Management** 9 Hour  
 Telephone Network Management, Distributed Computing Environment, TCP/IP Based Networks, Communication Protocols and Standards, Protocol Layer and Services, Challenges of IT Managers, Network Management, Network and System Management, Network Management System Platform, Current status and future of Network Management, Network Management Standards, Network Management Model - Organizational model, Information Model, Management Information Trees, Communication Model, ASN.1, Terminology, Symbols and Conventions, Functional Model

**Unit-2 – Network Management Protocol** 9 Hour  
 Introduction to SNMP, SNMP v1 model, Organization Model, System overview, SNMP v1 Information model, Structure of Management Information, Managed Objects, MIB-Object Group, System Group, Interfaces Group, Address Translation group, IP Group, ICMP Group, TCP Group, UDP Group, SNMP, MIB, User-Based Security Model, Access Control

**Unit-3 – Remote Monitoring Protocol** 9 Hour  
 Remote Monitoring, RMON SMI and MIB, RMON1, RMON2, System Utilities for Management Tool, Network Statistics Measurement Systems, Traffic Load, Protocol Statistics, Data and Error Statistics, Network Management System, Components, Requirements, System Management, Network Management Applications, Configuration Management, Inventory Management, Performance Management Tools

**Unit-4 – Network Management and Application Protocol** 9 Hour  
 Network Management Applications, Fault Management -Architecture, Fault location, Fault isolation Algorithm, Self-healing, avoiding failures, Configuration setting, Configuration discovery and Change Control, Configuration Management Applications, Patch Management, Approaches for Performance Management, Performance Monitoring and Reporting, Performance trouble shooting, Capacity Planning, Account Management, Report Management System and User Reports, Policy Management, Service Level Management

**Unit-5 - Network Design and Planning** **9 Hour**

Network Design for Enterprise Network, Network Design Process, Data Collection, Data Generation, Traffic Generators, Cost Generators, Topology, Architecture, Graph, Link, Algorithms, Network Design Techniques, Performance Analysis, Queuing Essentials, Loss and Delay, Reliability, Network Cost

<b>Learning Resources</b>	1. Greg Tomsho, Ed Tittel, David Johnson, "Guide to Network Essentials", Eighth Edition, Cengage Learning, 2019 2. Teresa C.Piliouras , "Network Design Management and Technical Perspectives", Second Edition 2015	3. Mani Subramanian "Network Management Principles and Practice", Second Edition, Pearson Publication, 2012. 4. Dinesh Chandra Verma, "Principles of Computer Systems and Network Management", Springer, 2009.
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)	Life-Long Learning CLA-2 (10%)							
		Theory	Practice	Theory	Practice				
Level 1	Remember	20%	-	20%	-	20%	-		
Level 2	Understand	30%	-	30%	-	30%	-		
Level 3	Apply	30%	-	30%	-	30%	-		
Level 4	Analyze	20%	-	20%	-	20%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Vijay Aravind .S Manager, Accenture, BengaluruEmail:vijayaravin@gmail.com	1. Dr. ZayarazGodandapani Professor, Dept. of CSE, Pondicherry Engineering College	1. Dr. A. Vijay Vasantha, SRM IST

**ACADEMIC CURRICULA**  
**UNDERGRADUATE/ INTEGRATED POST  
GRADUATE DEGREE PROGRAMMES**  
(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume - 11F

(Syllabi for Computer Science and Engineering w/s in  
Cybersecurity Programme Courses)



**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

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Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

# ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021



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Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

<b>Course Code</b>	21CSC308T	<b>Course Name</b>	SECURITY RISK MANAGEMENT PRINCIPLES	<b>Course Category</b>	C	PROFESSIONAL CORE	L 3	T 0	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the fundamental knowledge about Security Risk.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Understand the various analysis on Security Risk Management															
<b>CLR-3:</b>	Understand the demand for IS Audit.															
<b>CLR-4:</b>	Understand the IT audit and its activities.															
<b>CLR-5:</b>	Understand the techniques for implementing security in audit.															
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>															
<b>CO-1:</b>	Acquire the knowledge on the fundamentals of Risk management												-	2	-	
<b>CO-2:</b>	Acquire the ability to apply various techniques for data collection												-	2	-	
<b>CO-3:</b>	Utilize the principles of data analysis												-	-	3	
<b>CO-4:</b>	Acquire the ability to apply IS audit												-	2	-	
<b>CO-5:</b>	Apply the knowledge gained on auditing methodologies												-	-	3	

**Unit-1 – Introduction to Risk** **9 Hour**  
 Introduction to Risk, Elements of risk, Information Security Risk Management Overview, Information Risk Management Activities, Risk Management and the Security Program, Drivers, Laws, Regulations, Threat Source Leveraging a Vulnerability, Federal Information Security Management Act of 2002 (FISMA), Gramm-Leach-Bliley Act (GLBA), Health Insurance Portability and Accountability Act (HIPAA), ISO 27001, ISO 27005, Risk Management Frame work, Practical Approach.

**Unit-2 – Data Collection and Planning** **9 Hour**  
 Introduction to data collection, Planning – the essential element, The Sponsors, Characteristics of a good project sponsor, the project team, Factors that decide upon the size of the project team, Data collection mechanisms, Collectors and Containers, Executive interviews, Questionnaire, Document requests, List of documents for the assessor, IT Assets inventory, Asset Scoping, Asset Scoping – Requirements, Techniques involved in asset scoping, Profile survey, Control survey

**Unit-3 – Data Analysis** **9 Hour**  
 Introduction to data analysis, Compiling Observations, Compiling Observations from Organizational Risk Documents, Format to collect your observations. List of the documents to encounter, Threat Catalog, List of threat catalogs that can be used as references, Sample Threat Catalog, Vulnerability Catalog, Vulnerability Catalog types, Documentation process, Threat Vulnerability Pairs, Sample Threat and Vulnerability Pairs, Confidentiality, Confidentiality Determination Matrix, Analyzing Confidentiality Determination Matrix, Developing Sample Confidentiality Determination Matrix.

**Unit-4 – Information Security Audit** **9 Hour**  
 Demand for IS audit, Auditor Role, Auditee Role, Process of auditing information system, Preplanning the audit, Audit process Perform audit, Hierarchy of internal controls, gathering audit evidence, conducting audit evidence, Reporting audit evidence, Strategy planning for organizational control, Issues register, Risk management tools, Distinct types of risk tools, Planning Performance

**Unit-5 - Information Security Audit Analysis** **9 Hour**

Detailing Information Security Audit, Purpose of IS Audit, Expectation from IS Auditor, Steps to Conduct IS Audit, Classification of Audit, Traditional Audit, Difference Between Audit and Assessment, Relationship Between Auditor, Auditee and Client; Their Duties, SLA Introduction, SLA Components, Auditing Firm Organizational Chart, Auditing Firm functionalities, Policy Vs Procedures Standard Vs Guideline, Basic Types of Measurement Metrics, Members of Auditing Committee, Skills Matrix, Example, Audit Evidence, Examples, Direct and Indirect Evidence.

<b>Learning Resources</b>	1. Evan Wheeler, "Security Risk Management", Syngress ISBN: 97815, 2011 2. Bruce Newsome, "A Practical Introduction to Security and Risk Management", 2013	3. David L. Cannon, "CISA Certified Information Systems Auditor Study Guide", John Wiley & Sons, ISBN: 978-0-470-23152-4, 2009.
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)	Life-Long Learning CLA-2 (10%)							
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
		1. Arun.A

<b>Course Code</b>	21CSC310J	<b>Course Name</b>	MALWARE ANALYSIS	<b>Course Category</b>	C	PROFESSIONAL CORE	L 2	T 0	P 2	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the fundamentals of static and dynamic analysis.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Gain knowledge about running malware in virtual environment.															
<b>CLR-3:</b>	Study about disassembly constructs and its structures.															
<b>CLR-4:</b>	Study about new processors and file types using the IDA SDK															
<b>CLR-5:</b>	Explore popular plug-ins that make writing IDA scripts easier, allow collaborative reverse engineering															
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Gain knowledge about the different forms of malware.												-	3	3	
<b>CO-2:</b>	Set up a safe virtual environment to analyze malware.												-	-	3	
<b>CO-3:</b>	Navigate, comment, and modify disassembly.												-	-	3	
<b>CO-4:</b>	Use code graphing to quickly make sense of cross references and function calls												-	-	3	
<b>CO-5:</b>	Use debugger to tackle hostile and obfuscated code.												-	-	-	

**Unit-1 - Introduction to Malware** 12 Hour  
 What is Malware Analysis? -Why Malware Analysis? -Types of Malware Analysis-Basic Static Analysis- Determining the File Type- Fingerprinting Malware- Anti-Virus Scanning- Extracting Strings- Determining File Obfuscation- Inspecting PE Header Information- Comparing and Classifying Malware- Lab: Setting up and configuring Windows and Linux VM.

**Unit-2 - Dynamic Analysis** 12 Hour  
 System and Network Monitoring- Process Inspection with Process Hacker- System Interaction with Process Monitor- Logging system using Noriben- Capture Network Traffic with Wire shark- Simulating services with INetSim- Analyzing Malware Executable- Analyzing DLL using runll32.exe- Lab: Perform dynamic analysis on different families of Windows Malware.

**Unit-3 - Static Analysis** 12 Hour  
 Advanced Static Analysis- Understanding Computer Basics- Level of Abstraction- Reverse Engineering- X86 Architecture- Main Memory- Instructions- Opcodes and Operands- Registers- Simple Instructions- The Stack- Conditionals- Branching – REP Instructions- C Main Methods-. Global Vs Local Variables- Disassembling Arthematic Operations- Understanding Functional Calls- Disassembling Arrays- Identifying Structs- Analyzing Linked List Traversal. Lab: Perform shell code analysis in x86 architecture.

**Unit-4 - Advanced Dynamic Analysis** 12 Hour  
 Debugging- OLLYDBG- Loading Malware- OllyDbg Interface- Memory Map- Rebasing- View Threads and Stacks- Executing Code- Breakpoints- Loading DLLs- Tracing- Exception Handling- Patching- Reversing application using x64dbg- Debugging a Binary using IDA Pro. Lab: Analyze malware binary using debugging tools.

**Unit-5 - Malware Functionalities** 12 Hour  
 Malware Behavior- Downloader- Backdoor- Credential Stealer- Persistent Mechanism- Privilege Escalation- Covering Tracking. Lab: Covert Malware Launching

<b>Learning Resources</b>	1. Michael Sikorski, <i>Practical Malware Analysis – The Hands-On Guide to Dissecting Malicious Software</i> , Kindle Edition, No Starch Press; 1 edition (1 February 2012), ISBN: 1593272901. 2. Monnappa K A, <i>Learning Malware Analysis: Explore the concepts, tools, and techniques to analyze and investigate Windows malware</i> , Packt Publishing; 1st edition (29 June 2018)	3. Chris Eagle, <i>the IDA Pro Book</i> , 2nd Edition, No Starch Press, 2011. ISBN-10: 1-59327- 289-8.
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Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1 <i>Remember</i>	15%	-	-	15%	15%	-
Level 2 <i>Understand</i>	25%	-	-	20%	25%	-
Level 3 <i>Apply</i>	30%	-	-	25%	30%	-
Level 4 <i>Analyze</i>	30%	-	-	25%	30%	-
Level 5 <i>Evaluate</i>	-	-	-	10%	-	-
Level 6 <i>Create</i>	-	-	-	5%	-	-
Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Karthik Expert Member from k7 Computing	1. Dr Bhawana Rudra Assistant Professor (Grade II) National Institute of Technology, Warangal	1. Mr. V. Joseph Raymond, SRMIST

# ACADEMIC CURRICULA

Professional Elective Courses

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**(Deemed to be University u/s 3 of UGC Act, 1956)**

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

<b>Course Code</b>	21CSE229J	<b>Course Name</b>	CHECK POINT SYSTEM ADMINISTRATION	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 0	P 2	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		Program Outcomes (PO)												<b>Program Specific outcomes</b>		
CLR-1:	Describe the basic functions of the Gaia operating system and Understand how SmartConsole is used by administrators to give user access.	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
<b>CLR-2:</b>	Understand licensing and contract requirements for Check Point security products.															
<b>CLR-3:</b>	Describe the essential elements of a Security Policy and Understand the Check Point policy layer concept, how to enable the Application Control and URL Filtering software															
<b>CLR-4:</b>	Describe how to configure manual and automatic NAT.															
<b>CLR-5:</b>	Identify tools designed to monitor data, determine threats and recognize opportunities for performance improvements and Articulate how the Intrusion Prevention System is configured, maintained and tuned.															

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Program Outcomes (PO)												<b>Program Specific outcomes</b>		
CO-1:	Describe the key elements of Check Point's unified security management architecture.	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
<b>CO-2:</b>	Understand Check Point Licensing and creation of various security policies.	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
<b>CO-3:</b>	Gain insight on how Check Point security features are enabled and policies applied for inspection of various applications.	-	-	2	-	-	-	-	-	-	-	-	-	-	-	3
<b>CO-4:</b>	Understanding Network Address Translation and User Access Management	-	-	2	-	-	-	-	-	-	-	-	-	-	-	3
<b>CO-5:</b>	Learn how Check Point firewalls are managed and network traffic is monitored and threat prevention.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

<b>Unit-1 - Introduction to Check Point Technology and Management Operations</b>	<b>12 Hour</b>
Introduction to checkpoint Technology - Checkpoint security architecture, Controlling network traffic. Introduction to checkpoint deployment – Check point deployment options, Deployment considerations, Deployment options, Introduction to Gaia operating system. Install the Primary Security Management Server - Installing the Gaia Operating System, Installing the Security Management Server Software, Installing smart Console. Configure a Security Gateway – Powering on the security gateway. Configuring the security gateway. Check Point Security Management Operations - Network Communication, Smart Console, Smart Console Applications, Administration. Establishing Secure Internal Communication – Creating Gateway Objects in Smart Console, Testing SIC status to the Gateway. Managing User Access – Creating new administrators and Assigning profiles, Testing Administrator Profile Assignments – Managing Concurrent Administrator sessions, Taking over an administrator session.	

<b>Unit-2 - Check Point Licensing and Creating Various Security Policies</b>	<b>12 Hour</b>
Check Point Licensing – Licensing overview, Smart Update. Manage Licenses – Verifying the status of Existing Licenses in Smart Console, Attaching a License Using Smart Console, and Creating a License Report. Security Policy Management – Introduction to the Security Policy, Rule base, Global Properties, Publishing Policy, Policy Packages, and Install Policy. Creating the Alpha Standard Security Policy – Creating Policy Objects, Creating a standard security policy, Installing the Standard Security Policy, Testing the Standard Security Policy. Creating the Bravo Security Policy – Establishing SIC to B-GW, Adding a License to B-GW, Enabling Security Zones on B-GW, Creating B-GW Security Zones Policy, Testing Internet Connectivity.	

<b>Unit-3 - Check Point Policy Layers</b>	<b>12 Hour</b>
Policy Layers – Policy Layers Concept, Traffic Inspection, Managing Layers. Configure Order Layers – Adding Two New Order Layers to be Shared, Configuring the New Ordered Layers Rule, Using the Shared Layer on Bravo Policy, Testing the Shared APPI+URL Layer on Bravo Gateway, Testing Shared Data Control Layer on Bravo Gateway. Configure a Shared Inline Layer – Creating Shared DMZ Layer, Sharing the	

*Inline DMZ Layer with Bravo-Policy, Testing the Shared Inline DMZ Layer. Application Control & URL Filtering - Application Control & URL Filtering, Application Control, URL Filtering, Configuring Application Control & URL Filtering. Configure a Unified Policy – Creating a Unified Policy Layer, Updating the App URL Layer, Creating a Unified Policy. Configure HTTPS Inspection Policy – Enabling HTTPS Inspection, Creating an HTTP Inspection Rule, Deploying the Security Gateway Certificate, Testing Unified-Policy with HTTPS Inspection.*

**12 Hour**

**Unit-4 - Network Address Translation, User Management and Configure Identity Awareness**  
*Network Address Translation – Understanding Network Address Translation, Manual and Automatic NAT. Configuring Network Address Translation – Configuring Automatic NAT on Network Objects, Configuring Manual Static NAT Rules, Configuring Manual Proxy ARP, Testing the Automatic Hide NAT Configuration, Testing the Static NAT Configuration. User Access Management – Overview of User Access Management, Methods for Acquiring Identities, Identity Sharing, Distinguished Name, Using Multiple LDAP Servers, Retrieving Information from a User Directory Server, Managing Users on a User Directory Server. Configure Identity Awareness – configuring the Security Policy for Identity Awareness, Defining the User Access Role, Testing Identity Awareness Connection.*

**12 Hour**

**Unit-5 - Traffic Visibility, Monitoring and Threat Prevention**  
*Traffic Visibility – Using Smart Console, Analyzing Logs. Generate and View Traffic – Configuring Log Management on the Security Management Server, Viewing Logs and Performing Searches to gather Historic Data. Monitoring System States – Monitoring Traffic and Connections. Monitor System States – Enabling the Monitoring Blade, Monitoring Status with Smart View Monitor, Configuring Alerts in Smart View Monitor, Configuring Suspicious Activity Rules. Threat Prevention – Threat Prevention, Autonomous Threat Prevention, Intrusion Prevention system, IPS Profile Setting and Protections, IPS Tuning and Maintenance, Anti-Malware, Threat Emulation and Threat Extraction, Internet of Things Protections. Configuring Threat Prevention – Enabling Autonomous Threat Prevention, Testing Anti-Virus Threat Prevention*

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>Check Point Certified Security Administrator (CCSA), Student and Lab Manual, Check Point Secure Academy, Check Point Software Technologies Ltd, 2022. (<a href="https://read.kortext.com/reader/pdf/2003557/11">https://read.kortext.com/reader/pdf/2003557/11</a>)</li> <li><a href="https://www.checkpoint.com/mind/self-study-resources/">https://www.checkpoint.com/mind/self-study-resources/</a></li> <li><a href="http://supportcontent.checkpoint.com/documentation_download?ID=46577">http://supportcontent.checkpoint.com/documentation_download?ID=46577</a></li> <li>Firewall, Pre-R80 Security Gateways with R80 Security Management, 28 March 2016, Check Point Software Technologies Ltd.</li> <li>Check Point Security Management R80 Administration Guide, 15 January 2017.</li> </ol>	<ol style="list-style-type: none"> <li>Multi-Domain Security Management, R80, Administration Guide, 30 March 2016.</li> <li>CCSA™ NG: Check Point Certified Security Administrator Study Guide, Justin Menga, San Francisco, SYBEX Inc., Alameda, CA, <a href="http://www.sybex.com">www.sybex.com</a>.</li> <li>Security Administration, Student &amp; Lab Manual, © 2019 Check Point Software Technologies Ltd. R80.20 v1.</li> <li>Check Point Certified Security Administrator (CCSA R80): 156-215.80 Exam.</li> </ol>
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<b>Bloom's Level of Thinking</b>		<b>Continuous Learning Assessment (CLA)</b>				<b>Summative Final Examination (40% weightage)</b>	
		<b>Formative CLA-1 Average of unit test (45%)</b>		<b>Life-Long Learning CLA-2 (15%)</b>			
		<b>Theory</b>	<b>Practice</b>	<b>Theory</b>	<b>Practice</b>	<b>Theory</b>	<b>Practice</b>
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	30%	-	-	25%	30%	-
Level 4	Analyze	30%	-	-	25%	30%	-
Level 5	Evaluate	-	-	-	10%	-	-
Level 6	Create	-	-	-	5%	-	-
	Total	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
		1. Dr. Vigneshwaran P, SRMIST
		2. Dr. C.N.S. Vinoth Kumar, SRMIST
		3. Dr. S. Thanga Revathi, SRMIST

<b>Course Code</b>	21CSE281T	<b>Course Name</b>	CRYPTOGRAPHY AND NETWORK SECURITY	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	<i>The purpose of learning this course is to:</i>												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	Acquire fundamental knowledge on the concepts of finite fields, number theory and cryptography	1	2	3	4	5	6	7	8	9	10	11	12												
<b>CLR-3:</b>	Describe the various block cipher algorithms and public key cryptosystems																								
<b>CLR-4:</b>	Utilize the principles of hash functions and digital signature																								
<b>CLR-5:</b>	Acquire the knowledge on firewall and security applications.																								
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>														Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Implement the Classical Encryption Techniques.	2	2	-	-	-	-	-	-	-	-	-	-												
<b>CO-2:</b>	Implement the various block cipher algorithms and public key cryptosystems	2	2	-	-	-	-	-	-	-	-	-	-												
<b>CO-3:</b>	Apply the principles of hash functions and digital signature	2	-	-	-	-	-	-	-	-	-	-	-												
<b>CO-4:</b>	Demonstrate the configuration of Firewall and the concepts of WLAN Security.	-	-	-	-	-	-	-	-	-	-	-	-											3	
<b>CO-5:</b>	Apply the knowledge gained in various security applications in real-time problems	2	2	-	-	-	-	-	-	-	-	-	-											3	

**Unit-1 - Introduction to Security and Number Theory** 9 Hour  
 Basics of Security – CIA Triad – Threats, Attacks and Services – Classical Cryptography –symmetric and asymmetric cipher- Substitution – Transposition – Cryptanalysis. Tutorial 1: Substitution techniques. Number Theory: Groups, Rings, Fields- Modular Arithmetic – Euclidean Theorem – Extended Euclidean Theorem – Galois Field – Tutorial 2: Implement Euclid and extended. Prime Numbers – Fermat's Theorem – Euler's totient function – Euler's Theorem – Chinese Remainder theorem –Primitive Roots-Discrete Logarithms-Elliptic curve arithmetic -Tutorial 3: Implement Chinese Remainder Theorem

**Unit-2 - Block Cipher and Public Key Cryptography** 9 Hour  
 Block Cipher – Feistel Ciphers – Data Encryption Standard (DES) – DES Structure – Key Generation – Simplified DES – Advanced Encryption Standard (AES) – Basic Structure – Transformations – Key Expansions Process – Tutorial 4: Implement SDES - Modes of operation. Public Key Cryptosystems – RSA Algorithm – Tutorial 5: Implement RSA algorithm - ElGamal Cryptosystems – Diffie-Hellman key exchange – Elliptic curve cryptography- Quantum Cryptography – Threshold Cryptography - Tutorial 6: Implement Diffie-Hellman Key exchange algorithm

**Unit-3 - V Hash Functions and Digital Signatures** 9 Hour  
 Message authentication requirements- Message Authentication functions -Hash Functions-Hash Algorithms: MD5- Tutorial 7: Implement MD5 - Secure Hash Algorithm- Tutorial 8: Implement SHA - Digital signatures: Digital signature requirements- Digital Signature scheme- Elgamal Digital signature scheme- Schnoor Digital signature scheme- User Authentication protocol- Kerberos - Tutorial 9: Implement Elgamal Digital signature scheme.

**Unit-4 - Introduction to Network Security** 9 Hour  
 Networking Devices (Layer1,2,3)- Different types of network layer attacks -Buffer Overflow and Malicious Software – Tutorial 10: Discussions on Buffer overflow attack - Password Management – Introduction to Firewall- Firewall Generations – Tutorial 11: Discussions on Firewall configurations - Intrusion Detection System – Types of IDS – Intrusion Prevention System – Wireless LAN – Wireless LAN Security – Network Access Control and Cloud Security- Tutorial 12: Discussions on IDS.

**Unit-5 - Security Applications****9 Hour**

Digital Certificate – Key Management – Kerberos – Key Agreement and Distribution – PKI – X.509 Certificate – E-Mail Security – PGP – S/MIME – Tutorial 13: Discussions on E-mail security - IP security – IPSEC protocol suite – functionalities – Transport mode – Authentication Header – Introduction to Encapsulation Security Payload - IKE Phase I, II - Virtual Private Network (VPN) – Tutorial 14: Discussions on VPN - Web Security – Secure Socket Layer (SSL) –Transport Layer Security – Secure Electronic Transaction (SET) – Blockchain - Tutorial 15: Discussions on SSL

<b>Learning Resources</b>	1. William Stallings, "Cryptography and Network Security", 3rd Edition, Pearson Education, 2003. 2. Charlie Kaufman, Radia Perlman, Mike Speciner, "Network Security", Prentice Hall, 2nd edition, ISBN-10: 0130460192, ISBN-13: 978-0130460196, 2002.	3. Charles Pfleeger, "Security in Computing", Prentice Hall, 4th Edition, ISBN-10: 0132390779, ISBN-13: 978-0132390774, 2006. Earl Gose, Richard Johnsonbaugh, Steve Jost, "Pattern Recognition and Image Analysis", Prentice Hall of India Private Ltd., New Delhi – 110 001, 1999.
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**Learning Assessment**

Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1 <i>Remember</i>	10%	-	10%	-	10%	-
Level 2 <i>Understand</i>	20%	-	20%	-	20%	-
Level 3 <i>Apply</i>	20%	-	20%	-	20%	-
Level 4 <i>Analyze</i>	20%	-	20%	-	20%	-
Level 5 <i>Evaluate</i>	20%	-	20%	-	20%	-
Level 6 <i>Create</i>	10%	-	10%	-	10%	-
Total	100 %		100 %		100 %	

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. S. Sajiv, Technical Leader, CISCO 2. Mr. Varun Subramanian, QA Automation Tester, Likewise	1. Dr. A. Balaji, School of Computing Science and Engineering (SCSE), VIT Bhopal University	1. Ms.G. Sujatha, SRMIST KTR

<b>Course Code</b>	21CSE282T	<b>Course Name</b>	INFORMATION SECURITY	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 3	T 0	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	To understand the basics of Information Security												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	To know the legal, ethical, and professional issues in Information Security															
<b>CLR-3:</b>	To know the aspects of risk management															
<b>CLR-4:</b>	To become aware of various standards in this area															
<b>CLR-5:</b>	To know the technological aspects of Information Security															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12			
<b>CO-1:</b>	Discuss the basics of information security															
<b>CO-2:</b>	Illustrate the legal, ethical, and professional issues in information security															
<b>CO-3:</b>	Demonstrate the aspects of risk management.															
<b>CO-4:</b>	Become aware of various standards in the Information Security System															
<b>CO-5:</b>	Design and implementation of Security Techniques.															

<b>Unit-1 - Introduction</b>	<b>9 Hour</b>
History, What is Information Security? Critical Characteristics of Information, NSTISSC Security Model, Components of an Information System, Securing the Components, Balancing Security and Access, The SDLC, The Security SDLC	
<b>Unit-2 - Security Investigation</b>	
9 Hour for Security, Business Needs, Threats, Attacks, Legal, Ethical and Professional Issues - An Overview of Computer Security - Access Control Matrix, Policy-Security policies, Confidentiality policies, Integrity policies and Hybrid policies	
<b>Unit-3 - Security Analysis</b>	
9 Hour Risk Management: Identifying and Assessing Risk, Assessing and Controlling Risk - Systems: Access Control Mechanisms, Information Flow and Confinement Problem	
<b>Unit-4 - Logical Design</b>	
9 Hour Blueprint for Security, Information Security Policy, Standards and Practices, ISO 17799/BS 7799, NIST Models, VISA International Security Model, Design of Security Architecture, Planning for Continuity	
<b>Unit-5 - Physical Design</b>	
9 Hour Security Technology, IDS, Scanning and Analysis Tools, Cryptography, Access Control Devices, Physical Security, Security and Personnel	

<b>Learning Resources</b>	1. Michael E Whitman and Herbert J Mattord, —Principles of Information Securityll, Vikas Publishing House, New Delhi, 2021 2. Matt Bishop, — Computer Security Art and Sciencell, Pearson/PHI, 2021	3. Micki Krause, Harold F. Tipton, — Handbook of Information Security Managementll, Vol 1-3 CRCPress LLC, 2019 4. Stuart McClure, Joel Scrambray, George Kurtz, —Hacking Exposedll, Tata McGraw-Hill, 2019
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	10%	-	10%	-	10%	-		
Level 2	Understand	20%	-	20%	-	20%	-		
Level 3	Apply	20%	-	20%	-	20%	-		
Level 4	Analyze	20%	-	20%	-	20%	-		
Level 5	Evaluate	20%	-	20%	-	20%	-		
Level 6	Create	10%	-	10%	-	10%	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.M. Vivekanandan,Nokia 2. Mr. Santhosh Kumar,CTS	1. Karthikeyan.C.M. T, Govt College of Engg,Bargur 2. Syedthouheed, Reva University, Bangalore	1. D.Saveetha, SRMIST

<b>Course Code</b>	21CSE283T	<b>Course Name</b>	CYBER LAW	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Understand the basics of cyber law and cyber security												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	familiarize the issues those are specific to amendment rights												-	-	-	3									
<b>CLR-3:</b>	Become aware on copyright issues in software's												-	-	-	3									
<b>CLR-4:</b>	Understand the Cyber-crimes and Cyber Frauds												-	-	-	-									
<b>CLR-5:</b>	Understand the Legal Framework												-	-	-	-									
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Gain in-depth knowledge on information on cyber security and issues specific to amendment rights												-	-	-	-	-	-	-	-	-	-	3		
<b>CO-2:</b>	Apply the knowledge on copyright issues within software packages												-	-	-	-	-	-	-	-	-	-	3		
<b>CO-3:</b>	Comprehend ethical laws of computer for various countries												-	-	-	-	2	-	-	-	-	-	-		
<b>CO-4:</b>	Defines the Cyber-crimes and frauds												-	-	-	-	-	-	2	-	-	-	-		
<b>CO-5:</b>	Apply the knowledge of Legal framework												-	-	-	-	-	-	-	2	-	-	-		

**Unit-1 - Introduction** 9 Hour  
History of Internet and World Wide Web - Need for cyber law - Cyber-crime on the rise - Important terms related to cyber law - Cyber law in India - Need for cyber law in India - History of cyber law in India - Information Technology Act, 2000 - Overview of other laws amended by the IT Act, 2000 - National Policy on Information Technology 2012

**Unit-2 - Overview of The Information Technology Act, 2000** 9 Hour  
Applicability of the Act - Scheme of the Act - Important provisions of the Act - Digital Signature under the IT Act, 2000 - E-Governance - Attribution, Acknowledgement and Dispatch of Electronic Records - Certifying Authorities - Controller of Certifying Authorities (CCA) - Security Guidelines for Certifying Authorities - Electronic Signature Certificates - Duties of Subscribers - Penalties and Offences Intermediaries - RULES ISSUED UNDER THE IT ACT, 2000

**Unit-3 - Cyber-crimes / Cyber Frauds** 9 Hour  
Definition of cybercrime - First Cyber-crime- Types of cyber frauds - Cyber frauds in India - Preventive measures - Cyber-crimes - Who commits cyber-crimes? - Penalties and offences under the IT Act, 2000 - Offences under other legislations - Investigation of cyber-crimes in India - Regulatory Authorities

**Unit-4 - Cyber Crimes& Legal Framework** 9 Hour  
Cyber Crimes against Individuals, Institution and State – Hacking - Digital Forgery -Cyber Stalking/Harassment - Cyber Pornography -Identity Theft & Fraud - Cyber Terrorism - Cyber Defamation - Right to Privacy and Data Protection on Internet -Concept of privacy - Self-regulation approach to privacy -Ingredients to decide confidentiality of information -Intellectual Property Issues in Cyber Space -Interface with Copyright Law -Interface with Patent Law - Trademarks &Domain Names Related issues -Dispute Resolution in Cyberspace

<b>Unit-5 - Cyber Security</b>	<b>9 Hour</b>
Network and website Security Risks -Hacking -E-business Risk management issues -Firewall -Security framework -Cryptocurrency -Blockchain -Technology Stack: Protocol, Currency -Crowd Funding -Bitcoin - prediction Markets -Smart Property -Smart Contract -Decentralized Governance Services -E Payments -Digital Token based E payment systems -E Wallet - Online financial services in India -Law to Protect online financial service fraud	

<b>Learning Resources</b>	1. Justice Yatindra Singh, <i>Cyber Laws</i> , Universal Law Publishing Co, New Delhi, (2012). 2. Verma S, K. Mittal Raman, <i>Legal Dimensions of Cyber Space</i> , Indian Law Institute, New Delhi, (2004) 3. S. R. Bhansali, <i>Information Technology Act, 2000</i> , University Book House Pvt. Ltd., Jaipur (2003). 4. <i>Blockchain, Blueprint for a new Economy</i> , Melanie Swan, 2017 –O'Reilly 5. SudhirNaib, <i>The Information Technology Act, 2005: A Handbook</i> , OUP, New York, (2011) 6. Upadhyaya and A. Upadhyaya, <i>Material Science and Engineering</i> , Anshan Publications, 2007 7. Vasu Deva, <i>Cyber Crimes and Law Enforcement</i> , Commonwealth Publishers, New Delhi, (2003). 8. <i>Essential CyberSecurity Science</i> , Josiah Dykstra, 2017 –O'Reilly
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	10%	-	10%	-	10%	-		
Level 2	Understand	20%	-	20%	-	20%	-		
Level 3	Apply	20%	-	20%	-	20%	-		
Level 4	Analyze	20%	-	20%	-	20%	-		
Level 5	Evaluate	20%	-	20%	-	20%	-		
Level 6	Create	10%	-	10%	-	10%	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Dr. Venkata Prasad S, TATA consultancy services, svenkataprasad, @yahoo. com	1. Dr. Abhishek Srivastava, asrivastava@iiti.ac.in, CSE, IIT, Indore. 2. Dr. A. Amuthan, amuthan@pec.edu, Pondicherry Engineering College, Pondicherry.	1. Dr.S. Murugaanandam, SRMIST

<b>Course Code</b>	21CSE381T	<b>Course Name</b>	FORENSICS AND INCIDENT RESPONSE	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Gain knowledge on the basics of procedures for identification, preservation of electronic evidence												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	Understand the purpose and usage of various forensic tools																								
<b>CLR-3:</b>	Gain knowledge on how scientific evidence collection/extraction during investigation																								
<b>CLR-4:</b>	Acquire knowledge on file systems and its working																								
<b>CLR-5:</b>	Understand the windows and Linux investigation procedures																								
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Acquire the knowledge on basics of procedures for identification, preservation of electronic evidence												-	-	2	-	-	-	-	-	-	-	-	-	
<b>CO-2:</b>	Acquire the ability to identify the purpose and usage of various forensic tool												-	-	-	-	-	-	2	-	-	-	-	-	
<b>CO-3:</b>	Understand how scientific evidence collection/extraction during investigation												-	-	2	-	-	2	-	-	-	-	-	3	
<b>CO-4:</b>	Appreciate the concepts of file systems and its importance in forensic science.												-	-	-	-	-	2	-	-	-	-	-	3	
<b>CO-5:</b>	Apply the knowledge of windows and Linux investigation procedures												-	-	2	-	-	-	-	-	-	-	-	-	

<b>Unit-1 – Introduction to Incident</b>	<b>9 Hour</b>
Goals of Incident Response-Introduction to Incident Response Methodology (IRM)- Steps in Incident Response Methodology-IRM: Pre-incident preparation-IRM: Detection of incidents-IRM: Initial Response-IRM: Formulate a Response Strategy-IRM: Investigate the Incident-IRM: Reporting-Creating response toolkit – Windows-Volatile Data Collection – Windows-In-depth data collection – Windows-Storing collected data – Windows-Creating response toolkit – Unix-Volatile Data Collection – Unix-In-depth data collection – Unix-Storing collected data – Unix	

<b>Unit-2 – ACPO Principles</b>	<b>9 Hour</b>
Introduction to ACPO Principles-ACPO Principles of Computer Based Evidence-Introduction to computer Storage Formats-Understanding Storage Formats for Digital Evidence-Forensic Duplication-Forensic Duplication tools-Forensic Duplicate creation of HDD-Qualified Forensic Duplicate creation-Restored Image-Mirror Image-Forensic Duplication Tool Requirements-Creating a Forensic Duplicate of a Hard Drive-Evidence Handling-Types of Evidence-Challenges in Evidence Handling-Overview of Evidence Handling Procedure.- Evidence Handling Procedure-Evidence Handling reports	

<b>Unit-3 – File System Analysis</b>	<b>9 Hour</b>
Introduction to File System Analysis-What is a File System? - Five Data Categories-FAT Concepts-FAT Analysis-FAT - The Big Picture-Introduction to NTFS-Files in NTFS-MFT Concepts-MFT Attribute Concepts-Other MFT Attribute Concepts-Indexes in NTFS-NTFS Analysis - File System Category-NTFS Analysis - Content Category-NTFS Analysis - Metadata Category-NTFS Analysis - File Name Category-NTFS Analysis - Application Category-NTFS - The Big Picture	

<b>Unit-4 – Investigating Systems</b>	<b>9 Hour</b>
Introduction to Investigating Systems-Investigating Windows Systems-Where Evidence resides on Windows Systems-Conducting a Windows Investigation I-Conducting a Windows Investigation II-File Auditing-Theft of Information-Handling the departing employee-Investigating Unix Systems-Overview of steps - Unix Investigation-Reviewing pertinent logs-Performing keyword searches-Reviewing relevant files-Identifying unauthorized user accounts/groups-Identifying rogue processes-Checking for unauthorized access points-Analysing trust relationships-Detecting loadable kernel modules	

<b>Unit-5 – Investigating Hacker Tools</b>	<b>9 Hour</b>
Investigating Hacker Tools-What are the goals of tool analysis?- How are files compiled?- Static Analysis of Hacker Tools I-Static Analysis of Hacker Tools II-Dynamic Analysis of Hacker Tools I-Dynamic Analysis of Hacker Tools II-Evaluating Computer Forensics Tools-Types of Forensic Tools-Tasks performed by Forensic Tools-Tool comparisons-Computer Forensics Software Tools-Computer Forensics Hardware Tools-Validating and Testing Computer Forensics Software-Introduction to Forensic Report Writing-Understanding the Importance of Reports-Guidelines for Writing Reports-A Template for Computer Forensics Reports	

<b>Learning Resources</b>	1. Kevin Mandia, Chris Prosise, <i>Incident Response and computer forensics</i> , Tata McGrawHill, 2006. 2. Bill Nelson, Amelia Philips, and Christopher Steuart, —Guide to computer forensics and investigations, course technology, CengageLearning;4th edition, ISBN:1-435-49883-6,2009 3. Eoghan Casey,"Hand book Computer Crime Investigation's Forensic Tools and Technology", Academic Press, 1st Edition, 2001. 4. Brian Carrier, —File System Forensic Analysis, Addison-Wesley Professional; 1st edition 2005, ISBN13: 978-0321268174
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<b>Learning Assessment</b>						
<i>Bloom's Level of Thinking</i>	<i>Continuous Learning Assessment (CLA)</i>				<i>Summative Final Examination (40% weightage)</i>	
	<i>Formative CLA-1 Average of unit test (50%)</i>		<i>Life-Long Learning CLA-2 (10%)</i>			
	<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>
Level 1	Remember	15%	-	15%	-	15%
Level 2	Understand	25%	-	20%	-	25%
Level 3	Apply	30%	-	25%	-	30%
Level 4	Analyze	30%	-	25%	-	30%
Level 5	Evaluate	-	-	10%	-	-
Level 6	Create	-	-	5%	-	-
	Total	100 %		100 %		100 %

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr.M. Vivekanandan,Nokia 2. Mr. Santhosh Kumar,CTS	1. Karthikeyan.C.M. T, Govt College of Engg,Bangur 2. Syedthouheed, Reva University, Bangalore	1. D.Saveetha, SRMIST

<b>Course Code</b>	21CSE382T	<b>Course Name</b>	SECURITY MANAGEMENT	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes												
1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
<b>CLR-1:</b>	Outline various security management policies, principles, the various plans for security management.																									
<b>CLR-2:</b>	Explain risk management identification, risk assessment and risk identification techniques.																									
<b>CLR-3:</b>	Illustrate various types of analysis such as vulnerability analysis, penetration testing, audit trail analysis, system and network monitoring, and configuration management.																									
<b>CLR-4:</b>	Demonstrate the knowledge and skills for risk analysis and assessment of enterprise systems using various practical and theoretical tools.																									
<b>CLR-5:</b>	Manage detailed enterprise-wide security plans and policies.																									
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>																									
<b>CO-1:</b>	identify fundamentals of security management policies and plans.																									
<b>CO-2:</b>	obtain knowledge from risk assessment and risk identification techniques.																									
<b>CO-3:</b>	gain information from vulnerability analysis, penetration testing, audit trail analysis, system, and network monitoring.																									
<b>CO-4:</b>	analysis and assess the enterprise systems using various tool.																									
<b>CO-5:</b>	enhance their knowledge of obtaining enterprise-wide security plans and policies.																									

**Unit-1 - Introduction to Security Management** 9 Hour

Overview of security policies, models and mechanisms, Security Management Principles, Models and Practices, Security Planning and Asset Protection, Developing Security Programs and Disaster Recovery Plans

**Unit-2 - Principles of Risk and Risk Management** 9 Hour

Introduction and identification, risk analysis and evaluation, Practice of Risk Management, Risk Assessment- Types and sources of risk information, Risk identification techniques, Risk Treatment-Evaluating and selecting risk control mechanisms, Identifying, allocating, and resourcing risk controls.

**Unit-3 - Security Analysis and Safeguards** 9 Hour

Vulnerability analysis, Penetration testing, Protection Mechanisms, and Incident handling- Access Control and Authentication architecture, Auditing systems and audit trail analysis, Configuration Management

**Unit-4 - Network defense and countermeasures** 9 Hour

Intrusion Detection Systems (SNORT), Architectural configurations and survivability issues, Firewall configurations and network design, Virtual private networks, Dial-up security, Computer, and network forensic, Privacy Protection, Case studies on OS and application software (e.g., SELinux, Unix and Windows).

**Unit-5 - Standards and Security Certification Issues** 9 Hour

Rainbow Series, Common Criteria, Security Certification Process, Case studies, National and International Security Laws and Ethical Issues

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Management of Information Security, M. E. Whitman, H. J. Mattord Cengage Learning, 2016.</li> <li>2. Guide to Disaster Recovery 1st Edition by Michael Erbschloe.</li> <li>3. Guide to Network Defense and Countermeasures Paperback – Import by Greg Holden, 2003</li> <li>4. Security in Computing, 2nd Edition, Charles P. Pfleeger, Prentice Hall, 2005.</li> <li>5. Security Engineering: A Guide to Building Dependable Distributed Systems, Ross Anderson, Wiley, John &amp; Sons, Incorporated, 2001.</li> <li>6. Software Security: Building Security In (by Gary McGraw)</li> <li>7. The Art of Software Security Assessment: Identifying and Preventing Software Vulnerabilities (by Mark Dowd, John McDonald, Justin Schuh)</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>			
	<i>Bloom's Level of Thinking</i>	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. T Ravichandran, Product Manager, Servis2 IT Team, Chennai. 2. Dhanvant Kesavan, NTT Data Cyber security analyst, Chennai.		1. Dr. P. Balamurugan, SRMIST

<b>Course Code</b>	21CSE383T	<b>Course Name</b>	SECURITY GOVERNANCE, RISK AND COMPLIANCE	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Analyze the expanding role of IT governance and its effect on organizations.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Be aware of management issues in IT governance.															
<b>CLR-3:</b>	Analyze the role of risk to an organization and ways to identify key risk factors.															
<b>CLR-4:</b>	Evaluate various risks and appropriate actions.															
<b>CLR-5:</b>	Develop naming conventions for the resources in a system.															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
<b>CO-1:</b>	Having an overview of IT governance	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>CO-2:</b>	Undergo an risk assessment	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>CO-3:</b>	Describe legal and ethical considerations related to the handling and management of enterprise information assets.	-	-	-	2	-	-	-	-	-	-	-	-	-	-	3
<b>CO-4:</b>	Specify what constitutes admissible evidence in a legal proceeding and how to acquire and maintain this information	-	2	-	-	-	-	-	-	-	-	-	-	-	-	3
<b>CO-5:</b>	Create a set of policies that implement a specified organizational objective.	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-

**Unit-1 – Introduction to IT Governance** **9 Hour**  
 Introduction to IT Governance, IT Risk Management Life Cycle, IT Risk framework, IT Risk identification, IT Risk Security Governance, IT Risk assessment, IT Risk evaluation, IT Risk response, IT Risk monitoring and reporting.

**Unit-2 - Standards** **9 Hour**  
 overview of Industry Best Practice Standards, Model and Guidelines covering some aspect of IT governance, principles of Business/IT Alignment Excellence, principles of Program/Project Management Excellence, principles of IT Service Management and Delivery Excellence, principles of Vendor Management, Outsourcing Excellence, critical success factors, Case Study.

**Unit-3 – Security Design Principles** **9 Hour**  
 Security mind-set, Design principles, System/security life-cycle, Security implementation mechanisms, Information assurance analysis model, Disaster recovery, Forensics, threats, vulnerabilities, attacks, countermeasures

**Unit-4 – Security Trends and Audit** **9 Hour**  
 Trends, Auditing, Cost / benefit analysis, Asset management, Standards, Enforcement, Legal issues, Disaster recovery, security related issues and incidents.

**Unit-5 – Security Policies** **9 Hour**  
 Creation of policies, Maintenance of policies, Prevention, Avoidance, Incident response, Domain integration, social engineering, Protocol attacks, Security awareness

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>Iannarelli, J. G., &amp; O'Shaughnessy, M. O. (2015). <i>Information governance and security: Protecting and managing your company's proprietary information</i>. Waltham, MA: Butterworth Heinemann, Elsevier.</li> <li>Van Wyk, K. R., Graff, M. G., Peters, D. S., &amp; Burley, D. L. (2015). <i>Enterprise software security: A confluence of disciplines</i>. Upper Saddle River, NJ: Pearson Education.</li> <li>Legal Issues in Information Security, Joanna Lyn Grama, 2015. Jones &amp; Bartlett Learning, Second Edition, ISBN: 978-1-284-05474-3.</li> <li>Ethics of Big Data, Kord Davis, 2012. O'Reilly Media, ISBN: 978-1449311797</li> </ol>
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Kesawan HCL Technologies	1. Dr. Surendran Rajendran AMA International University Bahrain	1. Arun.A, SRMIST
2. Mr.Celeian, Symantec		

<b>Course Code</b>	21CSE384J	<b>Course Name</b>	SECURITY AUDIT AND RISK ASSESSMENT	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 0	P 2	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Outline the fundamentals of security audit components and process.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	Illustrate various security audit phases and methods to audit the resources																								
<b>CLR-3:</b>	Outline the process of data collection for security risk assessment.																								
<b>CLR-4:</b>	Explain how the collected risky data are analyzed to find the final risk score																								
<b>CLR-5:</b>	Introduce the concepts of risk assessment methodology																								
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Describe the concepts of Security audit components and process.												-	-	-	-	-	-	-	-	-	-	-		
<b>CO-2:</b>	Apply the various security audit phases and methods to audit the resources												-	-	-	-	-	-	-	-	-	-	-		
<b>CO-3:</b>	Demonstrate the process of data collection for security risk assessment.												-	-	2	-	-	2	-	-	-	-	-	3	
<b>CO-4:</b>	Evaluate the risk score using risk data analysis techniques.												-	-	-	-	-	2	-	-	-	-	-	3	
<b>CO-5:</b>	Assess the risk with different risk assessment methodology												-	-	2	-	-	-	2	-	-	-	-	-	

<b>Unit-1 - Basics of Information Security</b>																	<b>12 Hour</b>
Security Metrics and Reporting, Common Issues and Variances of Performance Metrics, Introduction to Security Audit, Need, Steps in Security Audit. Auditable resources in an organization, Servers and Storage devices, Infrastructure and Networks, Communication Routes, Lab1: Working with Trojans, Backdoors and sniffer for monitoring network communication System, Information Security Methodologies (Black-box, White-box, Grey-box), Phases of Information Security Audit and Strategies, Ethics of an Information Security Auditor.Lab2: Understanding Data Packet Sniffers, Security Audit Part I- Auditing PC-based Accounting System, Auditing Operating Systems, Auditing Networks, Auditing Electronic Data Interchange, Controlling and auditing Database Management Systems. Lab 3: Windows Hacking – NT LAN Manager, Secure 1 password recovery																	

<b>Unit-2 - Security Audit</b>																	<b>12 Hour</b>
Pre-audit checklist, Information Gathering, Vulnerability Analysis, Lab 1: UDP Scan Using nmap, TCP Connect Scan Using nmap, TCP SYN Scan Using nmap External Security Audit, Internal Network Security Audit, Firewall Security Audit, Lab 2: Vulnerability Identification and Prioritization, IDS Security Auditing, Social Engineering Security Auditing, Web Application Security Auditing, Information Security Audit Deliverables & Writing Report, Result Analysis, Post Auditing Actions, Report Retention etc. Lab 3: Web Application Security Configuration																	

<b>Unit-3 - Fundamentals of Risk</b>																	<b>12 Hour</b>
What is Risk? –Information Security Risk Assessment Overview Drivers, Laws, and Regulations- Risk Assessment Frame work – Lab1: Risk assessment with NIST framework. Phases of Security Risk Assessment, Data Collection: The Sponsors- The Project Team- Data Collection Mechanisms, Executive Interviews- Document Requests- IT Assets Inventories, Lab2: Data Collection using Container method, Profile & Control Survey-Consolidation, Lab3: Survey Consolidation of the collected data.																	

<b>Unit-4 - Risk Analysis</b>	<b>12 Hour</b>
Compiling Observations-Data Analysis: Preparation of catalogues- Lab1: Prepare an automated Threat-vulnerability pair matrix, System Risk Computation, Designing Impact Analysis Scheme-Confidentiality, Integrity and Availability, Impact Score, Lab2: Preparation of an automated impact score, designing control analysis, Designing Likelihood Analysis: Exposure, Frequency, Controls, Computing Final Risk Score, Lab3: Preparation of an automated Likelihood score and final risk score.	
<b>Unit-5 - Risk Classification and Prioritization</b>	<b>12 Hour</b>
Stem Risk Analysis-Risk Classification, Risk Ranking, Individual Risk Reviews, and Lab1: Prepare the Risk Analysis with individual system risk review and threat and vulnerability risk review, Organization risk Analysis, Risk Prioritization- Organization and System Specific Risk prioritization and Treatment, Lab2: Prepare an automated Organization and system specific risk prioritization and treatment template. Risk Assessment Methodologies- Result- Risk Registers-Process summary-post mortem. Lab3: Prepare the risk register.	

<b>Learning Resources</b>	1. Mark Talabis, "Information Security Risk Assessment Toolkit: Practical Assessments through Data Collection and Data Analysis", Syngress; 1 edition, ISBN: 978-1-59749-735-0, 2013.	4. <a href="https://www.sans.org/reading-room/whitepapers/threats/implementing-vulnerability-management-process-34180">https://www.sans.org/reading-room/whitepapers/threats/implementing-vulnerability-management-process-34180</a>
	2. Whitman, Michael E., and Herbert J. Mattord. Management of information security. Cengage Learning, 2013.	5. <a href="http://csrc.nist.gov/publications/nistpubs/800-40-Ver2/SP800-40v2.pdf">http://csrc.nist.gov/publications/nistpubs/800-40-Ver2/SP800-40v2.pdf</a>
	3. Andrew Vladimirov Michajlowski, Konstantin, Andrew A. Vladimirov, and Konstantin V. Gavrilenko. Assessing information security: strategies, tactics, logic, and framework. IT'S Governance Ltd, 2010.	

Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	-	15%	15%	-		
Level 2	Understand	25%	-	-	20%	25%	-		
Level 3	Apply	30%	-	-	25%	30%	-		
Level 4	Analyze	30%	-	-	25%	30%	-		
Level 5	Evaluate	-	-	-	10%	-	-		
Level 6	Create	-	-	-	5%	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts

<b>Course Code</b>	21CSE385J	<b>Course Name</b>	ADVANCED MALWARE ANALYSIS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	2	<b>T</b>	0	<b>P</b>	2	<b>C</b>	3
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<b>Pre-requisite Courses</b>	Nil	<b>Co-requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>														
<b>CLR-1:</b>	Understand the purpose of malware analysis.																											
<b>CLR-2:</b>	Gain knowledge about taxonomy of malware and infection vectors.																											
<b>CLR-3:</b>	Gain knowledge about protective mechanisms and dependencies.																											
<b>CLR-4:</b>	To analyze different malware families and perform static and dynamic mechanisms.																											
<b>CLR-5:</b>	Explore popular plug-ins that make writing OllyDbg debugger easier, allow collaborative reverse engineering																											

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Engineering Knowledge	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
<b>CO-1:</b>	Gain knowledge about the different forms of malware.	-	2	2	-	2	-	-	-	-	-	-	-	-	-	-	
<b>CO-2:</b>	Set up a safe virtual environment to analyze malware.	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	
<b>CO-3:</b>	Navigate, comment, and modify malware samples.	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	
<b>CO-4:</b>	Use tools and perform static and dynamic analysis.	-	2	-	-	-	-	-	-	-	-	-	-	-	-	3	
<b>CO-5:</b>	Use debugger to tackle hostile and obfuscated code.	-	-	-	-	-	2	-	-	-	-	-	-	-	-	3	

<b>Unit-1 - Malware Analysis and Reverse Engineering</b>	12 Hour
blueprint- Malware Analysis and Reverse Engineering- Types and purpose of Malware Analysis- Limitation- Effective Malware Analyst- Lab: Basic static analysis using python	
<b>Unit-2 - Malware Taxonomy and Deployment</b>	12 Hour
Malware Classes- Malware Infection Vectors- Types of Infection Vector- Potential Infection Vector- Lab: Setting up lab for dynamic analysis	
<b>Unit-3 - Protective Mechanisms and Dependencies</b>	12 Hour
States of Malware- Static and Dynamic – Dependency Types- Malware Collections- Malware Inspection- PE File – Handle Files – Inspecting Static Malware – Inspecting Dynamic Malware - Malware Analysis Use Case- Tools of the trade-Lab: Dynamic analysis of Downloader, Dropper , Fake AV and Ransomware	
<b>Unit-4 - Reverse Engineering</b>	12 Hour
OllyDbg- Memory Map- Viewing thread and stack- Execution code- Breakpoints- Loading DLL's- Tracing- Exception Handling- Patching- Analyzing shell code- Understanding x64 debugger – Lab: Reverse applications using x64 debugger	
<b>Unit-5 - Advanced Functionalities</b>	12 Hour
Launcher's- Process Injection – Process Replacement- Hook Injection- APC Injection- Simple Cipher's- Custom Encoding- Decoding- Lab- Use IDA Pro and look for potential encoding in given malware sample	

<b>Learning Resources</b>	<p>1. Michael Sikorski, <i>Practical Malware Analysis – The Hands-On Guide to Dissecting Malicious Software</i>, Kindle Edition, No Starch Press; 1 edition (1 February 2012), ISBN: 1593272901.</p> <p>2. Monnappa K A, <i>Learning Malware Analysis: Explore the concepts, tools, and techniques to analyze and investigate Windows malware</i>, Packt Publishing; 1st edition (29 June 2018).</p> <p>3. Christopher C. C. Elisan, <i>Advanced Malware Analysis</i>, 1st Edition, Kindle Edition, ISBN-13: 978-0071819749</p>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>			
<i>Bloom's Level of Thinking</i>	<i>Formative CLA-1 Average of unit test (45%)</i>	<i>Life-Long Learning CLA-2 (15%)</i>							
		<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>				
Level 1	<i>Remember</i>	15%	-	-	15%	15%	-		
Level 2	<i>Understand</i>	25%	-	-	20%	25%	-		
Level 3	<i>Apply</i>	30%	-	-	25%	30%	-		
Level 4	<i>Analyze</i>	30%	-	-	25%	30%	-		
Level 5	<i>Evaluate</i>	-	-	-	10%	-	-		
Level 6	<i>Create</i>	-	-	-	5%	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. Karthik Expert Member from k7 Computing	1. Dr Bhawana Rudra Assistant Professor (Grade II) National Institute of Technology, Warangal	1. Mr. V. Joseph Raymond, Department of Networking and Communications SRMIST

<b>Course Code</b>	21CSE386J	<b>Course Name</b>	PENETRATION TESTING AND VULNERABILITY ASSESSMENT	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 0	P 2	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	study fundamental concepts in Vulnerability Assessment and Penetration Testing.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	experiment with Penetration testing framework - Metasploit & its Usage.															
<b>CLR-3:</b>	exploit vulnerability detection & explore various other social engineering techniques provided by Social Engineering Toolkit.															
<b>CLR-4:</b>	perform a penetration test using Metasploit.															
<b>CLR-5:</b>	execute a penetration test with integrated Metasploit services.															

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CO-1:</b>	study fundamental concepts in Vulnerability Assessment and Penetration Testing.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CO-2:</b>	experiment with Penetration testing framework - Metasploit & its Usage.															
<b>CO-3:</b>	exploit vulnerability detection & explore various other social engineering techniques provided by Social Engineering Toolkit.															
<b>CO-4:</b>	perform a penetration test using Metasploit.															
<b>CO-5:</b>	execute a penetration test with integrated Metasploit services.															

**Unit-1 - Need for Vulnerability Assessment** 12 Hour  
The life cycles of Vulnerability Assessment and Penetration Testing -Introduction to Nessus - Installing Nessus on different platforms -prerequisites - Policy configuration - Scan configuration -Implementation of scanning the IT infrastructure using Nessus tool - Report interpretation - False positive analysis - Vulnerability analysis & Vulnerability exploiting -Performing scan results analysis, which will cover false positive analysis, vulnerability analysis, exploiting vulnerabilities, and so on.

**Unit-2 - Vulnerability assessment versus penetration testing** 12 Hour  
The need for a penetration testing framework - Introduction to Metasploit - Setting up Your Environment – Metasploit - Metasploit components -Playing around with msfconsole - Variables in Metasploit - Browse through the directory structure of the Metasploit Framework & try out some of the common console commands - Information gathering and enumeration - Password sniffing - Advanced search with shodan - Try to explore and execute the Shodan auxiliary module to find out various internet connected devices

**Unit-3 - Vulnerability Hunting with Metasploit** 12 Hour  
Managing the database – NMAP - Post exploitation - Using any auxiliary module that can be used for vulnerability detection & explore various features of meterpreter. - Need of client-side attacks with Metasploit - The msfvenom utility - Social Engineering with Metasploit - Explore various other social engineering techniques provided by Social Engineering Toolkit & Get familiar with various parameters and switches of msfvenom - Web Application Scanning with Metasploit - Web application scanning using WMAP - Metasploit Auxiliaries for Web Application - enumeration and scanning - Find and exploit vulnerabilities in the following vulnerable applications: DVWA, Muttillidae, OWASP Webgoat

**Unit-4 - Organizing a penetration test****12 Hour**

Conducting a penetration test with Metasploit - Case study - diving deep into an unknown network - Perform post-exploitation on the Windows 7 system and identify five best post exploitation modules - The absolute basics of exploitation - Exploiting stack-based buffer overflows with Metasploit - Bypassing DEP in Metasploit modules - Implementation Metasploit exploit module for DEP bypass - Performing a penetration test with integrated Metasploit services - Exploiting the Active Directory (AD) with Metasploit - Generating manual reports - Perform a penetration test on a network using OpenVAS built-in connectors and various Metasploit extensions, and how a proper report of the test can be generated

**Unit-5 - Vulnerability Management Plan****12 Hour**

The Six Stages of Vulnerability Management - Measuring the Performance of a Vulnerability Management Program - Demonstration of any windows based Vulnerability Management Tools - Vulnerability Management Tools - Evaluating Vulnerability Management Tools - Open Source and Free Vulnerability Management Tools - Demonstration of any open source Vulnerability Management Tools - Patch Management - Building a Patch Test Lab- Patch Distribution and Deployment - Demonstration of any Patch Management Software

<b>Learning Resources</b>	1. Himanshu Kumar - Learning Nessus for Penetration Testing_ Master how to perform IT infrastructure security vulnerability assessments using Nessus with tips and insights from real-world challenges. 2. Sagar Rahalkar, Nipun Jaswal - The Complete Metasploit Guide_ Explore effective penetration testing techniques with Metasploit-Packt Publishing (2019)	3. Steve Manzuik, Andre Gold, Chris Gafford - Network Security Assessment_ From Vulnerability to Patch-Syngress (2006) 4. Thomas R. Peltier, Justin Peltier, John A. Blackley - Managing A Network Vulnerability Assessment-Auerbach Publications (2003)
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**Learning Assessment**

Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%
Level 2	Understand	25%	-	-	25%	25%
Level 3	Apply	30%	-	-	30%	30%
Level 4	Analyze	30%	-	-	30%	30%
Level 5	Evaluate	-	-	-	-	-
Level 6	Create	-	-	-	-	-
	Total	100 %		100 %		100 %

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. S. Sajiv, Technical Leader, CISCO	1. Dr. A. Balaji, School of Computing Science and Engineering (SCSE), VIT Bhopal University	1. Dr. S. Prabakeran, SRMIST, KTR
2. Mr. Varun Subramanian, QA Automation Tester, Likewise		

<b>Course Code</b>	21CSE387J	<b>Course Name</b>	HACKER TECHNIQUES, TOOLS, AND INCIDENT HANDLING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	2	<b>T</b>	0	<b>P</b>	2	<b>C</b>	3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Explain the history and current state of hacking and penetration testing, including ethical and legal implications.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Implications.															
<b>CLR-3:</b>	Identify common information gathering tools and techniques.															
<b>CLR-4:</b>	Identify and remove common types of malwares from infected systems.															
<b>CLR-5:</b>	Identify Trojans, backdoors, and covert communication methods.															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
<b>CO-1:</b>	Analyze how port scanning and fingerprinting are used by hackers.	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>CO-2:</b>	Analyze wireless network vulnerabilities exploited by hackers.	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>CO-3:</b>	Gain knowledge to Perform web and database attacks.	-	2	-	-	-	-	-	-	-	-	-	-	-	-	3
<b>CO-4:</b>	Acquire knowledge to Perform network traffic analysis and sniffing by using appropriate tools.	-	-	-	-	2	-	-	-	-	-	-	-	-	-	3
<b>CO-5:</b>	Utilize the concepts of Compare and contrast defensive technologies.	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-

<b>Unit-1 - Introduction</b>	<b>12 Hour</b>
The Next Generation - TCP/IP Review, Cryptographic Basics, Symmetric and Asymmetric Encryption - Purpose of Public Key Infrastructure - Hashing - Physical Security - Lab 1: Cloud Investigations for the steps for conducting a cloud security incident investigation and with essential cloud logging assets for incident response. Data collection and isolation for compromise assessment, applying cloud recovery and remediation following an incident, Complete cloud compromise incident response walkthrough. Lab 2: Assessing and Securing Systems on a Wide Area Network (WAN) Lab 3: Applying Encryption and Hashing Algorithms for Secure Communications.	

<b>Unit-2 - Information Gathering and Footprinting</b>	<b>12 Hour</b>
Technical Overview of Hacking - The Information-Gathering Process, The Information on a Company Web Site, Discovering Financial Information, Google Hacking, Exploring Domain Information Leakage, Tracking an Organization's Employees, Exploiting Insecure Applications, Using Basic Countermeasures. Port Scanning - Determining the Network Range, Identifying Active Machines, Mapping Open Ports, OS Fingerprinting, Mapping the Network, Analyzing the Results Lab 4: Data Gathering and Footprinting on a Targeted Website Lab 5: Using Ethical Hacking Techniques to Exploit a Vulnerable Workstation Lab 6: Attacking a Vulnerable Web Application and Database	

<b>Unit-3 - Web and Database Attacks</b>	<b>12 Hour</b>
Enumeration and Computer System Hacking -Windows Basics, Commonly Attacked and Exploited Services, Enumeration, System Hacking, Types of Password Cracking, Using Password Cracking, Using PsTools, Rootkits, Covering Tracks, Wireless Vulnerabilities - The Importance of Wireless Security, A Brief History of Wireless Technologies, Working with and Securing Bluetooth, Working with Wireless LANs, Threats to Wireless LANs, Wireless Hacking Tools, Protecting Wireless Networks, Web and Database Attacks - Attacking Web Servers , Examining an SQL Injection, Examining an SQL Injection, Vandalizing Web Servers, Database Vulnerabilities Lab 7 : Password Guessing Attacks with Hydra, Password Cracking with John the Ripper, Password Cracking with Hashcat. Lab 8: Domain Password Audit Tool, Cloud Bucket Discovery, The Many Uses of Netcat. Lab 9 - Metasploit Attack and Analysis, Client-side Exploitation with the Browser Exploitation Framework (BeEF), Windows System Resource Usage Database Analysis, Command Injection Attack, Cross-Site Scripting Attack, SQL Injection Attack, Server-Side Request Forgery (SSRF) and Instance Metadata Service (IMDS) Attack	
<b>Unit-4 - Attacks and Malware Lifecycle</b>	<b>12 Hour</b>
Sniffers session Hijacking and Denial of Service attacks - Malware-viruses and they function-worms and how they function works-significance of Trojans-Detection of Trojan and viruses, Trojan tools, distribution methods-Trojan constructionkits-backdoors-convertcommunication-spyware-adware-scareware-ransomware-Lab 10 Identifying and Removing Malware on a Windows System.Lab11: Analyzing Network Traffic to Create a Baseline Definition Lab12 .Auditing a Wireless Network and Planning for a Secure WLAN Implementation	
<b>Unit-5 - Eless Security Technologies</b>	
Defensive Technologies and incident response - Defence in depth, Intrusion detection system-the purpose of firewalls- Honeypots Honeynets- the role of controls- security best practices- incident response and defensive technologies- incident response- incident response plans- planning for disaster recovery- evidence handling and administration- requirements of regulated industries Lab 13: Investigating and Responding to Security Incidents Lab14: Securing the Network with an Intrusion Detection System (IDS) Lab15: Defense Plan to Prevent Attacks	

<b>Learning Resources</b>	1. Hacker Techniques, Tools, and Incident Handling, 3rd Edition. By Sean-Philip Oriyan and Michael G. Solomon. Released August 2020. Publisher(s): Jones & Bartlett Learning. 2. Joshua Wright Hacker Techniques Training   Incident Handling Course   SANS SEC504 2019	3. Digital forensics and incident response, johansen 4. Hacker Techniques Training   Incident Handling Course   SANS SEC504 5. Hacking Exposed: Network Security Secrets and Solutions, McClure(Stuart), Scambray(Joel)
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Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	-	15%	15%	-		
Level 2	Understand	25%	-	-	20%	25%	-		
Level 3	Apply	30%	-	-	25%	30%	-		
Level 4	Analyze	30%	-	-	25%	30%	-		
Level 5	Evaluate	-	-	-	10%	-	-		
Level 6	Create	-	-	-	5%	-	-		
	Total	100 %		100 %		100 %			

Course Designers			
Experts from Industry		Experts from Higher Technical Institutions	
1. Mr.T.Madhan, Team Leader, Tata Consultancy Services, siruseri Campus, Chennai, madhan.tk@gmail.com		1. Dr. S. Janakiraman, Associate Professor, Pondicherry University, sj.dbt@pondiuni.edu.in	1. Dr. R. Naresh, SRMIST
2. Mrs.K.Saranya, IT Analyst, Tata Consultancy Services, siruseri Campus, Chennai, saranya.k6@gmail.com		2. Dr. R.Shyamala, Associate Professor, Anna University College of Engineering Tindivanam, vasuchaaru@gmail.com	2. Dr. C.N.S. Vinoth Kumar, SRMIST

<b>Course Code</b>	21CSE399J	<b>Course Name</b>	COMPREHENSIVE LINUX FOR ALL	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 0	P 2	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>	<i>The purpose of learning this course is to:</i>	<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>
		1	2	3	4	5	6	7	8	9	10	11	12	
<b>CLR-1:</b>	Introduce the key role of an Linux Operating system													
<b>CLR-2:</b>	Insist the File system Management of a Linux Operating system													
<b>CLR-3:</b>	Emphasize the importance of Server Management concepts of an Enterprise Linux Operating system													
<b>CLR-4:</b>	Realize the significance of GIT repositories and databases													
<b>CLR-5:</b>	Comprehend the need of Security vulnerability in Linux Operating system													
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1
<b>CO-1:</b>	Identify the need of an Linux Operating system	3	-	-	-	-	-	-	-	-	-	-	-	PSO-1
<b>CO-2:</b>	Know the Process management functions of an Linux Operating system	2	-	2	-	-	-	-	-	-	-	-	-	PSO-2
<b>CO-3:</b>	Understand the need of Users and Group Management in Linux Operating system	-	-	2	2	-	-	-	-	-	-	-	-	PSO-3
<b>CO-4:</b>	Find the significance of GIT repositories and databases	-	-	-	2	3	-	-	-	-	-	-	-	-
<b>CO-5:</b>	Recognize the essentials of File Management part of an Linux Operating system	-	-	-	2	3	-	-	-	-	-	-	-	-

<b>Unit-1 - Starting with Linux</b>	<b>12 Hour</b>
Understanding What Linux is- Exploring Linux History- Understanding How Linux Differs from Other Operating Systems- Understanding How Linux Distributions Emerged- Creating the Perfect Linux Desktop- Lab: Ubuntu OS Installation on Virtual Machines- Starting With the Ubuntu Desktop Live Image- Handling Ubuntu Desktop- Using the Desktop- Understanding the Importance of Threads- Lab: Understanding Basic Desktop Application Management in Ubuntu- Adding an Application Launcher- Managing Files and Folders-- Installing and Managing Additional Software- Lab: Knowing Advanced Desktop Application Management in Ubuntu- Using Tools- Lab: Configuring Basic Tools in Ubuntu OS- Working with Shell in Ubuntu- Lab1: Getting Aquatinted with Different Types of Shell- Lab3: Basic Shell Management	

<b>Unit-2 - Gaining Access</b>	<b>12 Hour</b>
Using the Root User Account-Exploring Administrative Commands, Configuration Files, and Log Files- Using Other Administrative Accounts- Lab: Implementing Privilege Escalation- Using Shell Variables, Expanding Arithmetic Expressions Expanding Variables- Lab: Manipulating Environmental / Shell Variable- Getting Information About Commands and Help- Managing User Accounts in Ubuntu- User Management- Lab: Managing Regular User Account-Group Management-Lab: Group Management- Moving Around the File system Ubuntu- File Management- Lab: Working with Basic File System- Permission Management- Lab: Working With File System Permissions- Access Control Lists- Lab: Managing User and Group Permissions- Working with Text Files in Ubuntu	

<b>Unit-3 - File Manipulations</b>	<b>12Hour</b>
Lab: Editing Text Files from Shell Prompt- Managing Running Processes- Process Management-Lab: Monitoring Process Activity- Writing Simple Shell Scripts- Understanding Shell Scripts- Lab: Implementing Basic Shell Programs- Understanding Server Managing in RHEL - Install the Server RHEL - Lab: RHEL 8 Installation on Virtual Machine- Initial Server Configuration- Lab: Configuring and Verifying the Initial Server Settings- Remote Server Management- Lab: RHEL Remote Server Management-Initial Server Configuration- Lab: Configuring and Verifying the Initial Server Settings-Remote Server Management-Lab: RHEL Remote Server Management- File Transfer-Lab: Securely Copying Files Between Servers-Log Management- Lab1: Monitoring System Logs-Lab2: Recording and Managing Server Logs- Server Monitoring- Lab: Monitoring the Health of the Server	

**Unit-4 - Managing Software in RHEL** 12 Hour

Lab: System Software and Package Management- Administering Networking in RHEL - Lab: Examining and Configuring Network in Server- Starting and Stopping Services in RHEL - Lab: Managing Daemons and Services in RHEL - Configuring a Web Server in RHEL - Lab: Managing a Basic Webserver-Advance Webserver Management-Lab: Advance Webserver Management- Secure Webserver-Lab: Securing the Webserver Effectively- Managing Disks and File systems-Lab: Making Simple Partitions- Logical Volume Management- Lab: Implementing Logical Volume Management (LYM)- Configuring Samba Server in RHEL - Lab: Deploy A Samba Share Directory- Configuring an NFS File Server In RHEL - Lab: Deploy a NFS Share Export- Introducing Container Technology

**Unit-5 - Introduction to GIT** 12Hour

Getting Started With GIT and its Architecture- Lab: Installing and Configuring GIT in RHEL - Remote Repositories- Lab: Exploring GIT Remote Repository- Branching and Merging- Lab: Learning and Exploring Branches in GIT - Configuring Databases in Linux- Lab: Maria DB (MySQL) Installation and Configuration in RHEL -Mongo DB-Lab: Mongo DB Installation and Configuration in RHEL -Understanding Linux Security OS- Lab: Kali Linux Installation on Virtual Machine- Description About Different Security Tools in Kali Linux-Hands-on Study on NMAP And METASPLOIT-Lab: Gathering Information Using NMAP - METASPLOIT - Lab: Vulnerability Management Using METASPLOIT - Knowing Linux as Cloud Workhorse- Amazon Web Service (AWS- Lab: Operating and Managing an Ec2 Instance in AWS Cloud

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Christopher Negus, <i>Linux® BIBLE</i>, John Wiley &amp; Sons, Inc., Indianapolis, Indiana, Canada, 2020, 10<sup>th</sup> edition</li> <li>2. SUSE LLC, <i>SUSE Linux Enterprise server 12 SPA Administration Guide</i>, 2021, version 1.3</li> <li>3. Adrian Andrade, Fiona Allen, Victor Costea, Hervé Quatremain, Snehangshu Karmakar, Marc Kesler, Ed Parenti, Saumik Paul, Dallas Spohn, Red Hat Enterprise Linux 8.2 RH199 RHCSA Rapid Track</li> <li>4. Technical Content Development Team, <i>Comprehensive Linux for IT Professionals</i>, 2022, 1<sup>st</sup> edition</li> </ol>
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**Learning Assessment**

Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%
Level 2	Understand	25%	-	-	20%	25%
Level 3	Apply	30%	-	-	25%	30%
Level 4	Analyze	30%	-	-	25%	30%
Level 5	Evaluate	-	-	-	10%	-
Level 6	Create	-	-	-	5%	-
	Total	100 %		100 %		100 %

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Stanley Raj M, IT solution Architect	1. Mr. Abdul Majeet Khan, Red Hat Certified Architect – Level V	1. Dr.G.Maragatham, SRMIST
2. Mr. SathishBabu R Cloud Architect		2. Ms. Aruna S, SRMIST

<b>Course Code</b>	21CSE485T	<b>Course Name</b>	DATABASE SECURITY	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		Program Outcomes (PO)												<b>Program Specific outcomes</b>		
CLR-1:	Demonstrate understanding of Fundamentals of Security in database technology with its security architecture in modern computer systems in a typical enterprise.	1	2	3	4	5	6	7	8	9	10	11	12			
<b>CLR-2:</b>	Formulate a working definition of data warehouse and various geospatial models.	-	2	-	-	2	-	-	2	-	2	-	-	PSO-1	PSO-2	PSO-3
<b>CLR-3:</b>	identify hazards and vulnerabilities in matrix models.	-	2	-	-	2	-	-	2	-	2	-	-	-	-	3
<b>CLR-4:</b>	Demonstrate the knowledge and skills for administration & protection of the active databases.	-	2	-	-	2	-	-	2	-	2	-	-	-	-	3
<b>CLR-5:</b>	Manage database security and reliability on secured software designs.	-	2	-	-	2	-	-	2	-	2	-	-	-	-	3

  

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Program Outcomes (PO)												<b>Program Specific outcomes</b>		
CO-1:	identify fundamentals of security issues, requirements & Authentication.	1	2	3	4	5	6	7	8	9	10	11	12			
<b>CO-2:</b>	obtain knowledge from data warehouse and different geospatial models.	-	2	-	-	2	-	-	2	-	2	-	-	-	-	3
<b>CO-3:</b>	gain information from different matrix models.	-	2	-	-	2	-	-	2	-	2	-	-	-	-	3
<b>CO-4:</b>	design different models & protection of the active databases.	-	2	-	-	2	-	-	2	-	2	-	-	-	-	3
<b>CO-5:</b>	enhance their knowledge of obtaining security software designs.	-	2	-	-	2	-	-	2	-	2	-	-	-	-	3

<b>Unit-1 – Security Issues in Database</b>	<b>9 Hour</b>
Polyinstantiation, Integrity Lock, Sensitivity Lock, Security Models, Access Control (Grant & Revoke Privileges), Distributed Database Security, Outsourced Database and security requirements, Query Authentication Dimension, Condensed RSA & Merkle Tree	
<b>Unit-2 - Security in Data Warehouse &amp; OLAP</b>	<b>9 Hour</b>
Star Schema, Snowflake Schema, Multi-Dimension range query, Data cube - Data leakage in Data Cube, Geospatial Database Security, Geospatial data models, Geospatial Authorization, Access Control Models: Geo-RBAC & Geo-LBAC, Database Watermarking & Attacks on Watermarking	
<b>Unit-3 - Introduction to Access Matrix Model</b>	<b>9 Hour</b>
Take Grant Model, Acten Model PN Model, Harston Model, Hsiao's Model, Fernandez Model, Bell Lapadula's Model, Biba's Model & Dion's Model	
<b>Unit-4 – Database Security Models</b>	<b>9 Hour</b>
Sea View Model, Jajodia Model, Sandhu's Model, The Orion Model, Jajodia Model, Kogan's Model, Sorion Model, A Model for Frame based systems & A Model for the Protection of Active Database	
<b>Unit-5 - Security software Design</b>	<b>9 Hour</b>
A Methodological Approach to Security Software Design, Secure DBMS Design Security Packages, Database Security Design, Retiss System, ASE System discovery, Bussolati AND Martella's Model & Case Study.	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Database Security and Auditing, Hassan A. Afyouni, India Edition, CENGAGE Learning, 2009.</li> <li>2. Database Security, Castano, Second edition, Pearson Education.</li> <li>3. Michael Gertz and Sushil Jajodia (Editors), Handbook of Database Security: Applications and Trends, ISBN-10: 0387485325. Springer, 2007.</li> <li>4. Bhavani Thuraisingham, Database and Applications Security: Integrating Information, Security and Data Management, CRC Press, Taylor &amp; Francis Group, 2005.</li> <li>5. Database security by Alfred basta, Melissa zgola, CENGAGE learning.</li> <li>6. Handbook of Database Security: Applications and Trends. (2008). Germany: Springer US.</li> </ol>
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)	Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

#### Course Designers

##### Experts from Industry

1. Elaiyaraja K, Eagle Software India Pvt Ltd.

##### Experts from Higher Technical Institutions

1. Dr. Noor Mohammad, IIITDM

##### Internal Experts

1. Dr. A. Suresh, SRMIST

<b>Course Code</b>	21CSE486T	<b>Course Name</b>	OPERATION SYSTEM SECURITY	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>														
<b>CLR-1:</b>	Outline the fundamentals of efficient security operations in a center													<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>												
<b>CLR-2:</b>	Illustrate the basics of Infrastructure and Organizational Structures																											
<b>CLR-3:</b>	Emphasize the most valuable resource person in an organization																											
<b>CLR-4:</b>	Explain the working of Daily Operations, Training and Metrics.																											
<b>CLR-5:</b>	Acquire knowledge on the concepts of Intelligence and Outsourcing																											
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
<b>CO-1:</b>	Understand the basic concepts of operation system security on centers													2	-	-	-	-	-	-	-	-	-	-				
<b>CO-2:</b>	Identify infrastructural requirements, structures, and operational procedures													-	-	3	-	-	-	-	-	-	-	-				
<b>CO-3:</b>	Classify the operational security functions and management procedures.													-	-	3	-	-	-	-	-	-	-	3				
<b>CO-4:</b>	Identify and acquire knowledge on daily operations and trainings.													2	-	-	-	3	-	-	-	-	-	-	3			
<b>CO-5:</b>	Understanding the concept of system metrics, thresholds, outsourcing and deliverables													2	-	3	-	3	-	-	-	-	-	-	-			

**Unit-1 - Operating System Security** 9 Hour  
Defining an operations Center, Purpose of the Operation Center, Emergency Operations Center, Mission Operations Center, Threat Operations Center, Network Operations Center, Let Us Build a SOC, Logs, Events, Alerts, False Positive, True Positive, False Negative , True Negative, Incidents , Problems, Define your Requirements, Identify your Customers: Internal versus External Customers, Human Resources, Legal, Audit, Engineering /R&D, IT, External Customers, Customer Objectives, Service level Agreements, Build and Document your Use cases.

**Unit-2 - Infrastructure Security** 9 Hour  
Organisational Infrastructure – Operations Infrastructure, Support Infrastructure , Organisational Security Infrastructure, Perimeter Defences, Network Defences, Host Defences, Application Defences Data Defences, Policies and Procedures, Security Architecture , Siem/Log Management, Operation Center Infrastructure Ticketing Systems, Building the Ticket System, Subject, Parsed Values from Events, Time Ticket Created, User |Group | Queue, Source(SIEM, Email, Phone ), Category, Status, Reason Codes, Acknowledgement/Ticket Feedback, Workflow and Automation, Portal Interference, Mobile Devices, Support Infrastructure, Physical, Private SOC Network, Video Projectors, Labs. Different Reporting Lines, Legal, CISO, CIO, Compliance, SOC Organisation, Engineering, Security Architecture, Security Monitoring and Analysis, responsibility, Authority, Fulfilling needs.

**Unit-3 - Mostvaluable resource** 9 Hour  
Operational Security, Culture, Personality, Core skill sets, Analysis, Security Analyst- Job Description Security Engineering, Security Operation Engineer- Job Description, Security Architect, Security Architect-Job Description, SOC Team Lead, SOC Team Lead – Job Description, SOC Management, SOC Manager- Job Description , SOC Games, Special Projects, Do not Forget your People.

<b>Unit-4 - Operations</b>	<b>9 Hour</b>
Problem and change Event Communications- Master stage Logs, Shift turnovers, Daily Operations Calls, Critical Bridges, IR, Detection, Confirmation, Analysis, Containment, Recovery, Review, Communication Plan, Regular Workshops, Checklists, Shift Schedules, Types of Shift Schedules, Other Shift Options, Follow the Sun, Shift Rotation, Dealing with Absenteeism. Internal Functional Training, Internal Skill set Training , Playbooks and Runbooks, Job Task Qualification Training, Tools and Product Training, Formal Training and Certifications , Schools and Universities, vendor Training , OJT, Training Plans, SOC shift Operations, Leaders, Customer Notifications, SOC Phones, Progression and Visibility, Training Exercises.	
<b>Unit-5 - Outsourcing</b>	<b>9 Hour</b>
Heads Up Display, Supervisor Metrics, Vulnerabilities, Vulnerability Prioritizing, Base CVSS2 Threshold, Temporal CVSS2 Threshold, Asset Prioritizing as a Part of Metrics, Historical Monitoring of Patches. Know Thyself, Known IP Space, Know Thy Enemy, Blacklists, Block Listing Projects, Other Types of Lists, Organisational and Industry Partners, Proactive Activity Monitoring. Types of MSSPs, - Strategic Partners, Pure Play Providers, Boutique Providers. Advantages of MSSP Outsourcing- Cost, Organisational, Enhanced Capabilities, SLA, Documentation, Disadvantages to MSSP Outsourcing, and Large Numbers of Customers. Lack of Dedicated Resources, Data Storage Issues, Costs, Quality of Work and Staffing, How the Services will be Delivered, people, Size Verses Experience, Service Execution, Tools, Similar Versus Larger MSSP, Security, DR, Exit Strategy, MSSP Selection, Providing the Service, Testing Your MSSP.	

<b>Learning Resources</b>	1. David Nathans <i>Designing and Building a Security Operations Center</i> , Elsevier Science - Syngress. 2. Gregory Jarvey and Scott McCoy, <i>Security Operations Center Guidebook A Practical Guide for a Successful SOC</i> · Elsevier Science- 2017. 3. Joseph Muniz, Gary McIntyre, Nadhem AlFardan, <i>Security Operations Center, Building, Operating, and Maintaining Your SOC</i> · Pearson Education- 2015.	4. Robert H. Deatherage, Jr. , <i>Security Operations an Introduction to Planning and Conducting Private Security Details for High-Risk Areas</i> · Taylor & Francis - 2021 5. Robert McCrie, <i>Security Operations Management</i> · Elsevier Science - 2011
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Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr S. Venkata Prasad, Tata Consultancy Services, Chennai	1. Dr. G. Srinivasan, IIITDM, Chennai	1. Dr.S.Murugaanandam, SRMIST.

<b>Course Code</b>	21CSE487T	<b>Course Name</b>	CYBER WARFARE	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>	<i>The purpose of learning this course is to:</i>	Program Outcomes (PO)												<b>Program Specific outcomes</b>
		1	2	3	4	5	6	7	8	9	10	11	12	
<b>CLR-1:</b>	Describe the relationships between cyber warfare, information assurance, information operations, and network-centric warfare													
<b>CLR-2:</b>	Develop and maintain an effective cybersecurity workforce prepared to support various cyber warfare activities													
<b>CLR-3:</b>	Apply international cybersecurity policy and doctrine to develop frameworks for effective deterrence and management of operational risk													
<b>CLR-4:</b>	Define technical and operational requirements for command & control, situational awareness, and decision support systems for operational cybersecurity organizations													
<b>CLR-5:</b>	Describe trends in the development of cyber warfare capabilities from an international perspective													

<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
<b>CO-1:</b>	Understand the cyber war and its importance, battlefield of cyber war.	-	-	2	-	-	-	-	2	-	-	-	-	-	-	-
<b>CO-2:</b>	Analyze the organized crimes in cyberspace and the role of cyber in Military Doctrines	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
<b>CO-3:</b>	Manage the development of cyber capabilities to meet weaponization standards	-	-	2	-	-	-	-	-	-	-	-	-	-	-	3
<b>CO-4:</b>	Identify and apply decision frameworks for ethical and legal concepts in the context of cyber warfare	-	-	-	-	-	-	-	2	-	-	-	-	-	-	3
<b>CO-5:</b>	Develop and maintain an effective cybersecurity workforce prepared to support various cyber warfare activities with the legal status	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-

#### **Unit-1 - Cyber Warfare, Threatscape and Cyberspace Battlefield** 9 Hour

What is Cyber Warfare? – What is Cyber Warfare? Have We Seen a Cyber War? Why Cyber Warfare Is Important? Introduction to Cyber Warfare Threatscape: definition of cyberwar, motivation, attackers, threats, Attack Methodology with the Tools and Techniques Used to Execute Them, Defense in Depth—How Organizations Defend Today (Defensive Mountain Range), What the Threat Is After (What We Should Focus on Defending). The Cyberspace Battlefield - Boundaries in Cyber Warfare, Where Cyber Fits in the War-Fighting Domains, Review of the Threat Actors, Fielding Systems at the Speed of Need.

#### **Unit-2 - Cyber Doctrine, Warrior and Accessing the problem** 9 Hour

Cyber Doctrine - Current U.S. Doctrine, Sample Doctrine/Strategy from Around the World, Key Military Principles That Must Be Adapted to Cyber Warfare, Guidance and Directives, Operations and Exercises. Cyber Warriors - What Does a Cyber Warrior Look Like? Differences from Traditional Forces, Present Cyber Warfare Forces, Staffing for Cyber War. Assessing the Problem - The Complex Domain of Cyberspace, Cyber Warfare in the 20th and 21st Centuries, China, Israel, Russia, The Second Russian-Chechen War (1997–2001), The Estonian cyber-attacks (2007), The Russia-Georgia War (2008), Iran, North Korea, Cyber Espionage, Titan Rain, Cyber Crime, Future Threats, Increasing Awareness, Critical Infrastructure, The Conficker Worm: The Cyber Equivalent of an Extinction Event? Africa: The Future Home of the World's Largest Botnet? The Way Forward.

<b>Unit-3 - Weapons – Logical, Physical and Psychological</b>	<b>9 Hour</b>
Logical Weapons - Reconnaissance Tools, DNS, Scanning Tools, Access and Escalation Tools, Exfiltration Tools, Sustainment Tools, Assault Tools, Obfuscation Tools. Physical Weapons - How the Logical and Physical Realms Are Connected? Infrastructure Concerns, Supply Chain Concerns, Tools for Physical Attack and Defense. Psychological Weapons - Social Engineering Explained, How the Military Approaches SE, How the Military Defends Against SE.	
<b>Unit-4 - Computer Network Exploitation, Defense and Non-State Actors</b>	<b>9 Hour</b>
Computer Network Exploitation - Intelligence and Counter-Intelligence, Reconnaissance, Surveillance. Computer Network Attack - Waging War in the Cyber Era, The Attack Process. Computer Network Defense - What We Protect, Security Awareness and Training, Defending Against Cyber Attacks. Non-State Actors in Computer Network Operations - Individual Actors, Corporations, Cyber Terrorism, Organized Cyber Crime, Autonomous Actors - The Rise of the Nonstate Hacker.	
<b>Unit-5 - Legal System Impacts and status of Cyber Warfare, Challenges and Future of Cyber War</b>	
Legal System Impacts - Legal Systems, Key U.S. Laws, Privacy Impacts, Digital Forensics. Ethics - Ethics in Cyber Warfare, Bellum Iustum (Just War Theory). The Legal Status of Cyber Warfare - Cyberspace Challenges - Cybersecurity Issues Defined, Interrelationship of Cybersecurity Challenges, Way Ahead. The Future of Cyber War - Emerging Trends, Trends Driving Where We Will Go	

<b>Learning Resources</b>	1. <i>Cyber Warfare</i> , 2nd Edition, by Jason Andress, Steve Winterfeld, Released October 2013, Publisher(s): Syngress, ISBN: 9780124166332. 2. <i>Inside Cyber Warfare</i> , 2nd Edition, Jeffrey Carr, Released December 2011, Publisher(s): O'Reilly Media, Inc. ISBN: 9781449310042 3. <i>The Basics of Cyber Warfare: Understanding the Fundamentals of Cyber Warfare in Theory and Practice</i> , Steve Winterfeld and Jason Andress, Elsevier, 2012, ISBN: 978012404737.	4. <i>Information Operations - Doctrine and Practice: A Reference Handbook</i> , Christopher Paul, Praeger Security International, 2008, ISBN: 0275995917. 5. <i>Law, Policy, and Technology: Cyberterrorism, Information Warfare and Internet Immobilization</i> , Pauline C. Reich, and Eduardo Gelstein, IGI Global, 2012, ISBN: 1615208313 6. <i>Information Warfare and Security</i> , Dorothy Denning, Addison Wesley Professional, 1998, ISBN: 0201433036
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Learning Assessment						
Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%
Level 2	Understand	25%	-	20%	-	25%
Level 3	Apply	30%	-	25%	-	30%
Level 4	Analyze	30%	-	25%	-	30%
Level 5	Evaluate	-	-	10%	-	-
Level 6	Create	-	-	5%	-	-
	Total	100 %		100 %		100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. N. Arun, Senior Software Engineer, Quick Heal		1. Vigneshwaran P, SRMIST

<b>Course Code</b>	21CSE488T	<b>Course Name</b>	HACKER MIND: PROFILING THE IT CRIMINAL	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>												
<b>CLR-1:</b>	Compare and contrast the differences between digital evidence and traditional evidence												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>											
<b>CLR-2:</b>	Critically evaluate standards and good practices for digital evidence and digital crimes																									
<b>CLR-3:</b>	Describe and critique digital crime process models																									
<b>CLR-4:</b>	Discuss data and identify data sources																									
<b>CLR-5:</b>	Discuss the ways in which digital evidence is authenticated																									
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	
<b>CO-1:</b>	Understanding the Concept of Cyber Criminology												-	-	2	-	-	-	-	-	-	-	-	-	-	
<b>CO-2:</b>	Identify the challenges faced nationally and internationally at combating cybercrime, and the steps being taken by organizations and law enforcement to address these challenges												-	-	-	-	-	-	2	-	-	-	-	-	-	
<b>CO-3:</b>	Identifying the Contemporary Forms of Crimes												-	-	2	-	-	-	-	2	-	-	-	-	-	3
<b>CO-4:</b>	Know psychology of cyber criminals.												-	-	2	-	-	-	-	-	-	-	-	-	-	3
<b>CO-5:</b>	Take what they have learned in class and apply it to cybercrime-related current events.												-	-	2	-	-	-	-	-	-	-	-	-	-	-

<b>Unit-1 - Principles and Concepts of Cyber Criminology</b>	9 Hour
Crime, Tort, Misdemeanour, Cyber Space, Cyber Crime, Cyber Criminology, Information Security, Penetration Testing, Incident Response, GRC, etc.- Conventional crimes vs. Cyber Crimes.	
<b>Unit-2 - Contemporary Forms of Crimes</b>	9 Hour
White Collar Crimes, Economic Offences, Organized Crimes, Terrorism, Crime and Media and other contemporary forms of crimes.	
<b>Unit-3 - Psychology of Cyber Criminals</b>	9 Hour
Types of Cyber Criminals – Modus Operandi of Cyber Criminals – Profiling of Cyber Criminals - Tools and Techniques adopted by Cyber Criminals – Psychological theories relating to cyber criminals.	
<b>Unit-4 - Cyber Crime</b>	9 Hour
Sociological and Criminological Perspectives – Causes of Cyber Crimes - Criminological Theories and Cyber Crime – Routine Activity Theory, Social Learning Theory, Differential Association Theory, Differential Opportunity Theory, Media and Crime and latest theories and other related theories.	
<b>Unit-5 - Crime Prevention</b>	9 Hour
Crime and sense of security - Social control and crime prevention - Community and crime prevention - Contemporary crime prevention strategies Tutorial The Role of Criminal Justice Administration and Cyber Crimes a. Police – Organizational structure of Police in India – Different wings in the States and Districts and their functions - Police & Law Enforcement – F.I.R. – cognizable and non-cognizable offences, bail able and non-bail able offences – arrest , search, seizure – Interrogation of suspects and witnesses – charge sheet – Cybercrime cells – structure & investigation of cybercrime cases . b. Judiciary - Different types of courts – Cyber Appellate Court / Tribunals / Powers – Proceedings in the court before trial, after trial, plea of guilty, sentencing. c. The Role of N.G.O.s in the Prevention of Cyber Crimes d. The Role of Victims of Cyber Crimes in the Criminal Justice Administration	

<b>Learning Resources</b>	<p>1. Clifford, Ralph. 2021. <i>Cybercrime: The Investigation, Prosecution and Defense of a Computer-Related Crime</i>. Second Edition. Carolina Academic Press.</p> <p>2. Holt, Thomas. 2019. <i>Crime On-Line: Correlates, Causes and Context</i>. Second Edition. Carolina Academic Press.</p>	<p>3. McQuade, Samuel. 2006. <i>Understanding and Managing Cybercrime</i>. Pearson.</p> <p>4. Yar, Majid. 2013. <i>Cybercrime and Society</i>. Second Edition. Sage Publications.</p>
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Venkata Prasad S, TATA consultancy services, svenkataprasad@yahoo.com	<p>1. Dr. Abhishek Srivastava, asrivastava@iiti.ac.in, CSE, IIT, Indore.</p> <p>2. Dr. A. Amuthan, amuthan@pec.edu, Pondicherry Engineering College, Pondicherry.</p>	1. Dr.M B Mukesh Krishnan, SRMIST

<b>Course Code</b>	21CSE489T	<b>Course Name</b>	MOBILE AND WIRELESS SECURITY	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Outline the fundamentals Mobile and Wireless Networks												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Illustrate the importance of security and explain about Mobile Security															
<b>CLR-3:</b>	Introduce and explain about WiFi, Bluetooth security in Wireless Networks															
<b>CLR-4:</b>	Explain WiMAX and LTE Security in Wireless Networks															
<b>CLR-5:</b>	Implement about the Security of Downloadable Applications															

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>	
<b>CO-1:</b>	Understanding the modern concept and foundation of Mobile security												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>
<b>CO-2:</b>	Identify and classify various next generation networks														
<b>CO-3:</b>	Analyze various sources of vulnerabilities from Mobile.														3
<b>CO-4:</b>	Analyze various sources of vulnerabilities from Wireless Networks														3
<b>CO-5:</b>	Create network security attacks and its countermeasures														

<b>Unit-1 - Introduction to Mobile and Wireless Networks</b>	<b>9 Hour</b>
Mobile Cellular Networks – (Generation Networks), 802.11 Standards –802.11,802.15, 802.16, 802.20, 802.21, IEEE wireless networks, Mobile Internet networks, Attacks and defence strategies on Cellular networks, Security Issues in Mobile Communication: Mobile Communication History, Security – Wired Vs Wireless, Security Issues in Wireless and Mobile Communications, Security Requirements in Wireless and Mobile Communications, Security for Mobile Applications, Advantages and Disadvantages of Application – level Security	

<b>Unit-2 - Mobile Security</b>	<b>9 Hour</b>
Basics on security, Secure communication protocols, Importance of Authentication and Authorization, Challenges of Cybersecurity, Incident Response Process, Security risks in Mobile, Security in the GSM, GPRS security , 3G security ,Android Architecture, and Security Model for Android, Fundamentals of Android Development, Android Rooting, Intercepting Android Traffic, Attacks on Android, and Security Model for iOS, Case Studies on Mobile Security	

<b>Unit-3 - Wireless Security</b>	<b>9 Hour</b>
Wi-Fi Security: Introduction, Attacks on wireless networks: Active, passive attacks, DoS attacks, TCP, Trojan and Dictionary Attacks, Security in the IEEE 802.11 standard, Security in 802.1x, Security in 802.11i, Authentication in wireless networks, Layer 3 security mechanisms. Bluetooth Security: Introduction, Bluetooth technical specification, Bluetooth security	

<b>Unit-4 - WiMAX and LTE Security</b>	<b>9 Hour</b>
Introduction, WiMAX architecture and OFDM, Security risks involved in 802.16-2004, Security risks involved in 802.16e Security in GSM, UMTS, GPRS, VoIP security, LTE security	

<b>Unit-5 - Security of Downloadable Applications</b>	<b>9 Hour</b>
Introduction, Security policy, The implementation of a security policy, Execution environments for active contents, Validation of active contents, Detection of attacks	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Hakima Chaouchi, Maryline Laurent-Maknaviciu <i>Wireless and Mobile Network Security</i>, Wiley-ISTE, 2013.</li> <li>2. M. Au, R. Choo and G. Kessler, <i>Mobile security and privacy</i>. Cambridge, MA: Syngress, 2017.</li> <li>3. J. Joshi, <i>Network Security</i>. New York: Elsevier, 2009.</li> <li>4. S. AHMADI, <i>MOBILE WIMAX</i>. [Place of publication not identified]: ELSEVIER ACADEMIC Press, 2016.</li> <li>5. <a href="https://onlinecourses.nptel.ac.in/noc21_cs16/preview">https://onlinecourses.nptel.ac.in/noc21_cs16/preview</a></li> <li>6. <a href="https://blog.rsisecurity.com/what-is-the-mobile-security-framework/">https://blog.rsisecurity.com/what-is-the-mobile-security-framework/</a></li> <li>7. <a href="https://wimaxforum.org/">https://wimaxforum.org/</a></li> <li>8. <a href="https://www.coursera.org/lecture/security-awareness-training/mobile-devices-and-security-EMjmM">https://www.coursera.org/lecture/security-awareness-training/mobile-devices-and-security-EMjmM</a></li> </ol>
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<b>Learning Assessment</b>		<b>Continuous Learning Assessment (CLA)</b>				<b>Summative Final Examination (40% weightage)</b>	
<i>Bloom's Level of Thinking</i>	<i>Formative CLA-1 Average of unit test (50%)</i>	<i>Life-Long Learning CLA-2 (10%)</i>					
		<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>
Level 1	<i>Remember</i>	15%	-	15%	-	15%	-
Level 2	<i>Understand</i>	25%	-	20%	-	25%	-
Level 3	<i>Apply</i>	30%	-	25%	-	30%	-
Level 4	<i>Analyze</i>	30%	-	25%	-	30%	-
Level 5	<i>Evaluate</i>	-	-	10%	-	-	-
Level 6	<i>Create</i>	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Dr. Venkata Prasad S, TATA consultancy services, svenkataprasad@yahoo. com	1. Dr. Abhishek Srivastava, <a href="mailto:asrivastava@iiti.ac.in">asrivastava@iiti.ac.in</a> ,CSE,IIT, Indore. 2. Dr. A. Amuthan, <a href="mailto:amuthan@pec.edu">amuthan@pec.edu</a> , Pondicherry Engineering College, Pondicherry.	1. Dr.Mary Subaja Christo, SRMIST

<b>Course Code</b>	21CSE490J	<b>Course Name</b>	WINDOWS AND LINUX INTERNALS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 0	P 2	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>																																																		
<b>CLR-1:</b>	Understand the basic concepts of windows operation system tools and terminologies												<b>CLR-2:</b>	Exploring the operating system architecture and kernel drivers												<b>CLR-3:</b>	Classify the operational management services in windows operating system.												<b>CLR-4:</b>	Acquire knowledge on Linux operating system basics.												<b>CLR-5:</b>	learn the technical aspects and to apply Linux operating system kernel operations and file systems.											
<b>Engineering Knowledge</b>	1	2	3	4	5	6	7	8	9	10	11	12																																																				

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CO-1:</b>	Inspect and apply the basic concepts of windows operation system tools and terminologies	-	-	2	-	-	Modern Tool Usage	The engineer and society	Environment & Sustainability	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
<b>CO-2:</b>	Recognize and clarify the operating system architecture and kernel drivers	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
<b>CO-3:</b>	Demonstrate foundation knowledge of the operational management services in windows operating system.	-	-	-	-	-	-	-	2	-	-	-	-	-	-	3
<b>CO-4:</b>	Inspect and apply the basic concepts on Linux operating system basics.	-	-	2	-	-	-	-	-	-	-	-	-	-	-	3
<b>CO-5:</b>	Exploring the Linux operating system kernel operations and file systems.	-	-	-	-	-	-	-	2	-	-	-	-	-	-	3

**Unit-1 - Operating System Security** 12 Hour  
 Concepts and Tools, Windows Operating System Versions, Foundation Concepts and Terms, Windows API, Services, Functions, and Routines, Processes, Threads, and Jobs, Virtual Memory, Kernel Mode vs. User Mode, Terminal Services and Multiple Sessions, Objects and , Security ,Registry , Unicode , Digging into Windows Internals , Reliability and Performance Monitor , Kernel Debugging , Windows Software Development Kit ,Windows Driver Kit , Sysinternals Tools.

**Unit-2 - Windows Architecture** 12 Hour  
 System Architecture, Requirements and Design Goals, Scalability, Differences Between Client and Server Versions, Operating System Model, Architecture Overview, Portability , Symmetric Multiprocessing , Checked Build, Key System Components , Environment Subsystems and Subsystem DLLs , Ntdll.dll ,Executive , Kernel ., Hardware Abstraction Layer, Device Drivers,

**Unit-3 - Windows Management** 12 Hour  
 Management Mechanisms , The Registry , Viewing and Changing the Registry , Registry Usage , Registry Data Types , Registry Logical Structure,Transactional Registry (TxR) , Monitoring Registry Activity , Registry Internals , Services , Service Applications , The Service Control Manager ,www.it-ebooks.info viii Table of Contents Service Startup , Startup Errors ,Accepting the Boot and Last Known Good, Service Failures , Service Shutdown , Shared Service Processes , Service Tags, Service Control Programs, Windows Management Instrumentation , Providers , The Common Information Model and the Managed Object Format Language. , Class Association, WMI Implementation. , WMI Security, Windows Diagnostic Infrastructure. ,WDI Instrumentation, Diagnostic Policy Service ,Diagnostic Functionality

<b>Unit-4 - Linux Operating System</b>	<b>12 Hour</b>
Booting, Process and Interrupt Management, Virtual Filesystem (VFS, Linux Page Cache, IPC mechanisms., Booting, Building the Linux Kernel Image, Booting: Overview, Booting: BIOS POST, Booting: bootsector and setup, Using LILO as a bootloader, High level initialization, SMP Bootup on x86, Freeing initialisation data and code, Processing kernel command line, Process and Interrupt Management., Task Structure and Process Table, Creation and termination of tasks and kernel threads,, Scheduler, Linux linked list implementation, Wait Queues, Kernel Timers., Bottom Halves, Task Queues.,Tasklets, ,, How System Calls Are Implemented on i386 Architecture, Atomic Operations	
<b>Unit-5 - Linux Kernel</b>	<b>12 Hour</b>
Linux Versus Other Unix-Like Kernels, Hardware Dependency, Linux Versions, Basic Operating System Concepts, An Overview of the Unix File system, An Overview of Unix Kernels , Memory Addressing, Memory Addresses , Segmentation in Hardware, Segmentation in Linux , Paging in Hardware , Paging in Linux , Processes, Processes, Lightweight Processes, and Threads , Process Descriptor , Process Switch , Creating Processes , Destroying Processes	

<b>Learning Resources</b>	1. Solomon, David A., Mark E. Russinovich, and Alex Ionescu. <i>Windows internals</i> . Microsoft Press, 2009.	4. Bovet, Daniel P., and Marco Cesati. <i>Understanding the Linux Kernel: from I/O ports to process management</i> . "O'Reilly Media, Inc.", 2005.
	2. Yosifovich, Pavel, David A. Solomon, and Alex Ionescu. <i>Windows Internals, Part 1: System architecture, processes, threads, memory management, and more</i> . Microsoft Press, 2017.	5. Mauerer, Wolfgang. <i>Professional Linux kernel architecture</i> . John Wiley & Sons, 2010.
	3. Mohanta, Abhijit, and Anoop Saldanha. "Windows Internals." <i>Malware Analysis and Detection Engineering</i> . Apress, Berkeley, CA, 2020. 123-162.	

Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	-	15%	15%	-		
Level 2	Understand	25%	-	-	20%	25%	-		
Level 3	Apply	30%	-	-	25%	30%	-		
Level 4	Analyze	30%	-	-	25%	30%	-		
Level 5	Evaluate	-	-	-	10%	-	-		
Level 6	Create	-	-	-	5%	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr S, Venkata Prasad, TCS, Chennai	1. Dr. T Veera kumar, ECE, NIT, GOA.	1. Dr S Murugaanandam, SRMIST

<b>Course Code</b>	21CSE491T	<b>Course Name</b>	CYBER CRIMES AND DIGITAL FORENSIC	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	To Study about the Cyber Crime												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	To learn and understand cybercrimes occurrence															
<b>CLR-3:</b>	To study the fundamentals of Computer Forensics															
<b>CLR-4:</b>	To learn, analyze and validate Forensics Data															
<b>CLR-5:</b>	To study the tools and tactics associated with Cyber Forensics															

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CO-1:</b>	Understanding concepts related to cyber world and cyber law in general												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CO-2:</b>	Develop competitive edge on various facets of cyber crimes															
<b>CO-3:</b>	Understand data and identify data sources															
<b>CO-4:</b>	Understand and able to classify digital evidence															
<b>CO-5:</b>	Compare and contrast the differences between digital evidence and traditional evidence															

<b>Unit-1 - Criminal Law &amp; Prevention</b>	<b>9 Hour</b>
Introduction to Criminal law, Nature of Jurisprudence, Participants and Steps in the Criminal Justice Process, Theories of Punishment I: Retribution and Prevention, Theories of Punishment II: Rehabilitation and Incapacitation, Sentencing and Punishment, Correlation between law and social change, Legal evolution and social complexity, Symbolic and instrumental uses of law, Problems in the study of impact and effectiveness.	

<b>Unit-2 - Cyber Law &amp; IT Act 2000</b>	<b>9 Hour</b>
Introduction to Cyber Law, Evolution of the Information Technology Act, Genesis and Necessity, Salient features of the Information Technology Act, 2000, Various authorities under Information Technology act, Powers, Penalties & Offences, Amendments, Cyber Space Jurisdiction, Jurisdiction Issues under IT Act, 2000, Traditional Principles of Jurisdiction, Extra Terrestrial Jurisdiction, Case Laws on Cyber Space Jurisdiction.	

<b>Unit-3 - Cyber Forensics Fundamentals</b>	<b>9 Hour</b>
Cyber Forensic Basics, Introduction to Cyber Forensics, Storage Fundamentals, File System Concepts, Data Recovery, Operating System, Software, Basic Terminology, Applications	

<b>Unit-4 - Recovery Policies</b>	<b>9 Hour</b>
Data and Evidence Recovery, Introduction to Deleted File Recovery, Formatted Partition Recovery, Data Recovery Tools, Data Recovery Procedures and Ethics, Preserve and safely handle original media, Document a "Chain of Custody", Complete time line analysis of computer files based on file creation, file modification and file access, Recover Internet Usage Data, Recover Swap Files/Temporary Files/Cache Files, Introduction to Encase Forensic Edition, Forensic Tool Kit (FTK), Use computer forensics software tools to cross validate, findings in computer evidence-related case.	

<b>Unit-5 - Investigation Models</b>	<b>9 Hour</b>
Cyber Forensics Investigation and Decryption methods, Introduction to Cyber, Forensic Investigation, Investigation Tools, e-Discovery, Digital Evidence Collection, Evidence Preservation, Fundamentals of File Systems, Network Forensics Artefacts, Mobile Device Forensics, Digital Forensics writing Reports, E-Mail Investigation, E-Mail Tracking, IP Tracking, E-Mail Recovery, Encryption, Search and Seizure of Computers, Recovering deleted evidences, Password Cracking	

<b>Learning Resources</b>	1. David J. Loundy, Computer Crime, Information Warfare, and Economic Espionage, Carolina Academic Press (2018) (ISBN: 0890891109). 2. Jack Balkin, Et Al. Eds., And Cybercrime: Digital Cops In A Networked World (Nyu Press 2017) (ISBN: 0814799833). 3. Orin S. Kerr, Computer Crime Law: American Casebook Series (2016) (ISBN: 0314144005).	4. Orin S. Kerr, Computer Crime Law: American Casebook Series (2016) (ISBN: 0314144005). 5. Ralph D. Clifford, Cybercrime: The Investigation, Prosecution and Defense Of A Computer-Related Crime (Second Edition 2016) (ISBN: 0890897239). 6. Samuel C. Mcquade, Iii, Understanding and Managing Cybercrime (2016) (ISBN: 020543973x).
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr.Balan C, Scientist F, CDAC, cbalan@cdac.in 2. Mr.E.Balaji, IT Analyst, Tech Mahindra	1. Dr. S. Janakiraman, Associate Professor, Pondicherry University, sj.dbt@pondiuni.edu.in 2. Dr. R.Shyamala, Associate Professor, Anna University College of Engineering Tindivanam, vasuchaaru@gmail.com	1. Dr. C.N.S.Vinoth Kumar SRMIST 2. Dr.R.Naresh, SRMIST

<b>Course Code</b>	21CSE492T	<b>Course Name</b>	CYBER CRIMES AND CYBER SECURITY	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	introduce the cyber world and cyber law in general												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	explain about the various facets of cyber crimes															
<b>CLR-3:</b>	enhance the understanding of problems arising out of online transactions and provoke them to find solutions															
<b>CLR-4:</b>	Exhibit knowledge to secure corrupted systems, protect personal data, and secure computer networks in an organization															
<b>CLR-5:</b>	Practice with an expertise in academics to design and implement security solutions															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CO-1:</b>	Understanding concepts related to cyber world and cyber law in general												-	-	-	-
<b>CO-2:</b>	Develop competitive edge on various facets of cyber crimes												-	-	-	-
<b>CO-3:</b>	Analyze and evaluate the cyber security needs of an organization												-	-	-	3
<b>CO-4:</b>	Measure the performance and troubleshoot cyber security systems.												-	-	-	3
<b>CO-5:</b>	Implement cyber security solutions and use of cyber security, information assurance, and cyber/computer forensics software/tools.												-	-	-	3

<b>Unit-1 - Criminal Law &amp; Judicial Procedure</b>	<b>9 Hour</b>
Introduction to Criminal Law, History of criminal law, Penology and Treatment of Offender, Judicial process as an instrument of social ordering, Indian Penal Code, Indian Evidence Act, Legislature and Judiciary, Nature, content and justiciability, Directive Principles of State Policy, Inter relationship between Fundamental Rights and DPSP, Definitions under Code of Criminal Procedure -1973	

<b>Unit-2 - Cyber Law &amp; IT Act 2000</b>	<b>9 Hour</b>
Introduction to Cyber Law, Evolution of the Information Technology Act, Genesis and Necessity, Salient features of the Information Technology Act – 2000, Various authorities under Information Technology act, Powers, Penalties & Offences, Amendments, Cyber Space Jurisdiction, Jurisdiction Issues under IT Act, 2000, Traditional Principles of Jurisdiction, Extra Terrestrial Jurisdiction, Case Laws on Cyber Space Jurisdiction	

<b>Unit-3 - Security Risks and Threats</b>	<b>9 Hour</b>
Security Threat Management, Risk Assessment, Forensic Analysis, Security threat correlation, Threat awareness, Vulnerability sources and assessment, Vulnerability assessment tools, Threat identification, Threat Analysis, Threat Modeling, Model for Information Security Planning.	

<b>Unit-4 - Security Policies</b>	<b>9 Hour</b>
Security Elements, Authorization and Authentication, types, policies and techniques, Security certification, Security monitoring and Auditing, Security Requirements Specifications, Security Policies and Procedures, Firewalls, IDS, Log Files, HoneyPots	

**Unit-5 - Trusted Security Models** 9 Hour

Access control, Trusted Computing and multilevel, Security models, Trusted Systems, Software security issues, Physical and infrastructure security, Human factors, E-Mail Recovery, Encryption, Email, and Internet use policies

<b>Learning Resources</b>	1. Swiderski, Frank and Sydex, "Threat Modeling", Microsoft Press, 2018. 2. William Stallings and Lawrie Brown, "Computer Security: Principles and Practice", Prentice Hall, 2018.	3. Joseph M Kizza, "Computer Network Security", Springer Verlag, 2019 4. Thomas Calabres and Tom Calabrese, "Information Security Intelligence: Cryptographic Principles & Application", Thomson Delmar Learning, 2018.
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)	Life-Long Learning CLA-2 (10%)							
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Balan C, Scientist F, CDAC, cbalan@cdac.in 2. Mr.E.Balaji, IT Analyst, Tech Mahindra	1. Dr. S. Janakiraman, Associate Professor, Pondicherry University, sj.dbt@pondiuni.edu.in 2. Dr. R.Shyamala, Associate Professor, Anna University College of Engineering Tindivanam, vasuchaaru@gmail.com	1. Dr. C.N.S.Vinoth Kumar, SRMIST 2. Dr.P.Madhavan SRMIST

**ACADEMIC CURRICULA**

**UNDERGRADUATE/ INTEGRATED POST  
GRADUATE DEGREE PROGRAMMES**

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume - 11G

(Syllabi for Computer Science and Engineering w/s in  
Information Technology Programme Courses)



**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

# ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021



**SRM**

INSTITUTE OF SCIENCE & TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

<b>Course Code</b>	21CSC314P	<b>Course Name</b>	BIG DATA ESSENTIALS	<b>Course Category</b>	C	PROFESSIONAL CORE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Identify the basics of big data and hadoop												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	Demonstrate the tools and techniques in big data												-	-	-										
<b>CLR-3:</b>	Inspect the query language based on big data application												-	-	-										
<b>CLR-4:</b>	Interpret classification and clustering in big data application												-	-	-										
<b>CLR-5:</b>	Experiment the Big data Visualization tools												-	-	-										
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Acquire knowledge on the basics of big data												2	-	-	3	-	-	-	-	-	-	-	2	
<b>CO-2:</b>	Examine the tools and techniques using Hadoop, HDFS, and Map Reduce												-	-	-	3	3	-	-	-	-	-	-	3	
<b>CO-3:</b>	Build any database for the application in big data												2	-	-	3	-	-	-	-	-	-	-	3	
<b>CO-4:</b>	Apply different classification and clustering algorithms using data sets in an application												-	-	-	3	-	-	-	-	-	-	-	3	
<b>CO-5:</b>	Analyze the Visualization techniques in big data												2	-	-	3	3	-	-	-	-	-	-	-	3

<b>Unit-1 - Introduction</b>	<b>9 Hour</b>
Introduction to Big Data, Impact of Big Data, Parallel Processing, and Data Parallelism, Tools of Big Data, Introduction to the Hadoop Ecosystem, Introduction to MapReduce, The Hadoop Ecosystem/Common components: Introducing HDFS, Hive, HBase, and Spark, other modules, Installing Hadoop	
<b>Unit-2 - Hadoop Distributed File System</b>	
Features of HDFS, HDFS Commands, Retrieving file data from HDFS using Python Snakebite, Deleting files in HDFS using Python Snakebite, Map Reduce and Spark RDD Big Data, Working with HDFS, Working with HBase, Difference between HDFS and HBase, Hadoop Word Count using Map Reduce, Matrix Multiplication using Map Reduce	
<b>Unit-3 - Pig Programming</b>	
Introduction to Pig, Parallel processing using Pig, Pig Latin-Input and output, Hive: Introduction, data types and file formats, QL-data definition, data manipulation, QL views, indexes, Hive queries with partitioning.	
<b>Unit-4 - Spark Framework</b>	
GPU Computing, CUDA Programming model, Multiplication in CUDA, CUDA Memory model, Shared memory matrix multiplication Writing Spark application, Spark programming in R, Scala, Python, Java, Streaming application, Classification and Clustering in Big data, K-Means clustering, Decision Tree Classification, Naive Bayes Classification.	
<b>Unit-5 – Big Data Visualization</b>	
Introduction to big data visualization, Tree Maps, Maps, Gauge, Sunburst, Different visualization tools, Creating Visualization in Tableau, Different visualization methods in Tableau	

<b>Learning Resources</b>	<p>7. Sima Acharya, Subhashini Chellappan," BIG Data and Analytics" Wiley Publication, 2020.</p> <p>8. Michael Minelli,Michele Chambers, AmbigaDhiraj, "BigData, BigAnalytics - Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley Publication, 2018.</p> <p>9. Thomas Erl, "Big Data Fundamentals-Concepts, Drivers and Techniques", Pearson publication, 2016.</p> <p>10. Kyle Banker, PeterBakkum, Shaun Verch," MongoDB in Action" Dream tech Press publication 2016.</p> <p>11. Achari, Shiva "Hadoop Essentials" Birmingham, UK: Packt Publishing. 2015.</p> <p>12. Tom White, "HADOOP: The Definitive Guide", O Reilly 2012.</p>	
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Learning Assessment								
Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
	Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20%)			
	Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	15%	-	-	15%	-	15%	-
Level 2	Understand	25%	-	-	20%	-	20%	-
Level 3	Apply	30%	-	-	25%	-	25%	-
Level 4	Analyze	30%	-	-	25%	-	25%	-
Level 5	Evaluate	-	-	-	10%	-	10%	-
Level 6	Create	-	-	-	5%	-	5%	-
	Total	100 %		100%		100%		-

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
2. Kumanan P, Project Manager, CTS, Chennai	2. Dr.V.Vijayarajan, Associate Professor/HOD, Vellore Institute of Technology, Vellore	2. Mrs.V.Vijayalakshmi, SRMIST

<b>Course Code</b>	21CSC317J	<b>Course Name</b>	INFORMATION RETRIEVAL TECHNIQUES	<b>Course Category</b>	C	PROFESSIONAL CORE	L 2	T 0	P 2	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Understand the basics and importance of Information Retrieval												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	Analyze a problem based on fitting an appropriate modeling and retrieval evaluation to its solution																								
<b>CLR-3:</b>	Apply machine learning techniques for classification and clustering of Information																								
<b>CLR-4:</b>	Implementation of various search engine system operations																								
<b>CLR-5:</b>	Apply knowledge of Retrieving information on Text models and various recommender systems																								
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Define the basic methods of Information Retrieval and their importance																								
<b>CO-2:</b>	Interpret the Modeling methods and Evaluation of Information Retrieval																								
<b>CO-3:</b>	Infer appropriate methods for indexing, classification, and clustering																								
<b>CO-4:</b>	Clarify the various search engine system operations																								
<b>CO-5:</b>	Demonstrate recommender systems and language models																								

**Unit-1 - Introduction** 12 Hour  
Information Retrieval: Definition, Objectives, Functional Overview, Relationship to DBMS – Early Developments – Areas and Applications of Information Retrieval- Issues with IR – The IR Search Architecture - Data Retrieval and Visualization- Information versus Data Retrieval

**Unit-2 - Modeling and Performance Evaluation** 12 Hour  
IR Models – Boolean Model - Term Weighting – Vector Space Model – Probabilistic Model – Language Models – Neural Network Model – Text Processing and Retrieval Models – Retrieval Metrics – Query Processing and Refinement Techniques - Query Optimization - Precision -Recall - F-Measure

**Unit-3 - Indexing and Data Mining Techniques** 12 Hour  
Indexing: Introduction - Dictionaries - Inverted Files - Encoding - Static and Dynamic Inverted Indices - Scalable Indexing - Index Compression - Classification: K- Nearest Neighbor - Naïve Bayes - Support Vector Machines- Clustering: Partitioning method - K- Means Clustering - Hierarchical Clustering

**Unit-4 - Search Engines** 12 Hour  
The Web – History of Web - Searching the Web - Structure of the Web - Search Engine Architectures — Search Engine Ranking – Link-based Ranking – Simple Ranking Functions – Static and Dynamic Ranking - Search Engine Optimization - Google Search Engine - Web Crawler

**Unit-5 - Text Retrieval Model and Recommendations System** 12Hour  
Natural Language Processing in IR - Basic Document Retrieval - Stemming - n-gram models - Document Scoring - Document as a Vector - Token Recognition- Document Scoring -Document as a Vector - Advance Topics: Recommendation Systems - Sentimental Analysis - Recommender Systems Functions

<b>Practice:</b>						
Practice 1: Case Study on Data Retrieval Techniques Practice 2: Case Study on Various Data Visualization tools Practice 3: Extraction of Raw Data Practice 4: Implementation of Term Weighting Practice 5: Implementation of Text Processing Model Practice 6: Implementation of Neural Network Model Practice 7: Implementation of Scalable Indexing Practice 8: Implementation of Classification Technique on a dataset	Practice 9: Implementation of the Clustering technique on a dataset Practice 10: Case Study on Implementation of Various search engines Practice 11: Implementation of Page Ranking Algorithm on a search engine Practice 12: Implementation of Web Crawler Practice 13: Implementation of Basic Document Retrieval Practice 14: Case Study on various Recommendation Systems Practice 15: Implementation of Sentimental Analysis					
<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Ricardo Baeza-Yates and Berthier Ribeiro-Neto, –Modern Information Retrieval: The Concepts and Technology behind Search, Second Edition, ACM Press Books, 2011.</li> <li>2. Stefan Buetzcher, Charles L. A. Clarke and Gordon V. Cormack, –Information Retrieval: Implementing and Evaluating Search Engines, The MIT Press, 2016</li> <li>3. Jaime Spooner - Modern Information Retrieval, Exclic Press, 2019.</li> <li>4. Yates - Modern Information Retrieval, Pearson India, 1<sup>st</sup> Edition, 2016.</li> <li>5. Kowalski Gerald Et Al - Information Retrieval Architecture and Algorithms, Springer India, 1<sup>st</sup> Edition, 2013.</li> <li>6. Ricardo Baeza, Yates - Modern Information Retrieval: The Concepts and Technology Behind Search, Addison-Wesley Professional; 2nd edition, 2011</li> <li>7. Ricci, F. Rokach, L. Shapira, B. Kantor, –Recommender Systems Handbook, First Edition, 2011.</li> <li>8. Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütze, Introduction to Information Retrieval, Cambridge University Press. 2008.</li> <li>9. C. Manning, P. Raghavan, and H. Schütze, –Introduction to Information Retrieval, Cambridge University Press, 2008.</li> </ol>					
<b>Learning Assessment</b>						
Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1 <i>Remember</i>	15%	-	-	10%	25%	
Level 2 <i>Understand</i>	30%	-	-	25%	30%	
Level 3 <i>Apply</i>	30%	-	-	30%	25%	
Level 4 <i>Analyze</i>	25%	-	-	25%	20%	
Level 5 <i>Evaluate</i>	-	-	-	10%	-	
Level 6 <i>Create</i>	-	-	-	-	-	
Total	100 %		100 %		100 %	
<b>Course Designers</b>						
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>				
1. Mr. K. Arul, Project Manager, ANCIT Consulting, Bangalore 2. Mr. Gopinath Balu, Saama Technologies	1. Dr. D. Karthika Renuka, Professor, PSG College of Technology 2. Dr. A. Balasundaram, Assistant Professor (Gr-III), VIT Chennai	1. Dr. V.M. Gayathri, SRMIST 2. Dr. P. Supraja, SRMIST				

# ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021



**SRM**

INSTITUTE OF SCIENCE & TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

<b>Course Code</b>	21CSE267T	<b>Course Name</b>	STATISTICS FOR MACHINE LEARNING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Grasp the basics of statistics for machine learning												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Understand the concepts of machine learning models and supervised learning															
<b>CLR-3:</b>	Familiarize the unsupervised learning techniques															
<b>CLR-4:</b>	Gain knowledge in tree-based machine learning models															
<b>CLR-5:</b>	Utilize the reinforcement learning and recommendation Engines															

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CO-1:</b>	Acquire the knowledge on Statistics Machine Learning Terminologies.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CO-2:</b>	Perceive the concepts about the Machine Learning Models and Supervised Learning Technique															
<b>CO-3:</b>	Implement the Unsupervised Learning Techniques															
<b>CO-4:</b>	Apply the knowledge in tree-based machine learning models															
<b>CO-5:</b>	Analyze the concepts of Reinforcement Learning and Recommendation Engines															

<b>Unit-1 - Introduction to Statistical Terminology</b>	<b>9 Hour</b>
Statistical terminology for model building and validation- Major difference between statistical modeling and machine learning- Machine learning terminology - Steps in Machine learning development and deployment- Statistical fundamentals and terminology for model building and validation.	
<b>Unit-2 - Machine Learning Models and Supervised Learning</b>	
Regression in machine learning models-Types of Regression-Linear Regression-Simple Linear Regression-Multiple Linear Regression-Ridge and Lasso Regression-Logistic Regression, Supervised Learning - K-Nearest Neighbor- Naive Bayes-Support Vector Machine (SVM)	
<b>Unit-3 - Unsupervised Learning</b>	
K-means Clustering, Principal Component Analysis (PCA), Singular Value decomposition (SVD), Deep auto encoders, Deep auto encoders applied on handwritten digits using Keras	
<b>Unit-4 - Tree based Machine learning Models</b>	
Ecision Tree Classifier-Random Forest Classifier-Bagging Classifier-AdaBoost Classifier-Gradient Boost Classifier.	
<b>Unit-5 - Reinforcement Learning and Recommendations</b>	
Introduction to Reinforcement Learning-Characteristics of Reinforcement Learning-Reinforcement Learning Basics-Category1. Value Based- Category 2. Policy Based- Category 3. Actor centric- Category 4. Model Free - Category 5-Model Based-Fundamental categories in sequential decision making -Content based filtering-Collaborative Filtering- Applications of reinforcement learning with integration of machine learning.	

<b>Learning Resources</b>	1. Pratap Dangeti, "Statistics for Machine Learning", 1st edition, Packt Publishing, 2017 2. Richard Golden, "Statistical Machine Learning aUnified Framework", 1 <sup>st</sup> edition, CRC press, 2020 3. Himanshu Singh, "Statistics to Machine learning", 1 <sup>st</sup> edition, BPB publications, 2021 4. Peter Bruce, Andrew Bruce, "Practical Statistics for Data Scientists", 2 <sup>nd</sup> edition, O'Reilly, 2017 5. Gareth James, Daniela Witten, "An Introduction to Statistical Learning", 2 <sup>nd</sup> edition, Springer, 2014
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Amish Anand @wipro.com	1. Dr. Ameer, National Institute of Technology, Calicut 2. Dr. Varaprasad Rao, Sree Datttha Institute of Engineering & Science	1. Dr. J. Godwin Ponsam, SRMIST 2. Dr. R. Radhika, SRMIST

<b>Course Code</b>	21CSE310J	<b>Course Name</b>	QUANTUM COMPUTATION	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
							2	0	2	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Gain knowledge about quantum computing and quantum mechanics												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	Analyse the Quantum Circuits																								
<b>CLR-3:</b>	Utilize Open source Qiskit for quantum programming																								
<b>CLR-4:</b>	Learn about Grover and Deutsch Jozsa quantum algorithms																								
<b>CLR-5:</b>	Utilize the quantum concept and explore its applications																								
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Identify the need of quantum computing and quantum mechanics												1	3	-			-	-	-	-	-	2	-	-
<b>CO-2:</b>	Explore the Quantum gates and Quantum Circuits												2	3	1	-	-	-	-	-	-	-	2	-	-
<b>CO-3:</b>	Develop the quantum programs for circuit optimization.												2	3	-	3	-	-	-	-	-	-	2	-	-
<b>CO-4:</b>	Incorporate the Quantum algorithms Deustch Jozsa and Grover												2	3	-	3	-	-	-	-	-	-	2	-	-
<b>CO-5:</b>	Demonstrate the different Quantum simulators and real time applications												1	3	-	3	-	-	-	-	-	-	2	-	-

<b>Unit-1 – Introduction to Quantum Computation</b>	<b>12 Hour</b>
Need for Quantum Computing and fundamental concepts- Vector spaces, Probability- Complex numbers and mathematical preliminaries- Postulates of quantum mechanics- Bra-ket notations- Measurements- Composite systems- Bells theorem- Entanglement- Pure and Mixed states- Block sphere.	
<b>Unit-2 – Quantum Gates and Circuits</b>	<b>12 Hour</b>
Fubini study metric- Geometry of quantum states- Tutorial style problem solving session- Complexity classes- Turing machine- Turing machine concepts- Quantum gates- Quantum circuits- Quantum circuits design	
<b>Unit-3 – Quantum Circuit Optimization</b>	<b>12 Hour</b>
Quantitative measures of circuit- Analysis of quality of Circuits- Circuit optimization- Tutorial style problem solving sessions- Introduction to quantum algorithms- Deustch Jozsa algorithm- Oracles and Phase kick back- Deustch Jozsa Algorithm-details	
<b>Unit-4 – Quantum Grover algorithm</b>	<b>12 Hour</b>
Introduction to Grover algorithm- Detailed walk through on Grovers algorithm- Quantum Amplitude Estimation- Tutorial-problems analysis- Problem solving session- Programming concepts in Qiskit- Analysis of Qiskit- Exploring Qiskit- Programming in quantum- Analysis of exercises created by NPTEL- Usage of IBM composer.	
<b>Unit-5 – Quantum Applications</b>	<b>12 Hour</b>
Introduction to quantum applications- Research challenges of quantum- Introduction to QC Models- Physical Realization of Models- Tech landscape- VQE- Tutorial-problems- Problem solving session- Discussion of different use cases- Use case in logistics- Use case in ML and image processing- Use case in finance and quantum cryptography.	

<b>Lab Experiments</b>
Lab 1: Python basics
Lab 2: Navigation on Circuit composer and Qiskit in Quantum Lab
Lab 3: Project preparation phase 1 (Analysis of problem statement related to quantum computing)
Lab 4: Quantum hardware and Simulators
Lab 5: implement single and multiple qubit gates
Lab 6: Project preparation phase 2 (Design of the project based on problem statement)
Lab 7: Quantum circuits
Lab 8: Visualization tools (State vector and Q-Sphere)
Lab 9: Project preparation phase 3 (Implementation of quantum problem statement in cloud environment)
Lab 10: Quantum teleportation in Qiskit
Lab 11: Implementation of Grovers algorithm
Lab 12: Project preparation phase 4 (Testing of the software implemented)
Lab 13: project presentation and demo (use case developed)
Lab 14: Project thesis preparation
Lab 15: Project report submission (Thesis of use case developed)

<b>Learning Resources</b>	1. Quantum Computation and Quantum Information. M. A. Nielsen and I. L. Chuang, Cambridge University Press 2. Preskill Lecture notes: Available online: <a href="http://www.theory.caltech.edu/~preskill/ph229/">http://www.theory.caltech.edu/~preskill/ph229/</a> 3. Michael A. Nielsen and Isaac L. Chuang, "Quantum Computation and Information, Cambridge, 2002 4. Mikio Nakahara and Tetsuo Ohmi, "Quantum Computing", CRC Press, 2008 5. N. David Mermin, "Quantum Computer Science", Cambridge, 2007 6. <a href="https://qiskit.org/">https://qiskit.org/</a>	7. An Introduction to Quantum Computing. P. Kaye, R. Laflamme, and M. Mosca, Oxford University Press, New York 8. Quantum Computer Science. N. David Mermin: Cambridge University Press 9. Quantum Cryptography. D. Unruh: Available online: <a href="https://courses.cs.ut.ee/all/MTAT.07.024/2017_fall/uploads/">https://courses.cs.ut.ee/all/MTAT.07.024/2017_fall/uploads/</a> 10. NIST Post Quantum Cryptography, Available online: <a href="https://csrc.nist.gov/projects/post-quantum-cryptography/round-2-submissions">https://csrc.nist.gov/projects/post-quantum-cryptography/round-2-submissions</a> 11. Quantum Algorithms for Cryptographically Significant Boolean Functions - An IBMQ Experience. SAPV Tharrmashastha, D. Bera, A. Maitra and S. Maitra, Springer 2020.
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<b>Learning Assessment</b>						
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)		
		Theory	Practice	Theory	Practice	Theory
Level 1	Remember	15%	-	-	-	15%
Level 2	Understand	20%	-	-	-	20%
Level 3	Apply	45%	-	-	40%	45%
Level 4	Analyze	20%	-	-	30%	20%
Level 5	Evaluate	-	-	-	30%	-
Level 6	Create	-	-	-	-	-
	Total	100 %		100 %		100 %

<b>Course Designers</b>
<b>Experts from Industry</b>
1. Prabha Narayan, QKRISHI

  

<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
	1. Dr. Gayathri.M , SRMIST

<b>Course Code</b>	21CSE373T	<b>Course Name</b>	STREAMING ANALYTICS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the basic building blocks of stream processing												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Relate streaming data in real time															
<b>CLR-3:</b>	Explore the data ingestion options into stream processing engines															
<b>CLR-4:</b>	Extend stream processing results to end users															
<b>CLR-5:</b>	Explore NOSQL storage options to store real time data															
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>															
<b>CO-1:</b>	Illustrate the concepts and terminologies in stream processing												2	-	-	
<b>CO-2:</b>	Interpret stream processing applications using Apache Spark Streaming												2	2	-	
<b>CO-3:</b>	Summarize real-time streaming data pipelines and applications that adapt to the data streams using Kafka												2	2	-	
<b>CO-4:</b>	Interpret stream processing applications using Apache Storm Streaming												2	2	-	
<b>CO-5:</b>	Inquire real time data using NoSQL databases & MongoDB												2	2	-	

**Unit-1 - Fundamentals of Stream Processing** 9 Hour  
 Introducing Stream Processing, Stream Processing, Examples of Stream Processing, Scaling Up Data Processing, Distributed Stream Processing, Stream-Processing Model, Sources and Sinks, Immutable Streams Defined from One Another, Transformations and Aggregations, Window Aggregations, Stateless and Stateful Processing, Stateful Streams, An Example: Local Stateful Computation in Scala, Stateless or Stateful Streaming, Streaming Architectures, Components of a Data Platform, Architectural Models, The Use of a Batch-Processing Component in a Streaming Application, Referential Streaming Architectures, Streaming Versus Batch Algorithms

**Unit-2 - Apache Spark & Structured Streaming** 9 Hour  
 Apache Spark as a Stream-Processing Engine, Spark's Distributed Processing Model, Spark's Resilience Model, Introducing Structured Streaming, The Structured Streaming Programming Model

**Unit-3 - Kafka-A Realtime Data and Stream Processing** 9 Hour  
 Getting Started with Kafka, Kafka, Publish Subscribe messaging model, Kafka Architecture, Messages and Batches, Schemas, Topics and Partitions, Producers and consumers, Brokers and Clusters, Multiple Clusters, Data Ecosystem, Kafka Producers: Writing messages to Kafka, Kafka Consumers - Reading data from Kafka, Stream Processing- Stream Processing Design Patterns-Kafka Streams by Examples- Kafka Streams: Architecture Overview

**Unit-4 - Apache Storm** 9 Hour  
 Apache Storm - Introduction, Real-Time Processing and Storm Introduction, Storm Deployment, Topology Development, and Topology Options, Storm Parallelism and Data Partitioning, Integration of Storm, and Kafka

**Unit-5 - NoSQL Databases in Cloud and MongoDB** 9 Hour  
 NoSQL Data Bases, AWS Cloud Dynamo Database: Amazon DynamoDB features, Serverless, Introduction to MongoDB, MongoDB Data Model, MongoDB Architecture - Core Processes, MongoDB Tools, Standalone Deployment, Replication, Sharding, MongoDB Use Cases- Performance Monitoring, and Social Networking.

<b>Learning Resources</b>	1. Garillot F and Mass. G., <i>Stream Processing with Apache Spark</i> , 1st ed., O'Reilly Media, Inc., 2019. 2. Narkhede N, Shapira. G, and Palino T., <i>Kafka: The Definitive Guide - Real-Time Data and Stream Processing at Scale</i> , 1st ed., O'Reilly Media, Inc., 2017 3. Ankit Jain, <i>Mastering Apache Storm</i> , 1st ed., Packt Publishing, 2017	4. <a href="https://docs.mongodb.com/manual/changeStreams/">https://docs.mongodb.com/manual/changeStreams/</a> 5. Shakuntala Gupta Edward Navin Sabharwal, "Practical MongoDB Architecting, Developing, and Administering MongoDB" Apress, 2016 6. <a href="https://aws.amazon.com/dynamodb/features/?pg=dynamodb&amp;sec=hs">https://aws.amazon.com/dynamodb/features/?pg=dynamodb&amp;sec=hs</a>
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Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. Gangeyan Ranganathan, Project Delivery Specialist II , Deloitte Consulting Llp, Sacramento, California 2. Mr. Shri Raghu Raaman, Solidity Developer, Pixelvault Inc., Toronto, Canada	1. Dr Surendiran B, Associate Professor, National Institute of Technology, Puducherry 2. Dr. Selvakumar K, B.E., M.E., Ph. D, Assistant Professor Grade-II, Department of Computer Applications, National Institute of Technology Trichy, Tiruchirappalli-620015, Tamil Nadu, India	1. Dr. B Yamini, SRMIST 2. Dr. G Suseela, SRMIST

<b>Course Code</b>	21CSE475T	<b>Course Name</b>	APPLIED GRAPH THEORY	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>													
<b>CLR-1:</b>	Understand the basics of graph theory												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>												
<b>CLR-2:</b>	Gain Knowledge on trees and circuits																										
<b>CLR-3:</b>	Outline planar and dual graphs																										
<b>CLR-4:</b>	Illustrate about matching and coloring problems																										
<b>CLR-5:</b>	Learn the applications of graph theory																										
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12														
<b>CO-1:</b>	Comprehend the knowledge of graph basics												Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
<b>CO-2:</b>	Acquire the ability to solve the trees and circuit problems												-	-	3	3	-	-	-	-	-	-	-	2	-	-	
<b>CO-3:</b>	Design the Dual Graphs and detect the planarity												-	3	3	-	-	-	-	-	-	-	-	3	-	-	
<b>CO-4:</b>	Apply the knowledge of matching and coloring to solve complex problems												2	3	3	-	-	-	-	-	-	-	-	2	-	-	
<b>CO-5:</b>	Make use of the graph theory in real time applications												2	-	-	3	-	-	-	-	-	-	-	3	-	-	

**Unit-1 - Introduction to Graphs** 9 Hour  
Graphs-Definition of graphs and digraphs- Types of graphs- Directed graphs - Graph Isomorphism - Incidence and Adjacency Matrices- Subgraphs- Vertex degrees and counting -Large bipartite subgraphs - The handshake lemma - Havel-Hakimi Theorem- - Independent Sets and Cliques -Path, Walk, Connections and Circuits- Cycles-Euler graphs- Hamiltonian Path and Circuit- Travelling Salesman Problem

**Unit-2 - Trees and Circuits** 9 Hour  
Introduction to trees - Properties of trees - Pendant Vertices, Distance and Centre vertices- Rooted and Binary Trees- On counting trees- Spanning Trees: Finding spanning trees of a graph- Prim's Spanning Tree Algorithm, Kruskal's Spanning Tree Algorithm - Cut Sets: Properties of cut sets- Connectivity and Separability – Network Flows: 1-Isomorphism, 2-Isomorphism

**Unit-3 - Planar and Dual Graphs** 9 Hour  
Combinatorial and Geometric Graphs- Planar Graphs- Representations of a planar graphs -Kuratowski's Two Graphs - Detection of Planarity- Geometric Dual- Combinatorial Dual – Thickness and Crossings, Euler's Formula, Five – Color Theorem and the five color Conjecture, Non-Hamiltonian Planar Graphs, Planarity Algorithm

**Unit-4 - Matchings and Colorings** 9 Hour  
Matchings and Coverings in Bipartite Graphs - Chromatic number - Lower bounds from clique number and maximum independent set - Upper bounds from greedy coloring - Szekeres-Wilf and Brooks' Theorem - k-critical graphs - Cartesian product of graphs - Interval graphs - k-Chromatic graphs - Mycielski's construction - Turán's Theorem - Edge coloring - Line graphs - Vizing's Theorem

**Unit-5 - Applications of Graph Theory** 9 Hour  
Transport Networks – Extensions of Max-Flow and Min-Cut Problems - Minimal Cost Flows – The Multicommodity Flow- Further Applications – More on Flow Problems – Activity Networks in Project Planning – Analysis of an Activity Network – Graphs in Computer Programming - Graphs in Game Theory

<b>Learning Resources</b>	1. Narsingh Deo - Graph Theory with Applications to Engineering, Dover Publications McGraw Hill Education –2016 2. Robin J. Wilson - Introduction to Graph Theory, Pearson Education, Fourth Edition, 2004 3. J.A. Bondy and U.S.R. Murthy – Graph Theory with Applications, Elsevier Science Publishing, Fifth Edition, 2008 4. R. Gould – Graph Theory, Dover Publications, Reprint, 2012 5. Reinhard Diestel - Graph Theory, Springer Publisher, Fifth edition, 2017
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	-	-	-	-		
Total		100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Krishna Kumar, Technical Lead, Wipro 2. Mr. Lakshmi Kanthan Pudunagar Subbiah, Wintel CC team	1. Dr.K.M. Dhanya, Associate Professor, Government Engineering College, Palakkad 2. Dr.T. Suguna, Assistant Professor, Government College of Technology, Coimbatore	1. Dr.V.R. Balasaraswathi, SRMIST 2. Dr. Meenakshi K, SRMIST

<b>Course Code</b>	21CSE476T	<b>Course Name</b>	LOGICAL DEDUCTION AND NON-VERBAL REASONING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Explore the basic concepts of logics												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Identify the insights of logics in terms of Computer based Applications															
<b>CLR-3:</b>	Evaluate and understand predicate logic															
<b>CLR-4:</b>	Relate abstract and logical thinking skills to Computational Approach															
<b>CLR-5:</b>	Identify and analyze case studies that uses the ideology of non-verbal reasoning															
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Appraise the importance and role of logics in computer science												3	3	2	
<b>CO-2:</b>	Analyze the syntax and semantics of propositional logic and its applications												3	2	-	
<b>CO-3:</b>	Apply the concept of predicate logic to computational Science												3	2	-	
<b>CO-4:</b>	Ability to understand the logical and abstract thinking concepts of Non-Verbal Reasoning												-	2	-	
<b>CO-5:</b>	Utilize the Non-Verbal Reasoning knowledge gained to Computational Applications												-	2	-	

<b>Unit-1 - Logics in Computer Science</b>	<b>9 Hour</b>
Introduction: What is Logic – History of logic – Overview of logic in computer science, Sets, Relations and Functions, operations on Binary Relations, Ordering Relations, Partial order and Trees, Infinite Sets, Set theory -Basics for formulating Data Structures, Databases	
<b>Unit-2 - Propositional Logic and Applications</b>	
Introduction to Propositional Logic: Syntax, well-formed Formulas, Semantics, Interpretations, truth tables, satisfaction – Satisfiability, entailment, validity – CNF / DNF, Binary Decision Diagrams- Model Counting, Mathematical Induction, Deduction, Applications - Query Search Engines, Query Search Databases	
<b>Unit-3 - Predicate Logic</b>	
Introduction to Predicate Logic-Syntax and Semantics, well-formed Formulas, Quantifiers, Decision Problems, Equivalences, Translation of Predicates to Natural Language, Applications-Natural Language, Databases	
<b>Unit-4 - Non-Verbal Reasoning: Introduction to Logical and Abstract Concepts</b>	
Image Series, Shapes-Animation and computer graphics, Rule Deduction- Rule based Algorithms, Pattern, and Incomplete Patterns - Pattern Recognition Algorithms and Applications	
<b>Unit-5 - Non-Verbal Reasoning: Case Studies</b>	
Grouping of Identical Figures- Clustering Algorithms and Application, Cube, and dice - Naive Approach Vs Computational Approach, Figure Formation and Analysis-Knowledge Representation and reasoning	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>Michael Huth and Mark Ryan, <i>Logic in Computer Science Modelling and Reasoning about Systems</i>, 2nd Edition, 2004.</li> <li>Steve Reeves and Mike Clarke, <i>Logic for Computer Science</i>, Department of Computer Science Queen Mary, and Westfield College University of London U.K. Department of Computer Science University of Waikato New Zealand <a href="https://www.cs.waikato.ac.nz/~stever/LCS.pdf">https://www.cs.waikato.ac.nz/~stever/LCS.pdf</a>, 2003 Edition.</li> <li>Mauricio Ayala-Rincon, <i>Applied Logic for Computer Scientists</i>, <a href="https://users.aalto.fi/~rintanj1/notes-logic.pdf">https://users.aalto.fi/~rintanj1/notes-logic.pdf</a>, 2017.</li> <li>Uwe Schoning, <i>Logic for Computer Scientists</i>, <a href="http://tinman.cs.gsu.edu/~raj/8710/f16/UweSchoning/UweSchoningBook.pdf">http://tinman.cs.gsu.edu/~raj/8710/f16/UweSchoning/UweSchoningBook.pdf</a>, 1989</li> <li>Acob Eisenstein, <i>Natural Language Processing</i>, <a href="https://cseweb.ucsd.edu/~nmakashole/teaching/eisenstein-nov18.pdf">https://cseweb.ucsd.edu/~nmakashole/teaching/eisenstein-nov18.pdf</a>, 2018.</li> <li>RS Aggarwal, <i>A Modern Approach to Verbal and Non-Verbal Reasoning</i>, 16th Edition, 2018.</li> <li>John Vince, <i>Essential Computer Animation Fast How to Understand the Techniques and Potential of Computer Animation</i> 2000 Edition, Springer.</li> </ol>
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<b>Learning Assessment</b>		<b>Continuous Learning Assessment (CLA)</b>				<b>Summative Final Examination (40% weightage)</b>			
	<i>Bloom's Level of Thinking</i>	<i>Formative CLA-1 Average of unit test (50%)</i>		<i>Life-Long Learning CLA-2 (10%)</i>					
		<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>				
Level 1	<i>Remember</i>	15%	-	15%	-	15%	-		
Level 2	<i>Understand</i>	25%	-	20%	-	25%	-		
Level 3	<i>Apply</i>	30%	-	25%	-	30%	-		
Level 4	<i>Analyze</i>	30%	-	25%	-	30%	-		
Level 5	<i>Evaluate</i>	-	-	10%	-	-	-		
Level 6	<i>Create</i>	-	-	5%	-	-	-		
	<i>Total</i>	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. John Paul, Senior IT Analyst, Bank of America	1. Dr. Devan, Associate Professor, Department of CSE, Easwari Autonomous College	1. Dr. A. Helen Victoria, SRMIST
2. Mr. Lakshmi Narayanan, Telecom Engineer	2. Dr. L.C. Manikandan, Professor, Department of CSE, Valia Moonambakkathamma College of Engineering and Technology, Parippally, Thirunanthapuram, Kerala	2. Dr. M. Anand, SRMIST

<b>Course Code</b>	21CSE477T	<b>Course Name</b>	CLOUD NATIVE ARCHITECTURE FOR MODERN PLATFORMS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	2	<b>T</b>	1	<b>P</b>	0	<b>C</b>	3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>														
<b>CLR-1:</b>	Understand architectural principles behind a modern application platform.													<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>												
<b>CLR-2:</b>	Understand the best high-level structures for different kinds of applications, including web, database, thick-client, and web applications																											
<b>CLR-3:</b>	Understand the core principles of software design.																											
<b>CLR-4:</b>	Understand how Spring and ReactJS frameworks eliminate tedious configuration and repetitive coding tasks, making it easy to build enterprise-ready, production-quality software. Components of modern platforms.																											
<b>CLR-5:</b>	Understand micro services, reactive development, and other modern application designs.																											

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		<b>Program Outcomes (PO)</b>												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>																					
<b>CO-1:</b>	Demonstrate events, perform state updates, and manage conditional content; Apply styles dynamically and conditionally to create a modern UI.													2	3	-	-	-	-	-	-	-	-	-	3												
<b>CO-2:</b>	Implement components and stereotypes to satisfy given business requirements that could include both synchronous and asynchronous web applications.													-	-	3	2	-	-	-	-	-	-	3	-												
<b>CO-3:</b>	Design and implement a scalable polyglot persistence layer including regular star schema and document store.													-	-	3	-	2	-	-	-	-	-	2	-												
<b>CO-4:</b>	Design independent, composable, loosely coupled services that integrate well with device independent frontend UI components of modern platforms.													-	-	3	-	2	-	-	-	-	-	2	-												
<b>CO-5:</b>	Build non-functional characteristics such as scalability, performance engineering and security aspects into the solution.													-	-	3	3	-	-	-	-	-	-	2	-												

<b>Unit-1 - Modern Application Platforms</b>																	<b>9 Hour</b>
Introduction to modern application platforms, Introduction concept: distributed systems, Agility: user stories and acceptance test cases, Modelling: Requirements, Technology: Web, Web Stock and REST, Technology: Synchronous Controllers and asynchronous Web flux mapping- Workshop using user stories, spring boot framework, synchronous controllers, and Asynchronous Web Flux sockets. Plogot Persistence, Introduction Concept: Distributed Database, Technology: NoSQL and NewSQL Data modelling. Agility: Product Backlog, Modelling: Data, Technology: Mapping to Repositories, Workshop using Document Database and RDBMS. CA Project Instructions briefing, Service Fundamentals Introduction Concept: Cloud Computing Introduction, Agility: Pair Programming, Modelling: user Interface Technology Service design and API end points, Technology: Mapping Entities to Repositories, Workshop using service components, data access components and API endpoints.																	

<b>Unit-2 - Full Stack Components</b>																	<b>9 Hour</b>
Full Stack Components: Introduction Concept: Distributed Service communication, Agility: Test Driven Development, Modelling: Technical Backlog, Technology: Reactive Client-side Technologies, Technology: Build tools and Test automation, Technology: End to End Application Layering, Workshop using Synchronous components and client side. CA Project Mile stone MVP Submission, Cloud Native Reference Architecture, Introduction Concept: Cloud managed services (distributed), Modeling: Architectural Prototype, Technology: Reference Architecture, Technology: Cloud Native Design, Technology: Container Kuberentes part 1.																	

<b>Unit-3 - Micro Services</b>	<b>9 Hour</b>
Micro services Architecture: Introduction Concept: Domain Drive Design, Modelling: Bounded Context, Workshop using end to end layering of components and cloud hosting, and Technology: Element of micro services and implementation mechanism, Technology: Container - Kubernetes part 2, Technology: Inter-micro services communication, Workshop for moving from monolithic to microservices components, CA Project milestone Archetype Submission, Serverless Architecture, Introduction Concept: Function as a service, Modelling: Functions, Technology: Elements of functions and workflow implementation mechanism	
<b>Unit-4 - Functions and Containers</b>	<b>9 Hour</b>
Technology: Functions Vs Containers (Kubernetes vs Kubeless), Technology: Inter-functional communication, Workshop using serverless functions, Event Driven Architecture, Introduction Concept : Work Queue Systems, Technology : Producer, Consumer and Messages, Technology: Event Brokers versus message Brokers, Technology: Event-Driven Processing, Workshop using Event driven messages (both producers and consumer) and processing the same Design for Scalability, Introduction Concept: Application scaling, Concept: Data Scaling, Caching and Replication, Concept: Distributed systems communication Technology: Container orchestrated scaling and replication.	
<b>Unit-5 - Container Hosting</b>	
Workshop for container hosting, CA project milestone First Iteration Submission, Metrics, Monitoring and Performance Engineering, Introduction Concept: Quality metrics for non-functional Requirements, Concept: Distributed tracing for profiling and monitoring concept: Performance Engineering, Technology: Container orchestrated scaling and replication, Workshop for performance engineering, Security Architecture for Modern Platforms, Introduction Concept: Distributed Service Security, Modelling: Threat models and SWOT Analysis, Technology: Identity and access management, Technology: Data asset classification and Protection, Technology: Container security, Workshop for Security Implementation Platform Reliability Engineering, Introduction concept: Distributed service reliability, Technology: Service Level Indicators, Workshop for reliability Implementation.	

<b>Learning Resources</b>	1. Clean Architecture: A Craftsman's Guide to Software Structure and Design by Robert C. Martin; published by: Pearson; publication date: September 2017. 2. Johnson, Rod, et al. "The spring framework—reference documentation." interface 21 (2004): 27. 3. Walls, Craig. Spring in action. Simon and Schuster, 2022.	4. White, Joshua, and Willie Wheeler. Spring in practice. Simon and Schuster, 2013. 5. Boduch, Adam, and Roy Derkx. React and React Native: A complete hands-on guide to modern web and mobile development with React.js. Packt Publishing Ltd, 2020.
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Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	30%	-	30%	-		
Level 4	Analyze	30%	-	30%	-	30%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
Total		100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Srinivasan Varadharajan, Senior Principal Software Engineer, Manhattan Associates, Atlanta, United States. 2. Mr. Shiva Praveen, American Express, USA.	1. Dr. Surya Priya Asaithambi, Principal Lecturer and Consultant, Software Systems Practice, National University of Singapore. 2. Dr. B. Vinayaga Sundaram, Associate Professor, Madras Institute of Technology, Chennai.	1. Dr M. Thenmozhi, SRMIST 2. Dr. S. Metilda Florence, SRMIST

Course Code	21CSE479T	Course Name	FAULT TOLERANT SYSTEMS	Course Category	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards			Nil

Course Learning Rationale (CLR): <i>The purpose of learning this course is to:</i>		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Familiarize the measures of Fault tolerance and Dependable Systems												PSO-1	PSO-2	PSO-3	
CLR-2:	Understand the various techniques used for hardware fault tolerance.															
CLR-3:	Determine the various forms of redundancy for enhancing system reliability															
CLR-4:	Understand the various techniques for software fault tolerance															
CLR-5:	Exploring fault tolerance in real time systems															
Course Outcomes (CO): <i>At the end of this course, learners will be able to:</i>		Program Outcomes (PO)												Program Specific outcomes		
CO-1:	Identify the faults which may cause the system to fail												2	3	-	-
CO-2:	Apply various techniques for overcoming hardware failure and identify the best suited technique for the identified fault												2	3	-	-
CO-3:	Choose various redundancy forms to enhance reliability of the system identified with fault												2	3	-	-
CO-4:	Analyze the methodology best suited for identified software fault.												2	3	-	-
CO-5:	Illustrate the fault tolerance in real time systems.												2	3	-	-

**Unit-1 - Introduction to Fault-Tolerance** 9 Hour  
Error, Faults and Failures; Fault Classification, Basic Measures of Fault Tolerance: Traditional and Network; Reliability and Availability; Dependable system, techniques for achieving dependability, dependability measure

**Unit-2 - Hardware Fault Tolerance** 9 Hour  
Failure Rate, Reliability, and Mean Time to Failure, Canonical and Resilient Structures, Reliability Evaluation Techniques, Fault-Tolerance Processor-Level Techniques, Byzantine Failures.

**Unit-3 - Information Redundancy** 9 Hour  
Coding, Resilient Disk Systems, Data Replication, Algorithm-Based Fault Tolerance

**Unit-4 - Software Fault Tolerance** 9 Hour  
Acceptance Tests, Single-Version Fault Tolerance, N-Version Programming, Recovery Block Approach, Preconditions, Postconditions, and Assertions, Exception-Handling, Software Reliability Models, Fault-Tolerance Remote Procedure Calls

**Unit-5 - Checkpointing** 9 Hour  
Checkpoint Level, Optimal Checkpointing, Checkpointing in Distributed and Shared-Memory Systems, Checkpointing in Real-Time Systems, Case studies: IBM G5, IBM Sysplex, Itanium

<b>Learning Resources</b>	1. Israel Koren and C. Mani Krishna; <i>Fault-Tolerant Systems</i> ; Morgan-Kaufman Publishers, 2007 2. Dubrova, Elena. <i>Fault-tolerant design</i> . New York: Springer, 2013 3. Michael R. Lyu; <i>Handbook of Software Reliability Engineering</i> ; IEEE Computer Society Press (and McGraw-Hill), 1996 4. Martin L. Shooman; <i>Reliability of Computer Systems and Networks: Fault Tolerance, Analysis, and Design</i> ; John Wiley & Sons Inc., 2002 5. P. Jalote, "Fault Tolerance in Distributed Systems", Prentice-Hall Inc. 1994 6. D. K. Pradhan, "Fault-Tolerant Computing, Theory and Techniques", Prentice-Hall, 1998				
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)	Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

#### Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Joseph Aloysius, Consultant, TCS.	1. Dr. Latha, Prof & head, dept of CSE, St. Peters Engg college, chennai	1. Dr. V. Elizabeth Jesi, , SRMIST 2. Ms. G. Saranya, , SRMIST

<b>Course Code</b>	21CSE480T	<b>Course Name</b>	IMAGE AND VIDEO PROCESSING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>														
<b>CLR-1:</b>	Understand the basics of Digital Image Processing concepts.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>													
<b>CLR-2:</b>	Apply simple image enhancement techniques in spatial and frequency domain																											
<b>CLR-3:</b>	Analyze the concepts of Image compression and segmentation techniques																											
<b>CLR-4:</b>	Gain some basic knowledge on Digital video processing.																											
<b>CLR-5:</b>	Utilize the video processing and streaming techniques for real-time programming applications.																											
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>																											
<b>CO-1:</b>	Describe the basics of Digital Image Processing concepts.												3	-	-													
<b>CO-2:</b>	Identify appropriate image enhancement, smoothing and sharpening filters techniques for real time applications												-	2	-													
<b>CO-3:</b>	Implement image compression techniques for real time applications												-	2	-													
<b>CO-4:</b>	Acquire the fundamental concepts and terminologies in video processing.												3	2	-													
<b>CO-5:</b>	Demonstrate Video streaming Techniques for real time applications												-	-	2													
<b>Unit-1 - Fundamentals of Image Processing and Image Transforms</b> <span style="float: right;">9 Hour</span>																												
Basic steps of Image Processing System Sampling and Quantization of an image, Basic relationship between pixels. Image Segmentation: Segmentation concepts, Point, Line and Edge Detection, Thresholding, Region based segmentation																												
<b>Unit-2 - Image Enhancement</b> <span style="float: right;">9 Hour</span>																												
Spatial domain methods: Histogram processing, Fundamentals of Spatial filtering, smoothing spatial filters, Sharpening spatial filters. Frequency domain methods: Basics of filtering in frequency domain, Image smoothing, Image sharpening, Selective filtering.																												
<b>Unit-3 - Image Compression and Segmentation</b> <span style="float: right;">9 Hour</span>																												
Image compression fundamentals –Basic compression methods- Lossy & Lossless, Transform and Truncation coding, Huffman coding, Predictive coding, JPEG Standards. Image segmentation techniques.																												
<b>Unit-4 - Fundamentals of Video Processing</b> <span style="float: right;">9 Hour</span>																												
Analog Video, Digital Video. Time-Varying Image Formation models: Three-Dimensional Motion Models, Geometric Image Formation, Photometric Image Formation, Sampling of Video signals, Filtering operations																												
<b>Unit-5 - Streaming video over the Internet</b> <span style="float: right;">9 Hour</span>																												
Architecture for Video Streaming Systems, Video Compression, Application Layer Qos Control For Streaming Video, Continuous Media Distribution Services, Streaming Servers, Media Synchronization, Protocols For Streaming Video.																												

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Gonzaleze and Woods, "Digital Image Processing using MATLAB", 2nd Edition, McGraw Hill Education, 2016</li> <li>2. Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing", Third Edition, Pearson Education, 2014.</li> <li>3. S. Sridhar, "Digital Image Processing", Oxford University Press, 2020.</li> <li>4. A Murat Tekalp, "Digital Video Processing", PERSON, 2010</li> <li>5. Bovik, "Handbook of Image &amp; Video Processing", Academic Press, 2010</li> <li>6. Yao Wang, Jorn Ostermann and Ya Qin Zhang, "Video Processing and Communications", Prentice Hall Publishers, 2002.</li> </ol>
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Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

#### Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Albert Rex, HP, Chennai 2. Mr. Amish Anand, Wipro Technologies	1. Dr. Ameer, National Institute of Technology, Calicut 2. Dr. Varaprasad Rao, Sree Dattha Institute of Engineering & Science	1. Dr. K. Nimala, SRMIST 2. Dr. G. Geetha, SRMIST

# **ACADEMIC CURRICULA**

## **UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES**

**(With exit option of Diploma)**

**(Choice Based Flexible Credit System)**

**Regulations 2021**

**Volume - 11H**

**(Syllabi for Computer Science and Engineering w/s in  
Internet of Things Programme Courses)**



**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

**(Deemed to be University u/s 3 of UGC Act, 1956)**

**Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India**

# ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021



**SRM**

INSTITUTE OF SCIENCE & TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

<b>Course Code</b>	21CSC313J	<b>Course Name</b>	CLOUD COMPUTING FOR IoT	<b>Course Category</b>	C	PROFESSIONAL CORE	L 2	T 0	P 2	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Restate the Applications, Platform and Cloud services.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	Label the different levels of cloud platforms and various laws.																								
<b>CLR-3:</b>	State Cloud applications and new opportunities																								
<b>CLR-4:</b>	Recognize the security levels and privacy of several layers of IoT																								
<b>CLR-5:</b>	Evaluate the Authentication and Security of IoT.																								
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Memorize the essentials of Applications, Platform and Cloud services.												-	2	-	-	3	-	-	-	-	-	-	3	3
<b>CO-2:</b>	Categorize different levels of cloud platforms and IoT systems.												-	2	-	-	3	-	-	-	-	-	-	3	3
<b>CO-3:</b>	Demonstrate new opportunities and cloud applications												-	2	-	-	3	-	-	-	-	-	-	3	3
<b>CO-4:</b>	Analyze the different security levels and privacy of several layers of IoT												-	2	-	-	3	-	-	-	-	-	-	3	3
<b>CO-5:</b>	Assess their knowledge of the Authentication and Security of IoT.												-	3	-	-	3	-	-	-	-	-	-	3	3

<b>Unit-1 - Introduction to Cloud Computing</b>	<b>12 Hour</b>
Introduction to Cloud Computing, Characteristics of Cloud Computing, Software Virtualization, Containerizing applications, Virtual Machine Provisioning & Manageability, Cloud Deployment models, Introduction to IoT Platform, Cloud IoT Architecture, IoT Cloud Services, and Identity & Device Management.	
<b>Unit-2 - Cloud Modules and its Services</b>	
Introduction to Core IoT Modules, IoT cloud platforms like Open Shift & Kaa, Monitoring cloud services, Benefits & limitations, Deploy application over cloud, IoT Modules-A connected ecosystem, IoT Vs Machine-to-Machine (M2M) Vs SCADA, Metcalfe's law and Beckstrom's laws.	
<b>Unit-3 - Cloud Policies and Mechanism</b>	
Policies and Mechanisms for Resource Management, Stability of a Two-Level Resource Allocation Architecture, A Utility-Based Model for Cloud-Based Web Services, Resource Bundling: Combinatorial Auctions for Cloud Resources, Scheduling Algorithms for Computing Clouds, Resource Management and Dynamic Application Scaling, Architectural Styles for Cloud Applications, Existing Cloud Applications and Opportunities for New Applications.	
<b>Unit-4 - Security and Privacy of IoT</b>	
Security and Impact of the Internet of Things (IoT) on Mobile Networks, Networking Function Security, IoT Networking Protocols, Secure IoT Lower Layers, Secure IoT High Layers, Secure Communication Links in IoTs, Back-end Security, Secure IoT Databases, Security Products-Existing Test bed on Security and Privacy of IoTs	

**Unit-5 - Protocols of IoT****12 Hour**

Authentication in IoT, Computational Security for the IoT, Privacy-Preserving Time Series Data Aggregation, Secure Path Generation Scheme for Real-Time Green Internet of Things, Security Protocols for IoT Access Networks, Framework for Privacy and Trust in IoT, Policy-Based Approach for Informed Consent in Internet of Things, Network Robustness of Internet of Things and IoT security lifecycle.

<b>Lab Experiments</b>	
<ol style="list-style-type: none"> <li>1. Configure a VM instance in your local machine in cloud by creating a cloud account</li> <li>2. Allocate CPU, Memory size and storage space as per a specified requirement of Cloud</li> <li>3. Configure a Nested Virtual Machine (VM under another VM) in cloud and local machine</li> <li>4. Implementation of cloud scheduling algorithms using CloudSim</li> <li>5. Analyze cloud scheduling algorithms using OPNET</li> <li>6. Performance of Cloud scheduling algorithms using Cloud analyst tool</li> <li>7. Measure Cloud load balancing algorithms using Cloud Sim</li> <li>8. Investigate Cloud load balancing algorithms using OPNET</li> </ol>	<ol style="list-style-type: none"> <li>9. Experiment Cloud load balancing algorithms using Cloud analyst tool</li> <li>10. Evaluate IoT based home automation system</li> <li>11. Exploit IoT based water level control system</li> <li>12. Design a Factory automation using IoT</li> <li>13. Assess Secure data communications between two IoT devices</li> <li>14. Examine IoT based assistive device for aged persons</li> </ol> <p>Create an IoT based power automation system</p>

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Rajkumar Buyya, "Cloud Computing Principles and Paradigms", Wiley &amp; Sons publisher, 2010.</li> <li>2. David E.Y Sarna, "Implementing and Developing Cloud Computing Applications", CRC Press, 2018.</li> <li>3. Marco Schwartz, "Internet of Things with the Arduino Yun", Packt Publishing, 2014.</li> </ol>	<ol style="list-style-type: none"> <li>4. Whitehouse O, "Security of things: An implementers' guide to cyber-security for internet of things devices and beyond", 1st edition, NCC Group, 2014.</li> <li>5. DaCosta, Francis, and Byron Henderson, "Rethinking the Internet of Things: a scalable approach to connecting everything", 1st edition, Springer Nature, 2013.</li> </ol>
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Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	-	15%	15%	-		
Level 2	Understand	25%	-	-	20%	25%	-		
Level 3	Apply	30%	-	-	20%	30%	-		
Level 4	Analyze	30%	-	-	35%	30%	-		
Level 5	Evaluate	-	-	-	10%	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. G. Pradeep, Intel @ FICE, Bangalore	1. Dr. Sudeepa Mishra, Indian Institute of Technology, Ropar, Punjab.	1. Dr. A. Suresh, SRMIST
2. Mr. Rajachozhan, Zoho Corp, Chennai	2. Dr. Subramanian Ganesan, Professor, Oakland University, USA.	2. Dr. V. Anbarasu. SRMIST

<b>Course Code</b>	21CSC315J	<b>Course Name</b>	FOG COMPUTING	<b>Course Category</b>	C	PROFESSIONAL CORE	L 2	T 0	P 2	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Relate the basic concepts and the need of fog computing												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	Articulate the research challenges and opportunities in the Fog computing																								
<b>CLR-3:</b>	Predict the basic knowledge in Integrating Fog, IoT & cloud																								
<b>CLR-4:</b>	Grasp the infrastructure, middleware architectures and data management for Fog computing																								
<b>CLR-5:</b>	Classify the knowledge of Fog in various applications																								
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Contrast fog computing and edge computing												-	-	3	2	2	-	-	-	-	-	-	2	3
<b>CO-2:</b>	Classify and address the research challenges in Fog Edge computing platform												-	-	3	3	2	-	-	-	-	-	-	2	3
<b>CO-3:</b>	Summarize the knowledge in integrating IoT, Cloud and Fog												-	-	3	-	2	-	-	-	-	-	-	2	3
<b>CO-4:</b>	Execute various data management techniques and design of middleware for Fog computing												-	-	3	-	2	-	-	-	-	-	-	2	3
<b>CO-5:</b>	Experiment the knowledge of Fog in the design of various application												-	-	3	2	2	-	-	-	-	-	-	2	3

<b>Unit-1 - Introduction</b>	<b>12 Hour</b>
Fog Computing Basics, Fog and Edge Computing Completing the Cloud, Hierarchy of Fog and Edge Computing, Business models, Opportunities and Challenges, Fog Computing Communication Technologies.	
<b>Unit-2 - Addressing the Challenges in FEC</b>	<b>12 Hour</b>
The Networking Challenges, The Management Challenges, Miscellaneous Challenges.	
<b>Unit-3 - Foundation</b>	<b>12 Hour</b>
Management and Orchestration of Network Slices in 5G, Fog, Edge, and Clouds: Background, Network Slicing in 5G, Network Slicing in Software-Defined Clouds, Network Slicing Management in Edge and Fog, Future Research Directions.	
<b>Unit-4 - Middleware and Data Management</b>	<b>12 Hour</b>
Introduction, Need for Fog and Edge Computing Middleware, Design Goals, State-of-the-Art Middleware Infrastructures, System Model, Proposed Architecture, Case Study Example. Data Management in Fog Computing, Future Research and Directions.	
<b>Unit-5 - Application and Issues</b>	<b>12 Hour</b>
Fog Computing Realization for Big Data Analytics, Data Analytics in the Fog, Prototypes and Evaluation. Case Study 1: Fog Computing in E-Health Monitoring. Case Study 2: Intelligent Traffic Lights Management (ITLM) System.	

<b>Lab Experiments</b>	
<p>Lab 1: iFog Simulator installation and configuration setup.</p> <p>Lab 2: Implementation of Fog Nodes with different configuration set up.</p> <p>Lab 3: Demonstration on various fog simulators.</p> <p>Lab 4: Implementation of application models using iFog.</p> <p>Lab 5: Simulation of application models using iFog Master Worker application models.</p> <p>Lab 6: Simulation of application models using iFog Master Sequential Unidirectional application model.</p> <p>Lab 7: Design of sensor nodes and simulate with different tuple emission rates.</p> <p>Lab 8: Design of mobile edge node using iFog.</p>	<p>Lab 9: Connection of lower-level fog device with Gateway.</p> <p>Lab 10: Simulation of clustering in fog nodes</p> <p>Lab 11: A Case Study – Scheduling in Fog Computing</p> <p>Lab 12: A Case Study - Computational Offloading in Fog Computing</p> <p>Lab 13: A Case Study - Security and Privacy in Fog Computing</p> <p>Lab 14: A Case Study - Cloud-fog Collaborations</p> <p>Lab 15: A Case Study – Green Fog Computing</p>

<b>Learning Resources</b>	<p>1. Rajkumar Buyya and Satish Narayana Srivama, "Fog and Edge Computing Principles and Paradigms", Wiley Series on Parallel and Distributed Computing, 2019.</p> <p>2. Assad Abbas, Samee U. Khan, and Albert Y. Zomaya, "Fog Computing: Theory and Practice", Wiley Series on Parallel and Distributed Computing, 2020.</p>	<p>3. Amir Vahid Dastjerdi and Rajkumar Buyya, "Fog Computing: Helping the Internet of Things Realize its Potential]", University of Melbourne, 2016.</p> <p>4. Sudip Misra, Subhadeep Sarkar and Subarna Chatterjee, "Sensors, Cloud, and Fog: The Enabling Technologies for the Internet of Things", CRC Press, 2019.</p>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
Bloom's Level of Thinking		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	-	15%	15%	-		
Level 2	Understand	25%	-	-	20%	25%	-		
Level 3	Apply	30%	-	-	20%	30%	-		
Level 4	Analyze	30%	-	-	35%	30%	-		
Level 5	Evaluate	-	-	-	10%	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. Vignesh, TCS, Bangalore	1. Dr. Arulprakash, Professor, IIT Madras	1. Dr. V Anbarasu, SRMIST
2. Mr. Rajachozhan, Zoho Corp, Chennai	2. Dr. Raju Abraham, NIOT, Chennai	2. Dr. A. Suresh, SRMIST

# ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021



**SRM**  
INSTITUTE OF SCIENCE & TECHNOLOGY  
(Deemed to be University u/s 3 of UGC Act, 1956)

**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

**(Deemed to be University u/s 3 of UGC Act, 1956)**

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

<b>Course Code</b>	21CSE264T	<b>Course Name</b>	INTRODUCTION TO IOT: SENSORS, ACTUATORS AND MICROCONTROLLERS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Recognize the basic concepts of IoT and applications												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Recollect the fundamentals of sensors and actuators, their characteristics, and various classification of sensors and actuators															
<b>CLR-3:</b>	Identify about various classification of sensors and actuators															
<b>CLR-4:</b>	Articulate the basics of Interfacing devices and microcontrollers															
<b>CLR-5:</b>	Utilize on IoT based applications															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>
<b>CO-1:</b>	Recollect the fundamental concepts in IoT.												-	2	2	-
<b>CO-2:</b>	Determine the performance characteristics of sensors and actuators.												-	2	2	-
<b>CO-3:</b>	Classify the different sensors and actuators used in IoT.												-	2	2	-
<b>CO-4:</b>	Categorize the Interfacing methods, circuits and controllers used in IoT applications.												-	2	2	-
<b>CO-5:</b>	Solve IoT based Applications.												-	2	2	-

**Unit-1 - Introduction to IoT** 9 Hour  
 Introduction – Physical Design of IoT - Logical Design of IoT – IoT Enabling Technologies – IoT Levels & Deployment Templates – Domain Specific IoTs – Home Automation – Cities - Environment – Energy – Retail – Logistics – Agriculture – Industry – Health & Lifestyle.

**Unit-2 - Sensors and Actuators** 9 Hour  
 Definitions - Classification of Sensors and Actuators – Gathering Requirements for Interfacing – Performance Characteristics of Sensors and Actuators: Input and Output Characteristics – Temperature Sensors and Thermal Actuators – Optical Sensors and Actuators – Electric and Magnetic Sensors and Actuators.

**Unit-3 - Classification of Sensors and Actuators** 9 Hour  
 Mechanical Sensors and Actuators – Acoustic Sensors and Actuators – Chemical Sensor and Actuators – Radiation Sensors and Actuators – MEMS and Smart Sensors: Production of MEMS – MEMS Sensors and Actuators – Smart Sensors and Actuators – Sensor Networks.

**Unit-4 - Microcontrollers** 9 Hour  
 Interfacing Methods and Circuits – Amplifiers, Digital Circuits, Bridge Circuits, Data Transmission, Excitation Methods, and Circuits – Interfacing to Microprocessors: General Purpose Controller, General requirements for interfacing sensors and actuators - ESP8266, Node MCU, TI-CC3200, Access point and station mode, HTTP, MQTT, transmission and receiving, Intel-Galileo boards.

**Unit-5 - IoT Applications** 9 Hour  
 Application Domains of IoT – IoT based Smart Home Framework – IoT and Health care – IoT and Smart Mobility – Car Parking System – Major Instances of Crop Growth and IoT - IoT Architecture of Smart Agriculture – Smart Grid – IoT-based Smart Cities – IoT and Smart Education

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>Arshdeep Bahga and Vijay Madisetti, "Internet of Things, A Hands -on Approach", 1st Edition, Vpt Publisher, 2014.</li> <li>Nathan Ida, "Sensors, Actuators, and their Interfaces: A multidisciplinary Introduction", Institution of Engineering and Technology Publishing, 2020.</li> <li>Jacob Fraden, "Handbook of Modern Sensors: Physics, Designs, and Applications", Springer International Publishing, 2015.</li> <li>Agus Kurniawan, "Smart Internet of Things Projects", Packt publishing, 2016.</li> <li>Peter Waher, "Learning Internet of Things", Packt publishing, 2015.</li> <li>Muhammad Azhar Iqbal, Sajjad Hussain, Huanhai Xing and Muhammad Ali Imran, "Enabling the Internet of Things: Fundamentals, Design and Applications", Wiley Publications, 2021.</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>	
<i>Bloom's Level of Thinking</i>	<i>Formative CLA-1 Average of unit test (50%)</i>	<i>Life-Long Learning CLA-2 (10%)</i>					
		<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>
Level 1	Remember	15%	-	10%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	35%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. Rajachozhan, Zoho Corp, Chennai 2. Mr. Adarsh B, IoT Domain Expert, Happiest Mind Technologies, Hyderabad.	1. Dr. B. Surendiran, NIT, Puducherry 2. Dr. Nagendra Kumar S, Associate Professor, University of Hyderabad, Telangana	1. Ms. P. Mahalakshmi, SRMIST 2. Dr. A. Suresh. SRMIST

<b>Course Code</b>	21CSE265T	<b>Course Name</b>	INTRODUCTION TO EMBEDDED PROGRAMMING AND EMBEDDED OS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Identify the basics of Embedded Programming and GNU C Programming Tool Chain in Linux												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Solve program using Embedded C and Micro Python for Embedded programming															
<b>CLR-3:</b>	Articulate basic open-source software, packages, and simulation tools															
<b>CLR-4:</b>	Recognize Embedded programming on open-source boards															
<b>CLR-5:</b>	Define Embedded Operating systems and its importance in Embedded product design															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
<b>CO-1:</b>	Classify and demonstrate expertise on C programming tool chain												-	3	3	-
<b>CO-2:</b>	Perceive to write python codes for Embedded applications												-	3	3	-
<b>CO-3:</b>	Demonstrate the knowledge acquired can choose and apply appropriate Operating systems for the context of requirement												-	3	3	-
<b>CO-4:</b>	Convert in programming with logical acumen the open-source boards for any problem in Embedded industries												-	3	3	-
<b>CO-5:</b>	Extend the required programming skills that enhances their chances of employability in Embedded and IoT Industries												-	3	3	-

<b>Unit-1 - Introduction to Embedded Programming and GNU C Programming tool chain</b>	<b>9 Hour</b>
Introduce Object oriented programming with C: Basic skeleton, Header libraries for projects, ports, preprocess, basic sample codes; Steps of compilation; Handling time constraints: create delays (Hardware and Software) - timeout mechanism: loops and hardware - Introduction to GCC - Debugging with GDB - The Make utility - GNU Configure and Build System - GNU Binary utilities - Profiling - using gprof - Introduction to GNU C Library	

<b>Unit-2 - Introduction to Python programming on open-source board for Embedded Systems</b>	<b>9 Hour</b>
Introduction to basic Python programming: Variables, Basic operators, reading input from user, Basic datatypes, Conditional and control statement -Introduce basic open-source hardware: Arduino (or any recent version including NodeMCU), Raspberry Pi, PyBoard; Introduce basic port programming with Raspberry Pi/Arduino/NodeMCU for Embedded application;	

<b>Unit-3 - Introduction to Micro Python for Embedded Systems</b>	<b>9 Hour</b>
Introduction to Micro Python programming: High level comparison on Python standard libraries and micro-libraries, MicroPython-specific libraries, Port-specific libraries; Micro python on Microcontrollers; Micro Python programming with PyBoard and Node MCU	

<b>Unit-4 - Introduction to Simulation tools for Embedded development</b>	<b>9 Hour</b>
Introduction to Matlab; Embedded Programming with Matlab: Building Arduino/Raspberry Pi/ESP8266(NodeMCU) with Matlab, Introduce and demo using Embedded MATLAB Mex; Introduction to Proteus: Basic programming with Proteus and Raspberry Pi (or any open-source hardware)	

**Unit-5 - Introduction to Embedded Operating Systems** 9 Hour

Embedded Operating systems: Introduction, Types, Characteristics, Advantages and Disadvantages; Introduction to Real time operating systems (RTOS), Task Scheduling, Survey of RTOS

<b>Learning Resources</b>	1. Michael J Pont, "Embedded C", Pearson Education, 2007. 2. Barr, "Programming Embedded Systems: With C and GNU Development Tools", Second Edition, O'Reilly Publishers, 2006 3. Nicholas H. Tollervey, "Programming with Micro Python: Embedded Programming with Microcontrollers and Python", O'Reilly Publishers, 2017 4. <a href="https://www.labcenter.com/raspberry_pi/">https://www.labcenter.com/raspberry_pi/</a> 5. K.C. Wang, "Embedded and Real-Time Operating Systems", Springer International Publishing, 2017.				
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Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	10%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	30%	-	30%	-		
Level 4	Analyze	30%	-	35%	-	30%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Thirukumaran Raman, Head – R&D, IIoT COE, Chools Group, Bangalore	1. Dr. Manju Khari, Jawaharlal Nehru University, New Delhi	1. Dr. Kayalvizhi Jayavel, SRMIST
2. Mr. Rajachozhan, Zoho Corp, Chennai	2. Dr. T. M. Thasleema, Professor, Department of CSE, Central University of Kerala.	2. Dr. R. Kayalvizhi, SRMIST

<b>Course Code</b>	21CSE266T	<b>Course Name</b>	INTERNET OF THINGS ARCHITECTURE AND PROTOCOLS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>												
<b>CLR-1:</b>	Identify M2M & IoT analytics along with IoT and its applications												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>											
<b>CLR-2:</b>	Solve IoT Technical design constraints and its interaction with remote control																									
<b>CLR-3:</b>	Recognize knowledge of different layers in IP based and Web communication protocols																									
<b>CLR-4:</b>	Label the Transport Layer protocols in depth and Cloud based services																									
<b>CLR-5:</b>	State the real-world problems in IoT																									
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	
<b>CO-1:</b>	Outline the essentials of IoT and its applications.												-	3	3	-	-	-	-	-	-	-	-	2	2	-
<b>CO-2:</b>	Summarize IoT Architecture Reference model and its control.												-	3	3	-	-	-	-	-	-	-	-	2	2	-
<b>CO-3:</b>	Examine the IP based protocols and Authentication Protocols for IoT												-	3	3	-	-	-	-	-	-	-	-	2	2	-
<b>CO-4:</b>	Handle different layered protocols in IoT and cloud-based services.												-	3	3	-	-	-	-	-	-	-	-	2	2	-
<b>CO-5:</b>	Experiment real world problems in IoT with Arduino and Raspberry Pi												-	3	3	-	-	-	-	-	-	-	-	2	2	-

#### **Unit-1 - Architecture and Framework of IoT** 9 Hour

IoT- An Architectural Overview, Applications of IoT, IoT Conceptual framework, Design Principles, Standards and Considerations, M2M fundamentals, IoT Technologies, M2M and IoT analytics, Challenges of IOT and Sources of IoT.

#### **Unit-2 - Standardization of IoT** 9 Hour

IoT/M2M System layers, Design Standardization, The IoT Architectural Reference Model as Enabler, IoT in Practice, IoT in Logistics and Health, Functional and communication models, Real-World Design Constraints, Technical Design constraints and Interaction and remote control.

#### **Unit-3 - Authentication and Communication** 9 Hour

Web communication protocols for connected devices, Message communication protocols for connected devices, web connectivity for connected-devices network using gateway Internet connectivity principles, IP addressing in IoT, Proxy authentication, Media Access control, Application Layer Protocols and Zigbee smart energy.

#### **Unit-4 - Cloud based Services in IoT** 9 Hour

Transport layer: SCTP-TLS, DCCP, Data acquiring and storage, Organizing the data, Knowledge Acquiring, Managing and Storing processes, Cloud computing paradigm for data collection, IoT cloud-based services and Data enrichment.

#### **Unit-5 - IoT Devices in Real Time Scenario** 9 Hour

Security in IoT Protocols, Radio frequency identification technology, Wireless Sensor Networks, Introduction to Arduino, Arduino IDE, Node MCU, Introduction to Raspberry Pi, 6LoWPAN and RPL

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>Pethuru Raj and Anupama C. Raman "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press, 2017</li> <li>Arshdeep Bahga and Vijay Madisetti "Internet of Things: A Hands-on Approach", Universities Press, 2015.</li> <li>Qusay F. Hassan, "Internet of Things A to Z: Technologies and Applications", John Wiley &amp; Sons, 2018.</li> <li>David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, and Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press, 2017.</li> <li>Jan Holler, Vlasisos Tsatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos and David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	10%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	30%	-	30%	-		
Level 4	Analyze	30%	-	35%	-	30%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. G. Pradeep, Intel @ FICE, Bangalore 2. Mr. Adarsh B, Happiest Minds Technologies, Hyderabad	1. Dr. Sudeeptha Mishra, Indian Institute of Technology, Ropar, Punjab 2. Dr. P. Rajesh, Professor, Central University of Kerala.	1. Dr. A. Suresh, SRMIST 2. Dr. C. Malathy, SRMIST

<b>Course Code</b>	21CSE365T	<b>Course Name</b>	MACHINE LEARNING FOR IoT	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>																																																		
<b>CLR-1:</b>	Restate the basic theory underlying machine learning.												<b>CLR-2:</b>	Recognize the general concepts of Internet of Things and recognize various devices, sensors, and applications												<b>CLR-3:</b>	Grasp machine learning algorithms to solve problems of moderate complexity.												<b>CLR-4:</b>	Articulate to design, build, and integrate IoT platforms, incorporating different types of sensors, actuators, and machine learning methods												<b>CLR-5:</b>	Define the current requirements of applied machine learning with IoT and the issues raised by current research											
<b>Engineering Knowledge</b>	1	2	3	4	5	6	7	8	9	10	11	12	<b>Problem Analysis</b>	1	2	3	4	5	6	7	8	9	10	11	12	<b>Program Specific outcomes</b>	PSO-1	PSO-2	PSO-3																																			

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>																																																		
<b>CO-1:</b>	Summarize the basic theory underlying machine learning.												<b>CO-2:</b>	Solve general concepts of Internet of Things and recognize various devices, sensors, and applications												<b>CO-3:</b>	Analyze machine learning algorithms to solve problems of moderate complexity.												<b>CO-4:</b>	Estimate to build and integrate IoT platforms, incorporating different types of sensors, actuators, and machine learning methods.												<b>CO-5:</b>	Differentiate the framework for current requirements of applied machine learning with IoT and the issues raised by current research											
<b>Engineering Knowledge</b>	1	2	3	4	5	6	7	8	9	10	11	12	<b>Problem Analysis</b>	1	2	3	4	5	6	7	8	9	10	11	12	<b>Program Specific outcomes</b>	PSO-1	PSO-2	PSO-3																																			

<b>Unit-1 - Machine learning and its Models</b>	<b>9 Hour</b>
Introduction to Machine Learning: Definition of learning systems, Goals and applications of machine learning, Aspects of developing a learning system: training data, concept representation, Role of machine intelligence in IoT, Machine Learning Models: Bayesian classifiers, Nearest-neighbor classifiers, Linear and Polynomial classifiers, Random forests, Decision trees, Support vector machines, Dimensionality reduction methods, K-mean clustering, Artificial neural networks, Deep neural networks	

<b>Unit-2 - IoT- Data analytics</b>	<b>9 Hour</b>
Internet of Things: Data Analytics, IoT analytics challenges, IoT data acquisition, Data Exploration and Pre-processing, IoT technologies, Architecture and Networking protocols, IoT Communication Technologies, Devices and Gateways	

<b>Unit-3 - Sensor &amp; Actuators</b>	<b>9 Hour</b>
Overview of Sensors working, Analog and Digital Sensors, Interfacing of Temperature, Humidity, Motion, Light and Gas Sensor with Arduino, Interfacing of Actuators with Arduino, Interfacing of Relay Switch and Servo Motor with Arduino	

<b>Unit-4 - Computing Framework</b>	<b>9 Hour</b>
Fog computing, Edge computing, Cloud computing, Characteristics of Cloud Computing, Driving factors towards cloud, Architecture, Role of Networks in Cloud computing, protocols used, Role of Web services, Service Models: IaaS, PaaS, SaaS, NaaS, Cloud Clients, Deployment Models: Public Clouds, Community Clouds, Hybrid Cloud, Private Cloud, Issues in Cloud Computing, Applications, Distributed computing.	

**Unit-5 - Machine learning applications with IoT** 9 Hour

Applications of Machine learning in smart cities: Use cases - Smart energy, Smart mobility, Smart citizens, Urban planning, Smart city data characteristics, and applied machine learning algorithms to Internet of Things use cases.

<b>Learning Resources</b>	1. Vijay Madisetti and Arshdeep Bahga, "Internet of Things: A Hands-on Approach", University Press, 2014.	5. D. Barber, "Bayesian Reasoning and Machine Learning", Cambridge University Press, 2012.
	2. C.M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.J. Watt, R. Borhani, and A. K. Katsaggelos "Machine Learning Refined: Foundations, Algorithms and Applications", 1st Edition, Cambridge University Press, 2016.	6. Michael Stanley and Jongmin Lee "Sensor Analysis for the Internet of Things", Morgan & Claypool Publishers, 2018.
	3. Andrew Minteer "Analytics for the Internet of Things (IoT) Intelligent Analytics for your Intelligent Devices", Packt Publishing, 2017.	7. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill, 2017.
	4. Madhumathy P, M Vinoth Kumar and R. Umamaheswari "Machine Learning and IoT for Intelligent Systems and Smart Applications," CRC Press, 2021.	8. Cuno Pfister, "Getting Started with the Internet of Things", O'Reilly Media, 2011.

Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	10%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	30%	-	30%	-		
Level 4	Analyze	30%	-	35%	-	30%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Vignesh, TCS, Bangalore 2. Mr. Adarsh B, Happiest Minds Technologies, Hyderabad	1. Dr. E. Ilavarasan, Puducherry Technological University, Puducherry. 2. Dr. T. M. Thasleema, Professor, Department of CSE, Central University of Kerala.	1. Dr. M. Shobana, SRMIST 2. Dr. A. Suresh, SRMIST

<b>Course Code</b>	21CSE366T	<b>Course Name</b>	INTRODUCTION TO CLOUD APPLICATION DEVELOPMENT FOR IoT	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>												
<b>CLR-1:</b>	Compare the concepts of cloud computing											1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
<b>CLR-2:</b>	Perceive the basic knowledge on developing cloud applications.											Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
<b>CLR-3:</b>	Define the concepts of Internet of Things											-	-	3	2	-	-	-	-	-	-	-	-	3	3	3
<b>CLR-4:</b>	State the knowledge on integrating cloud in IoT platform											-	-	3	2	-	-	-	-	-	-	-	-	3	3	3
<b>CLR-5:</b>	Outline the smart computing of developed IoT applications											-	-	3	2	-	-	-	-	-	-	-	-	3	3	3

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>	
<b>CO-1:</b>	Memorize the cloud computing services and their models
<b>CO-2:</b>	Distinguish the different applications in the cloud environment.
<b>CO-3:</b>	Examine the architecture of IoT and identify the challenges
<b>CO-4:</b>	Implement the concept of IoT cloud convergence in Azure cloud environment
<b>CO-5:</b>	Demonstrate the cloud-based IoT applications in various domains

**Unit-1 - Introduction to Cloud Computing** 9 Hour  
 Introduction – Characteristics of Cloud Computing – Cloud Models – Service Models, Deployment Models - Cloud Service Examples – IaaS – PaaS – SaaS - Cloud-based Services and Applications - Cloud Concepts and Technologies.

**Unit-2 - Developing for Cloud** 9 Hour  
 Cloud services and Platforms - Cloud Application Design - Design considerations for cloud applications - Reference Architectures for Cloud Applications - Cloud Application Design Methodologies - Data Storage Approaches – Cloud Application Development in Python

**Unit-3 - Introduction to IoT** 9 Hour  
 Overview of IoT – IoT Architecture – Smart Computing – IoT Design: Issues and Challenges – Internet of Things Application Development – Application Development Phases – Wireless Technologies for IoT – Protocol Stack – Electronic Platforms – Developing IoT Applications

**Unit-4 - IoT Cloud Convergence** 9 Hour  
 Introduction-Opportunities and Challenges – Architecture for Convergence – Data Offloading and Computation: An IoT Perspective – Dynamic Resource Provisioning – Security aspects in IoT Cloud Convergence - Test Beds and Technologies – Developing IoT Applications in Azure.

**Unit-5 - Smart Computing over IoT - Cloud** 9 Hour  
 Introduction-Big Data Analytics and Cognitive Computing – Deep Learning Approaches – Algorithms, Methods, and Techniques, Case Studies, Enterprise Use Cases for Digital Transformation: Oil and gas industry transformation – License management system – Smart Campus

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>Arshdeep Bahga and Vijay Madisetti, "Cloud Computing: A Hands-On Approach", University Press, 2016.</li> <li>Parikshit N. Mahalle, Nancy Amritta P., Gitanjali Rahul Shinde, and Arvind Vinayak Deshpande, "The Convergence of Internet of Things and Cloud for Smart Computing", Newgen Publishing UK, 2022.</li> <li>Rekha Kodali, Dr. Gopala Krishna Behara, Sankara Narayanan Govindarajulu "Developing Cloud Native Applications in Azure using, NET Core," BPB Publications, 2020.</li> <li>Monika Mangla, Suneeta Salpathy, Bhagirathi Nayak and Sachi Nandan Mohanty, "Integration of Cloud Computing with Internet of Things", Wiley Publications, 2021.</li> </ol>
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)	Life-Long Learning CLA-2 (10%)							
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	10%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	30%	-	30%	-		
Level 4	Analyze	30%	-	35%	-	30%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

#### Course Designers

##### Experts from Industry

- Dr. Thirukkumaran Raman, IIoT COE, Chools Group, Bangalore
- Mr. Adarsh B, Happiest Minds Technologies, Hyderabad

##### Experts from Higher Technical Institutions

- Dr. P. Anandhakumar, Anna University, MIT Campus, Chennai
- Dr. E. Ilavarasan, Puducherry Technological University, Puducherry.

##### Internal Experts

- Dr. S. Thenmalar, SRMIST
- Dr. A. Suresh, SRMIST

<b>Course Code</b>	21CSE367T	<b>Course Name</b>	IoT FORENSICS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		Program Outcomes (PO)												<b>Program Specific outcomes</b>		
CLR-1:	Sense the software vulnerabilities and security solutions to reduce the risk of exploitation in the IoT Devices.	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
<b>CLR-2:</b>	State the performance and troubleshoot cyber security systems.	-	3	3	-	-	-	-	-	-	-	-	-	2	2	-
<b>CLR-3:</b>	Classify and execute risk management processes, risk treatment methods, and key risk and performance indicators	-	3	3	-	-	-	-	-	-	-	-	-	2	2	-
<b>CLR-4:</b>	Articulate knowledge to secure corrupted systems, protect personal data, and secure computer networks in an organization.	-	3	3	-	-	-	-	-	-	-	-	-	2	2	-
<b>CLR-5:</b>	Perceive with an expertise in academics to design and implement security solutions.	-	3	3	-	-	-	-	-	-	-	-	-	2	2	-

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Program Outcomes (PO)												<b>Program Specific outcomes</b>		
CO-1:	Identify the cyber security needs of an organization.	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
<b>CO-2:</b>	Recite key terms and concepts in Cryptography, Governance and Compliance.	-	3	3	-	-	-	-	-	-	-	-	-	2	2	-
<b>CO-3:</b>	Practice cyber security solutions and use of cyber security, information assurance, and cyber/computer forensics software/tools.	-	3	3	-	-	-	-	-	-	-	-	-	2	2	-
<b>CO-4:</b>	Understand IoT security architecture and investigate cybercrime issues.	-	3	3	-	-	-	-	-	-	-	-	-	2	2	-
<b>CO-5:</b>	Analyze the importance of IoT security in future and in agile development.	-	3	3	-	-	-	-	-	-	-	-	-	2	2	-

**Unit-1 - Overview of Digital Forensics** 9 Hour  
 Introduction to Digital Forensics, branches of digital forensics, digital evidence, Types of Evidence, Chain of custody, types of Cyber Crime, types of cyber criminals, crime scene management, evidence collection techniques - Switched Off System, Live System, Live response and triage-based acquisition techniques, order of volatility.

**Unit-2 - Evidence Collection** 9 Hour  
 Analysis of evidence, concept of imaging and cloning, file formats of forensic images, concept of write blocker, Hardware and Software Write blocker, Hash Function, fuzzy hash and hash collision, data recovery, tools for image creation and analysis.

**Unit-3 - File Artifacts** 9 Hour  
 MFT analysis, recycle bin forensics, i30 analysis, other NTFS artifacts - data, UsnJrnl, amcache, shimcache, shellbags, Ink files, jump lists, USB, and Bring Your Own Device (BYOD) Forensic Examinations, Incident response procedure, browser forensics, printer artifacts, yellow dot concept in printer forensics.

**Unit-4 - IoT Device Architecture** 9 Hour  
 Introduction to Internet of Things, IoT Architecture, Characteristics of IoT, IoT Security Challenges and Factors of Threat, Effects of IoT Security Breach, Role of Digital Forensics in Cybercrime Investigation for IoT, IoT in Digital Forensic, Digital Forensics Investigation Framework for IoT Devices, Road Map for Issues in IoT Forensics, IoT Security Steps, How to Access IoT Security.

**Unit-5 - IoT Security****9 Hour**

*Introduction to IoT Sensors: Security in Network Forensics, Cybersecurity Versus IoT Security and Cyber-Physical Systems , The IoT of the Future and the Need to Secure , The Future—Cognitive Systems and the IoT , Security Engineering for IoT Development , Building Security Into Design and Development , Security in Agile Developments , Focusing on the IoT Device in Operation , Cryptographic Fundamentals for IoT Security Engineering , Types and Uses of Cryptographic Primitives in the IoT , Encryption and Decryption , Symmetric Encryption , Asymmetric Encryption , Digital Signatures.*

<b>Learning Resources</b>	1. Darren R. Hayes, "A Practical Guide to Computer Forensics Investigations", Pearson Publisher, 2014.	4. Amelia Phillips, Bill Nelson, and Christopher Steuart, "Guide to Computer Forensics and Investigations", Fifth Edition, Cengage Learning, 2015.
	2. Eoghan Casey, "Digital Evidence and Computer Crime: Forensic Science, Computers and Book", 3rd Edition, Academic press, 2011. Eoghan Casey, "Handbook of Digital Forensics and Investigation", Academic press, 2009.	5. Rohatgi, Shipra, and Sakshi Srivastava, "A Generic Digital Scientific Examination System for Internet of Things",
	3. Michael Hale Ligh, Andrew Case, Jamie Levy, A. Aron Walters "The Art of Memory Forensics: Detecting Malware and Threats in Windows, Linux, and Mac Memory", 1st Edition, John Wiley&Sons, 2014.	6. Digital Forensics and Internet of Things: Impact and Challenges, pp: 87-110, Wiley, 2022.
		7. Karthika, D, "IoT Sensors: Security in Network Forensics," Digital Forensics and Internet of Things: Impact and
		8. Challenges, pp: 111-129, Wiley, 2022.

**Learning Assessment**

Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1 Remember	15%	-	10%	-	15%	-
Level 2 Understand	25%	-	25%	-	25%	-
Level 3 Apply	30%	-	30%	-	30%	-
Level 4 Analyze	30%	-	35%	-	30%	-
Level 5 Evaluate	-	-	-	-	-	-
Level 6 Create	-	-	-	-	-	-
Total	100 %		100 %		100 %	

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Anand Gurupatham, Renault Nissan, Chennai	1. Dr. Arulprakash, Professor, IIT Madras	1. Dr. C.N.S. Vinoth Kumar, SRMIST
2. Dr. Saravanan, Mahindra & Mahindra, Chennai	2. Dr. Raju Abraham, NIOT, Chennai	2. Dr. P. Madhavan, SRMIST

<b>Course Code</b>	21CSE368J	<b>Course Name</b>	NETWORK PROGRAMMING FOR IoT	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 0	P 2	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>													
<b>CLR-1:</b>	Articulate strong Practical skill on Raspberry Pi											1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3	
<b>CLR-2:</b>	Identify the Python programming Environment for Raspberry Pi											Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning				
<b>CLR-3:</b>	Perceive the basics of Cloud for IOT																										
<b>CLR-4:</b>	Implement Raspberry with the networks																										
<b>CLR-5:</b>	Engage small projects using IOT devices																										
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>																											
<b>CO-1:</b>	Hands on Hardware interfacing with Raspberry Pi															-	-	2	-	3	-	-	-	-	-	3	3
<b>CO-2:</b>	Configuration of Python on Raspberry Pi															-	-	2	-	3	-	-	-	-	-	3	3
<b>CO-3:</b>	Practice AWS for IoT															-	-	2	-	3	-	-	-	-	-	3	3
<b>CO-4:</b>	Implement the Networking of Raspberry Pi															-	-	2	-	3	-	-	-	-	-	3	3
<b>CO-5:</b>	Analyze and Demonstrate Real – time IoT systems with Python and Java															-	-	3	-	3	-	-	-	-	-	3	3

<b>Unit-1 - Raspberry Pi</b>	<b>12 Hour</b>
Introduction to Raspberry Pi: Getting Started with Raspberry Pi: Basic functionality of Raspberry Pi, setting up the board, booting Raspberry Pi 3, Downloading an Operating System, format an SD card and booting the OS, Interfacing Hardware with the Raspberry Pi, Raspberry Pi Remote Access, Bash Command line.	
<b>Unit-2 - Python for IOT</b>	
Python: Basics of Python programming language: Programming on the Raspberry Pi. Python on Raspberry Pi, Python Programming Environment - Micro Python: Features, Limitations, Experimenting with Python on PC, Installing Python 3 on Windows 10, Running the Python Console, Running Python Programs with the Interpreter.	
<b>Unit-3 - Cloud Storage for IOT</b>	
Introduction - Communication API - WAMP: AutoBahn for IoT - Xively Cloud for IoT - Python Web Application Framework: Djanjo - Amazon Web Services for IoT - Case Studies: Weather Monitoring system.	
<b>Unit-4 - Powering Pi</b>	
Installing Raspbian – formatting SD Cards – Connecting Raspberry Pi – Networking your Raspberry Pi, via Wireless Network – Creating Simple Raspberry Pi Application	
<b>Unit-5 - Case Study Projects</b>	
NetBeans – Introduction, Downloading and Configuring NetBeans, Revisiting Hello Raspberry Pi - Binary Timer – IOT Hat – Building Motion Activated Alarm System with Python	

#### **Lab Experiments**

1. Installation and Booting of Raspberry Pi
2. Interfacing Raspberry Pi with the Operating System
3. Sensing the available networks
4. Basics commands in Raspberry Pi
5. Python Programming on Raspberry Pi
6. Expressions, Functions, Strings
7. Sense the Finger using Raspberry Pi
8. Temperature Notification using Raspberry Pi
9. MySQL Database Installation in Raspberry Pi
10. SQL Queries by Fetching Data from Database in Raspberry Pi
11. Switch Light on and Off Based on the Input of User Using Raspberry Pi
12. Connecting Raspberry Pi through Wireless Networks
13. Downloading and configuring NetBeans
14. Weather Monitoring System
15. Mini - Project

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Simon Monk, "Programming the Raspberry Pi: Getting Started with Python", McGraw Hill Professional, 2012</li> <li>2. Charles Bell, "Micro Python for the Internet of Things, A Beginner's Guide to Programming with Python on Microcontrollers", Apress, 2017.</li> </ol>	<ol style="list-style-type: none"> <li>3. Stephen Chin and James L Weaver, "Rasberry Pi with Java: Programming the Internet of Things (IOT)", McGraw-Hill, 2015</li> <li>4. Jason Van Schooneveld, "Build Physical Projects with Python on the Raspber Pi", 2020. <a href="https://realpython.com/python-raspberry-pi/">https://realpython.com/python-raspberry-pi/</a></li> </ol>
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#### **Learning Assessment**

Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%
Level 2	Understand	25%	-	-	20%	25%
Level 3	Apply	30%	-	-	20%	30%
Level 4	Analyze	30%	-	-	25%	30%
Level 5	Evaluate	-	-	-	15%	-
Level 6	Create	-	-	-	05%	-
	Total	100 %		100 %		100 %

#### **Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Anand Gurupatham, Renault Nissan, Chennai	1. Dr. Arulprakash, Professor, IIT Madras	1. Dr. S. Thanga Revathi, SRMIST
2. Dr. Saravanan, Mahindra & Mahindra, Chennai	2. Dr. Raju Abraham, NIOT, Chennai	2. Dr. Mary Subaja Christo, SRMIST

<b>Course Code</b>	21CSE369J	<b>Course Name</b>	INTRODUCTION TO SECURITY OF INTERNET OF THINGS AND CYBER-PHYSICAL SYSTEMS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	2	<b>T</b>	0	<b>P</b>	2	<b>C</b>	3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Restate the basics of security challenges for IoT and Cyber Physical Systems												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	Recognize about the IoT Economy and the Need for IoT Security																								
<b>CLR-3:</b>	State the Secured IoT Systems Architectures																								
<b>CLR-4:</b>	Define the secured connectivity in IoT Systems																								
<b>CLR-5:</b>	Articulate towards Privacy and Access Control for IoT Security																								
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Outline the security challenges in IoT and CPS Platforms												-	-	3	2	-	-	-	-	-	-	-	3	3
<b>CO-2:</b>	Report the importance of IoT security in IoT Economy												-	-	3	2	-	-	-	-	-	-	-	3	3
<b>CO-3:</b>	Examine the Various Architectures in the IoT Systems												-	-	3	2	-	-	-	-	-	-	-	3	3
<b>CO-4:</b>	Classify the communication protocols and analyze their security concerns in Industrial IoT												-	-	3	2	-	-	-	-	-	-	-	3	3
<b>CO-5:</b>	Investigate the privacy and Access control in IoT Systems												-	-	3	2	-	-	-	-	-	-	-	3	3

<b>Unit-1 - Security Challenges in IoT and Cyber Physical Systems</b>	<b>12 Hour</b>
IoT Architectures, Properties and Security Requirements – Constrained Application Protocol – Datagram Transport Layer Security – Cyber Physical Systems (CPS) and Communications – CPS Models and Security Aspects – CPS Security Threats	
<b>Unit-2 - IoT Economy and Need for IoT Security</b>	
IoT System – IoT Components and Need for Security – Analyzing the Mirai Attack – Defending IoT Castle – Attacking IoT Castle and Breach Consequences – Understanding the IoT Economy and Cybercriminal Economy – Cryptocurrency and where Cybercriminal go to hide	
<b>Unit-3 - Architecting Secured IoT Systems</b>	
IoT System Architecture – IoT: Low-Cost System – IoT Architecture Layers – Fundamental Cloud Architecture and Security Architecture in IoT Systems – Security Architecture Process – Security Concerns of Industrial IoT	
<b>Unit-4 - Secure Connections</b>	
Connectivity in IoT – IoT Communication Protocol Classifications – Network Security for IoT – Security Analysis for Protocols – AI and IoT Unite – Safe Driving App meets Smart Fridge	
<b>Unit-5 - Privacy and Access Control</b>	
Information Privacy – Personal Information and Personal Knowledge – Privacy Controls – Privacy Legislations –Challenges of IoT Security Usability – Principles for Designing Usable IoT Security Controls	

<b>Lab Experiments</b>
<ol style="list-style-type: none"> <li>1. Wireshark filters and PCAP inspection</li> <li>2. Nmap scan of an IoT device and exploitation with Metasploit</li> <li>3. Burp Suite interception on IoT web portal for exposed secrets</li> <li>4. Using Postman to send password data to an IoT API</li> <li>5. Exploiting an IoT portal for consumer-grade devices</li> <li>6. Injecting commands into vulnerable IoT web services</li> <li>7. Obtaining and analyzing Specification Sheets</li> <li>8. Sniffing serial and SPI</li> <li>9. Recovering firmware from PCAP</li> <li>10. Recovering filesystems with binwalk</li> <li>11. Pillaging the filesystem</li> <li>12. WiFi PSK cracking</li> <li>13. BLE device interaction</li> <li>14. Zigbee traffic capture</li> <li>15. Conducting a replay transmission attack on IoT</li> </ol>

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Song Guo, Deze Zeng, "Cyber-Physical Systems: Architecture, Security and Application," Springer, First Edition, 2019</li> <li>2. David M Wheeler Damilare D Fagbemi and JC Wheeler, "The IoT Architect's Guide to Attainable Security and Privacy," CRC Press Taylor &amp; Francis Group, First Edition, 2020.</li> <li>4. Roshani Raut, Sandeep Kautish, Zdzislaw Polkowski, Anil Kumar, Chuan-Ming Liu, "Green Internet of Things and Machine Learning," Scrivener Publishing, Wiley, 2022.</li> <li>5. Anand Tamboli, "Build Your Own IoT Platform Develop a Flexible and Scalable Internet of Things Platform", Second Edition, Apress, 2022.</li> </ol>
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<b>Learning Assessment</b>		<i>Bloom's Level of Thinking</i>	Continuous Learning Assessment (CLA)				<i>Summative Final Examination (40% weightage)</i>			
			Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)					
			Theory	Practice	Theory	Practice				
Level 1	Remember	Remember	15%	-	-	15%	15%	-		
Level 2	Understand	Understand	25%	-	-	20%	25%	-		
Level 3	Apply	Apply	30%	-	-	20%	30%	-		
Level 4	Analyze	Analyze	30%	-	-	35%	30%	-		
Level 5	Evaluate	Evaluate	-	-	-	10%	-	-		
Level 6	Create	Create	-	-	-	-	-	-		
		Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
<ol style="list-style-type: none"> <li>1. Dr. R. Lenin Babu, Conversight.Ai, USA,</li> <li>2. Mr. U. Aravind Kumar, JPA Solutions, Bangalore,</li> </ol>	<ol style="list-style-type: none"> <li>1. Dr. K. Selvakumar, Professor, Annamalai University,</li> <li>2. Dr. K. G. Srinivasa, Professor, NITTR Chandigarh,</li> </ol>	<ol style="list-style-type: none"> <li>1. Dr. C. Rajesh Babu, SRMIST</li> <li>2. Dr. B. Balakiruthiga, SRMIST</li> </ol>

<b>Course Code</b>	21CSE370J	<b>Course Name</b>	DATA VISUALIZATION FOR IoT	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 0	P 2	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>													
<b>CLR-1:</b>	Relate the various types of data, apply, and evaluate the principles of data visualization												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>												
<b>CLR-2:</b>	Convert skills to visualization Techniques to a problem																										
<b>CLR-3:</b>	Retrieve structured approach to create effective visualization																										
<b>CLR-4:</b>	Extend valuable insight from the massive dataset using visualization																										
<b>CLR-5:</b>	Label interactive visualization for better insight using visualization tools																										
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning		
<b>CO-1:</b>	List the different data types, visualization types to bring out the insight and create, interpret plots												-	-	3	-	2	-	-	-	-	-	-	2	2	-	
<b>CO-2:</b>	Interpret the visualization towards the problem based on the dataset to bring out valuable insight.												-	-	3	-	2	-	-	-	-	-	-	2	2	-	
<b>CO-3:</b>	Demonstrate the analysis of a large dataset using various visualization techniques and tools.												-	-	3	-	-	2	-	-	-	-	-	-	2	2	-
<b>CO-4:</b>	Solve the streaming visualization Techniques for large scale data												-	-	3	-	2	-	-	-	-	-	-	-	2	2	-
<b>CO-5:</b>	Categorize various visualizations for geospatial and to Design visualization dashboard.												-	-	-	3	2	-	-	-	-	-	-	-	2	2	-

<b>Unit-1 - Introduction to Data Visualization and its Techniques</b>	<b>12Hour</b>
Overview of data visualization -Data Abstraction - Task Abstraction - Analysis: Four Levels for Validation. Visualization Techniques- Scalarand Point techniques-Colormaps- Contouring-Height Plots-Vector visualization techniques–Vector properties–Vector Glyphs–Vector Color Coding–Matrix visualization techniques.	
<b>Unit-2 - Visual Analysis and Types</b>	
VisualVariables-NetworksandTrees-MapColorandOtherChannels-ManipulateView-Heat Map. Time- Series data visualization – Text data visualization – Multivariate data visualization and case studies.	
<b>Unit-3 - Visualization Tools &amp; Techniques</b>	
Introduction to various data visualization tools: R –basics, Data-preprocessing, Statistical analysis, Plotly and ggplot library, Tableau, D3.js, Gephi.	
<b>Unit-4 - Visualization of Streaming Data</b>	
Best practices of Data Streaming, processing streaming data for visualization, presenting streaming data, streaming visualization techniques, streaming analysis.	
<b>Unit-5 - Geo-Spatial Visualization and Dashboard Creations</b>	
Chloropleth map, Hexagonal Binning, Dotmap, Cluster map, cartogram map, Dashboard creation using visualization tools for the IOT related use case applications.	

<b>Lab Experiments</b>
<ol style="list-style-type: none"> <li>1. A Study on R-programming tool</li> <li>2. A study on the Data Visualization Techniques</li> <li>3. Experiments on Acquiring and plotting data using R.</li> <li>4. Perform Correlation regression and analysis of variance on a dataset and visualize the results</li> <li>5. Explore Statistical Analysis- Multivariate Analysis</li> <li>6. Explore on the various libraries used for Text processing and perform Text visualization</li> <li>7. Perform PCA on a dataset and visualize the results</li> <li>8. A study on Tableau and Gephi Tools</li> <li>9. Preparing and training data based on K-means clustering analysis using R</li> <li>10. Using R programming deploy Histogram and Heat-map on a Streaming dataset and provide proper inference</li> <li>11. Experiment on Time-series analysis for stock market dataset</li> <li>12. Experiment on Visualization of massive dataset generated from IOT related applications</li> <li>13. Experiment on Visualization on Streaming dataset such as Stock market dataset, weather forecasting</li> <li>14. Perform effective visualization using Chloropleth map, Dotmap, and Cluster map</li> <li>15. Perform Dashboard creation for an IOT application using visualization tools</li> </ol>

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Tamara Munzer, "Visualization Analysis and Design", CRC Press, 2014.</li> <li>2. Aragues Anthony, "Visualizing Streaming Data: Interactive Analysis Beyond Static Limits", O'Reilly Media, Inc., 2018.</li> <li>3. Dr. Chun-hauh Chen, W.K.Hardle, A. Unwin, "Hand book of Data Visualization", Springer publication, 2016.</li> <li>4. Christian Toninski, Heidrun Schumann, "Interactive Visual Data Analysis", CRC press publication, 2020.</li> <li>5. Alexandru C. Telea, "Data Visualization: Principles and Practice", AK Peters, 2014.</li> </ol>
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<b>Learning Assessment</b>							
Bloom's Level of Thinking	Continuous Learning Assessment (CLA)					Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)				
	Theory	Practice	Theory	Practice	Theory	Practice	
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	30%	-	-	30%	30%	-
Level 4	Analyze	30%	-	-	25%	30%	-
Level 5	Evaluate	-	-	-	10%	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. Albert Rex, @HP Company, Chennai	1. Dr. Ameer, National Institute of Technology, Calicut	1. Dr. K. Nimala, SRMIST
2. Mr. Rajachozhan, Zoho Corp, Chennai	2. Dr. Raju Abraham, NIOT, Chennai	2. Mr. V. Nallarasan SRMIST

<b>Course Code</b>	21CSE371J	<b>Course Name</b>	IoT TECHNIQUES, TOOLS, AND ITS APPLICATION	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
							2	0	2	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Restate the phases in developing a flexible and scalable IoT Platform												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	Label the software defined approach to IoT																								
<b>CLR-3:</b>	Conclude the IoT Eco Systems and Services																								
<b>CLR-4:</b>	Grasp the role of Blockchain in IoT																								
<b>CLR-5:</b>	Articulate towards Green IoT Applications																								
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Discuss and define IoT Eco-System												-	-	2	-	3	-	-	-	-	-	-	3	3
<b>CO-2:</b>	Examine the IoT services and challenges												-	-	2	-	3	-	-	-	-	-	-	3	3
<b>CO-3:</b>	Exploit Blockchain and standards in IoT												-	-	2	-	3	-	-	-	-	-	-	3	3
<b>CO-4:</b>	Demonstrate Software Defined Internet of Everything in smart city												-	-	2	-	3	-	-	-	-	-	-	3	3
<b>CO-5:</b>	Summarize Green IoT Applications												-	-	2	-	3	-	-	-	-	-	-	3	3

<b>Unit-1 - IoT Eco-Systems</b>	<b>12 Hour</b>
IoT Reference Framework – OSI Model for IoT – IoT Requirements for Networking Protocols – IoT Protocol Stack: Link Layer and Internet Layer, IoT Protocol Stack: Application Protocols Layer, IoT Protocol Stack: Application Services Layer.	
<b>Unit-2 - IoT Services and Challenges</b>	
IoT Services Platform and Manager – Manager Discovery and Communications Manager – Element, Firmware, Topology and Group Manager – IoT Security Challenges and Requirements – IoT Domain Architecture, Attacks and Countermeasures – IoT Verticals	
<b>Unit-3 - Blockchain and Standards in IoT</b>	
Blockchain – Evolution and Anatomy of Blockchain – Features of Blockchain – Blockchain Applications in IoT – Blockchain Security in IoT – Industry Organizations and Standards Landscape	
<b>Unit-4 - Software Defined Internet of Everything</b>	
Internet of Everything- Smart city Integrated Perspective – Traditional Network Architecture – SDN Network Architecture – Application Scenario Analysis – Architecture and Deployment Models of SDN Protocols - Network Policies for Internet of Everything	
<b>Unit-5 - Green IoT</b>	
Green IoT and ML for Smart Computing – Machine Learning based Smart Applications- Lifecycle of Green IoT – Applications, Challenges and Opportunities for Green IoT – Machine Learning Enabled Techniques for Energy Consumption of IoT Devices – Energy Efficient Routing Infrastructure for Green Computing	

#### **Lab Experiments**

1. A Study on R-programming tool
2. A study on the Data Visualization Techniques
3. Experiments on Acquiring and plotting data using R.
4. Perform Correlation regression and analysis of variance on a dataset and visualize the results
5. Explore Statistical Analysis- Multivariate Analysis
6. Explore on the various libraries used for Text processing and perform Text visualization
7. Perform PCA on a dataset and visualize the results
8. A study on Tableau and Gephi. Tools
9. Preparing and training data based on K-means clustering analysis using R
10. Using R programming deploy Histogram and Heat-map on a Streaming dataset and provide proper inference
11. Experiment on Time-series analysis for stock market dataset
12. Experiment on Visualization of massive dataset generated from IOT related applications
13. Experiment on Visualization on Streaming dataset such as Stock market dataset, weather forecasting
14. Perform effective visualization using Chloropleth map, Dotmap, and Cluster map
15. Perform Dashboard creation for an IOT application using visualization tools

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Ammar Rayes and Samer Salam, "Internet of Things from Hype to Reality", Third Edition, Springer, 2022</li> <li>2. Gagangeet Singh Aujla, Sahil Garg Kuljeet Kaur and Biplob Sikdar, "Software Defined Internet of Everything", First Edition, Springer, 2022.</li> </ol>	<ol style="list-style-type: none"> <li>3. Roshani Raut, Sandeep Kautish, Zdzislaw Polkowski, Anil Kumar and Chuan-Ming Liu, "Green Internet of Things and Machine Learning", Scrivener Publishing, Wiley, 2022</li> <li>4. Anand Tamboli, "Build Your Own IoT Platform Develop a Flexible and Scalable Internet of Things Platform", Second Edition, Apress, 2022.</li> </ol>
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Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%
Level 2	Understand	25%	-	-	20%	25%
Level 3	Apply	30%	-	-	30%	30%
Level 4	Analyze	30%	-	-	25%	30%
Level 5	Evaluate	-	-	-	10%	-
Level 6	Create	-	-	-	-	-
	Total	100 %		100 %		100 %

#### **Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr R Lenin Babu, Conversight.Ai, USA, 2. Mr. U. Aravind Kumar, JPA Solutions, Bangalore,	1. Dr. K. Selvakumar, Professor, Annamalai University, 2. Dr. K. G. Srinivasa, Professor, NITTR Chandigarh,	1. Dr. C. Rajesh Babu , SRMIST 2. Dr. B. Balakiruthiga, SRMIST

<b>Course Code</b>	21CSE467T	<b>Course Name</b>	ADVANCED DATABASE SYSTEMS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		Program Outcomes (PO)												<b>Program Specific outcomes</b>		
CLR-1:	Restate the Fundamentals of Internet of Things and its technologies and Distributed processing techniques for IoT	1	2	3	4	5	6	7	8	9	10	11	12			
<b>CLR-2:</b>	Label the uses of Machine Learning in IoT, DL framework and cloud platforms for IoT.	-	-	2	3	-	-	-	-	-	-	-	-	PSO-1	PSO-2	PSO-3
<b>CLR-3:</b>	State the deep learning applications for IoT, Image Recognition, Speech/ Voice Recognition	-	-	2	3	-	-	-	-	-	-	-	-	2	3	-
<b>CLR-4:</b>	Articulate indoor localization and state detection techniques with available classifier.	-	-	2	3	-	-	-	-	-	-	-	-	2	3	-
<b>CLR-5:</b>	Grasp deep learning techniques in real time examples.	-	-	2	3	-	-	-	-	-	-	-	-	2	3	-

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Program Outcomes (PO)												<b>Program Specific outcomes</b>		
CO-1:	Classify the basic theory underlying in Internet of Things.	1	2	3	4	5	6	7	8	9	10	11	12			
<b>CO-2:</b>	Describe the Deep learning techniques in IoT and its limitations	-	-	2	3	-	-	-	-	-	-	-	-	2	3	-
<b>CO-3:</b>	Solve deep learning algorithms and problems of moderate complexity.	-	-	2	3	-	-	-	-	-	-	-	-	2	3	-
<b>CO-4:</b>	Analyze Indoor Localization and IoT based human psychological and psychological state detection using Deep Learning Techniques.	-	-	2	3	-	-	-	-	-	-	-	-	2	3	-
<b>CO-5:</b>	Investigate security attacks in IoT and detections, with real time examples.	-	-	2	3	-	-	-	-	-	-	-	-	2	3	-

**Unit-1 - Introduction** 9 Hour  
 Internet of Things - Data Analytics, IoT analytics challenges, IoT data acquisition, Data Exploration and Pre-processing, IoT technologies, Architecture and Networking protocols, IoT Communication – Data Access and Distributed processing for IoT.

**Unit-2 - IoT Ecosystems, Deep Learning Techniques, and Frameworks** 9 Hour  
 The End-to-End Life Cycle of the IoT - IoT application domains- The key characteristics and requirements of IoT data – Realtime Examples - Deep Learning Architectures for IoT - A soft introduction to ML - ML tasks - Delving into DL - Artificial neural networks - Neural network architectures - DL frameworks and cloud platforms for IoT – Limitations of IoT devices, edge/fog computing, and cloud perspective.

**Unit-3 - Deep Learning Application for IoT** 9 Hour  
 Image Recognition in IoT - IoT applications and image recognition - Transfer learning for image recognition in IoT - CNNs for image recognition in IoT applications - Audio/Speech/Voice Recognition in IoT - Speech/voice recognition for IoT - DL for sound/audio recognition in IoT - CNNs and transfer learning for speech recognition in IoT applications

**Unit-4 - Indoor Localization and State Detection** 9 Hour  
 Indoor Localization in IoT - An overview of indoor localization - Techniques for indoor localization - DL-based indoor localization for IoT - K-nearest neighbor (k-NN) classifier - AE classifier - Physiological and Psychological State Detection in IoT - IoT-based human physiological and psychological state detection - Deep learning for human activity and emotion detection in IoT - LSTM, CNNs, and transfer learning for HAR/FER in IoT applications - Data collection - Data exploration - Data preprocessing - Model training - Model evaluation.

**Unit-5 - IoT Security****9 Hour**

Security attacks in IoT and detections - Anomaly detection and IoT security - DL for IoT security incident detection - DNN, autoencoder, and LSTM in IoT security incidents detection - Advanced Aspects and Analytics in IoT - Predictive Maintenance for IoT - DL for predicting RLU – Realtime Examples - Deep Learning in Healthcare IoT - CNN and LSTM in healthcare applications – Deep Learning for Smart Cities IoT- Deep Learning for Industrial IoT

<b>Learning Resources</b>	1. Mohammad Abdur Razzaque and Md. Rezaul Karim, "Hands on Deep Learning for IoT", First Edition, Packet Publishing Ltd, 2019. 2. Amita Kapoor, "Hands on Deep Learning for IoT", First Edition, Packet Publishing Ltd, 2019.	3. Vijay Madisetti, Arshdeep Bahga, "Internet of Things: A Hands-on Approach", University Press, 2014 4. Andrew Minter, "Analytics for the Internet of Things (IoT) Intelligent Analytics for Your Intelligent Devices", Packt Publishing, 2017 5. Cuno Pfister, "Getting Started with the Internet of Things", O'Reilly Media, 2011.
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**Learning Assessment**

Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
	Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	15%	-	10%	-	15%	-	
Level 2	Understand	25%	-	25%	-	25%	-	
Level 3	Apply	30%	-	30%	-	30%	-	
Level 4	Analyze	30%	-	35%	-	30%	-	
Level 5	Evaluate	-	-	-	-	-	-	
Level 6	Create	-	-	-	-	-	-	
	Total	100 %		100 %		100 %		

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. R. Lenin Babu, Conversight AI, USA. 2. Mr. Vignesh, TCS, Bangalore	1. Dr. K. G. Srinivasa, Professor, NITTR Chandigarh, 2. Dr. E. Ilavarasan, Puducherry Technological University, Puducherry.	1. Dr. Meenakshi K, SRMIST 2. Dr. M. Shobana, SRMIST

<b>Course Code</b>	21CSE468T	<b>Course Name</b>	EDGE COMPUTING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>												
<b>CLR-1:</b>	Compare the concepts and technologies of IoT and Edge											1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
<b>CLR-2:</b>	State IoT and M2M communication											-	-	3	2	-	-	-	-	-	-	-	-	3	3	-
<b>CLR-3:</b>	Outline the protocols and standards of IoT and Edge											-	-	3	2	-	-	-	-	-	-	-	-	3	3	-
<b>CLR-4:</b>	Label the edge computing Architecture and its components											-	-	3	2	-	-	-	-	-	-	-	-	3	3	-
<b>CLR-5:</b>	Recognize the integration of Edge and Cloud Computing for IoT											-	-	3	2	-	-	-	-	-	-	-	-	3	3	-

**Course Outcomes (CO):** *At the end of this course, learners will be able to:*

<b>CO-1:</b>	Distinguish the concepts and technologies of IoT and Edge
<b>CO-2:</b>	Summarize the IoT and M2M Communication
<b>CO-3:</b>	Hands on practice on Arduino and RaspberryPi
<b>CO-4:</b>	Investigate the different cloud and edge analytics
<b>CO-5:</b>	Demonstrate the Edge computing integration with Cloud and IoT in an industrial application.

Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
-	-	3	2	-	-	-	-	-	-	-	-	3	3	-
-	-	3	2	-	-	-	-	-	-	-	-	3	3	-
-	-	3	2	-	-	-	-	-	-	-	-	3	3	-
-	-	3	2	-	-	-	-	-	-	-	-	3	3	-

**Unit-1 - IoT and Edge Computing** 9 Hour

Introduction to IoT – IoT Applications – Challenges in IoT – Introduction to Edge Computing – Need for Edge Computing – Challenges in Edge Computing

**Unit-2 - Edge Architecture and Protocols** 9 Hour

IoT Architecture – IoT versus Machine-to-Machine communication – IoT and Edge architecture - IoT and Edge Protocols – MQTT, COAP, AMQP, Low Power Lossy Network Routing, HTTP– Communication methods – Bluetooth, Zigbee, 6LowPAN, LoRaWAN, 5G, WiFi.

**Unit-3 - Modelling and Simulation** 9 Hour

ESP32, Arduino, RaspberryPi: Introduction, RaspberryPi Board: Hardware Layout and Pinouts, Operating Systems on RaspberryPi, Edge to Cloud Protocols, MQTT, MQTT publish- subscribe, MQTT architecture details, MQTT state transitions, MQTT packet structure, MQTT data types, MQTT communication formats –Introduction to fog Computing – Relationship between Edge and Fog with Cloud Computing - Fog/Edge Simulator: iFogSim, Edge CloudSim, Cloud4Net

**Unit-4 - Big Data Analytics in Edge Computing** 9 Hour

Big Data – Data Types in Big Data – Characteristics of big data – Benefits – Applications – Big Data Layered Architecture – Big Data Implementation: Hortonworks, Cloudera, MAP R – Edge Analytics – Benefits of Edge analytics – Difference between cloud analytics and edge analytics

**Unit-5 - Case Study / Industrial Applications** 9 Hour

Edge for Continuous Motion Recognition – Edge for Recognition of Sound from audio – Edge analytics in Irrigation System – IoT-Edge for Smart Energy Management – Edge analytics in Remote Monitoring and Maintenance for an industry – Edge analysis in Healthcare System – Smart Building.

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>K. Anitha Kumari, G. Sudha Sadasivam, D. Dharani, and M. Niranjanamurthy "Edge Computing: Fundamentals, Advances and Applications", (Advances in Industry 4.0 and Machine Learning), 1<sup>st</sup> Edition, CRC Press, 2021.</li> <li>Rajkumar Buyya and Satish Narayana Srirama, "Fog and Edge Computing: Principles and Paradigms", Wiley, 2019.</li> <li>Ripon Patgiri, Sivaji, and M.D. Borah "Edge Analytics," Springer, <a href="https://link.springer.com/book/10.1007/978-981-19-0019-8">https://link.springer.com/book/10.1007/978-981-19-0019-8</a>, 2022.</li> <li><a href="http://rucon.ec.tuwien.ac.at/files/Aral,%20De%20Maio%20-%20202020%20-%20Simulators%20and%20Emulators%20for%20Edge%20Computing.pdf">http://rucon.ec.tuwien.ac.at/files/Aral,%20De%20Maio%20-%20202020%20-%20Simulators%20and%20Emulators%20for%20Edge%20Computing.pdf</a></li> <li><a href="https://arxiv.org/ftp/arxiv/papers/1910/1910.03026.pdf">https://arxiv.org/ftp/arxiv/papers/1910/1910.03026.pdf</a></li> </ol>
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<b>Learning Assessment</b>		<b>Continuous Learning Assessment (CLA)</b>				<b>Summative Final Examination (40% weightage)</b>	
<i>Bloom's Level of Thinking</i>	<i>Formative CLA-1 Average of unit test (50%)</i>	<i>Life-Long Learning CLA-2 (10%)</i>					
		<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>
Level 1	<i>Remember</i>	15%	-	10%	-	15%	-
Level 2	<i>Understand</i>	25%	-	25%	-	25%	-
Level 3	<i>Apply</i>	30%	-	30%	-	30%	-
Level 4	<i>Analyze</i>	30%	-	35%	-	30%	-
Level 5	<i>Evaluate</i>	-	-	-	-	-	-
Level 6	<i>Create</i>	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. U. Aravind Kumar, JPA Solutions, Bangalore. 2. Mr. U. Aravind Kumar, JPA Solutions, Bangalore,	1. Dr. M. D. Selvaraj, Indian Institute of Information Technology, Chennai 2. Dr. K. G. Srinivasa, Professor, NITTR Chandigarh,	1. Mrs. V. Vijayalakshmi, SRMIST 2. Dr. A. Suresh. SRMIST

<b>Course Code</b>	21CSE469T	<b>Course Name</b>	ENERGY MANAGEMENT FOR IoT DEVICES	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Restate the rudiments of energy conservation and IoT												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	State the knowledge on various energy conservation schemes in IoT																								
<b>CLR-3:</b>	Utilize the conventional and optimization algorithms for conserving energy in IoT devices																								
<b>CLR-4:</b>	Find the various techniques of green IoT and impact of conventional techniques of IoT																								
<b>CLR-5:</b>	Articulate the knowledge on existing energy efficient architecture for energy conservation and harvesting																								
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Interpret the knowledge on IoT and energy conservation approaches in IoT												-	3	-	2	-	-	-	-	-	-	2	3	-
<b>CO-2:</b>	Choose appropriate energy conservation component for real world problems												-	3	-	2	-	-	-	-	-	-	2	3	-
<b>CO-3:</b>	Experiment the appropriate energy conservation algorithms for improving the lifetime of IoT devices												-	3	-	2	-	-	-	-	-	-	2	3	-
<b>CO-4:</b>	Analyze various green IoT techniques and able to design green IoT for real world problems												-	3	-	2	-	-	-	-	-	-	2	3	-
<b>CO-5:</b>	Develop and demonstrate energy efficient architecture for real world problems												-	3	-	2	-	-	-	-	-	-	2	3	-

<b>Unit-1 - Introduction</b>	<b>9 Hour</b>
Introduction to IoT, Architecture of IoT, Components of IoT, Applications of IoT, Challenges in IOT, Energy Management in IoT, Energy harvesting, Block diagram of energy harvesting, Various ambient energies, Energy harvesting schemes, Harvesting modules, Rectenna Model, Sensing antenna, DC-DC Converter, Wireless energy harvesting, Near Field Communication, Inductive coupling, Paradigmatic view of energy efficient IoT, Pragmatic energy efficient IoT system architecture.	

<b>Unit-2 - Energy Conservation Schemes</b>	<b>9 Hour</b>
Energy conservation schemes, Sleep/wakeup scheme, Data driven scheme, Mobility based scheme, Load balancing, Working of load balancing, Hardware based load balancing, Software Based Load Balancing, Compare hardware and software based load balancing techniques, Load balancing algorithms, Static Algorithms, Dynamic Algorithms, Issues of energy conservation in IoT, Basic model of smart home system, Energy Conservation in Smart Home and IoT, Automation and Sensors in Smart Home, Case study: energy conservation component for smart home	

<b>Unit-3 - Algorithms for Conserving Energy</b>	<b>9 Hour</b>
Static energy efficient algorithms, Exact allocation algorithm, Best Fit Heuristic Algorithm, Dynamic energy efficient algorithms, Hardware Level Solution, Dynamic Voltage Frequency Scaling (DVFS), Software Level Solution, First Fit Decreasing algorithm (FFD), Modified Best Fit Decreasing algorithm (MBFD), Genetic Algorithm (GA), Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO), Simulated Annealing (SA), Cat Swarm Optimization(CSO), Hybrid Genetic Algorithm and Cat Swarm Optimization (HGACSO), Hybrid Genetic Algorithm, Particle Swarm Optimization and Simulated annealing(HGAPSOSA), Comparison of dynamic energy efficient algorithm, Compare and contrast static and dynamic energy efficient algorithms.	

**Unit-4 - Green IoT****9 Hour**

*Green IoT an Overview, Smart Homes, Smart Cities, Energy Efficient smart health care, Importance of Green IOT, Taxonomy of green IoT techniques, Various Approaches to Achieve Green IoT, software based green IoT techniques, Hardware based green IoT techniques, Policy based techniques, Awareness based Approach - Toward Green IoT, Energy Awareness, IoT Based Smart Metering, Communication Technology Creating Awareness About Green Information, Promoting Recycling, Habitual Based Techniques, Comparative analysis of different green IoT approaches, Case study: impact of smart phones on the environment in present and future trends.*

**Unit-5 - Selected Applications of Energy Systems****9 Hour**

*Designing energy efficient IoT based Intelligent Transport System, Intelligent Transport System, Motivations for IoT in Transportation, Communication Technology and Related Power Issues, Information Extraction and Underlying Power Issues, Energy Efficiency Challenges and Corresponding Solutions, Further Challenges and Opportunities, Capacity Estimation of Electric Vehicle Aggregator for Ancillary Services, Development of Electric Vehicles, Motivation for Vehicle to Everything (V2X) and V2G Technology, Electric Vehicles and Solar Power Plants in Smart Grid Environment, Potential of EV to Grid Connection, Capacity Estimation of Aggregator, Battery Management System, Grid Connection and Performance Testing of V2G.*

<b>Learning Resources</b>	1. Mamt Mittal, Sudeep Tanwar, Basant Agarwal, Lalit Mohan Goyal, "Energy Conservation for IoT Devices Concepts, Paradigms and Solutions" Springer Singapore, 2019. 2. Madhur.B, "IoT projects with Bluetooth Low Energy - Harness the power of connected things" Packt Publishing, 2017.	3. Rushan Arshad, Saman Zahoor, Munam Ali Shah, Abdul Wahid and Hongnian Yu, "Green IoT: An Investigation on Energy Saving Practices for 2020 and beyond," Special Section on Future Networks: Architectures protocols and applications, IEEE Publisher, 2017.
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**Learning Assessment**

Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	10%	-	15%
Level 2	Understand	25%	-	25%	-	25%
Level 3	Apply	30%	-	30%	-	30%
Level 4	Analyze	30%	-	35%	-	30%
Level 5	Evaluate	-	-	-	-	-
Level 6	Create	-	-	-	-	-
	Total	100 %		100 %		100 %

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Ms. Aparna, TCS, Kolkata. 2. Mr. U. Aravind Kumar, JPA Solutions, Bangalore,	1. Dr. Arulprakash, Professor, IIT Madras 2. Dr. K. G. Srinivasa, Professor, NITTR Chandigarh,	1. Dr. V Anbarasu, SRMIST 2. Dr. A. Suresh. SRMIST

<b>Course Code</b>	21CSE470T	<b>Course Name</b>	APPLIED SOFTWARE TECHNIQUES IN IoT ENGINEERING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Distinguish the phases of data gathering and management of IoT Platform												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	Solve the software integration of communication protocol HTTP, MQTT																								
<b>CLR-3:</b>	State the CoAP and integrating the Edge computing and Interoperability																								
<b>CLR-4:</b>	Label the role of cloud service provider and taming the IoT																								
<b>CLR-5:</b>	Articulate towards IoT Applications																								
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Outline the phases of data gathering and state data management concepts of IoT Platform												-	-	-	-	-	-	-	-	-	-	2	3	-
<b>CO-2:</b>	Summarize Software Integration of communication protocol used in IoT												-	-	2	3	-	-	-	-	-	-	2	3	-
<b>CO-3:</b>	Appraise the CoAP to integrate the edge devices and interoperability												-	-	2	3	-	-	-	-	-	-	2	3	-
<b>CO-4:</b>	Implement a scenario using emerging cloud computing technologies												-	-	2	3	-	-	-	-	-	-	2	3	-
<b>CO-5:</b>	Inspect the IoT Applications and its performances												-	-	2	3	-	-	-	-	-	-	2	3	-

**Unit-1 - Sensing Technologies** 9 Hour  
 Getting Started – Definition – Setting up, Initial Edge Tier Applications – Design Concepts, Data Simulation – Simulating Sensors and Actuators and its application, Data Emulation – Emulating sensors and actuators, Data Management – Data Translation and Management concepts

**Unit-2 - Communication Technologies** 9 Hour  
 Introducing the MQTT protocol – Preparing – Publishing – Checking encrypted communication – Adding MQTT support to the actuator - Testing MQTT - Security considerations - MQTT Integration – Java client. Introducing the HTTP protocol - Creating an HTTP server - Adding dynamic synchronous resources - Adding dynamic asynchronous resources

**Unit-3 - Interoperability** 9 Hour  
 CoAP – Adding CoAP to the devices - CoAP Server Implementation - CoAP Client Integration – Concepts, Edge Integration – adding TLS – add security. Benefits of interoperability – Achieving interoperability using CoAP – Adding LWM2M – Testing LWM2M device

**Unit-4 - Emerging Cloud Computing Technologies** 9 Hour  
 Integrating with various cloud services – Programming – integrating with an IoT CSP – Taming the IoT. XMPP – Adding XMPP – Connecting to broker – Data available – Publishing – Adding chat interface – Testing.

**Unit-5 - Product Life Cycle & Use cases** 9 Hour  
 Defining ownership of data – understanding provisioning – Adding – Managing – tokens for identification – Testing. Use case: Home Environment monitoring and temperature adjustment, Garden monitoring and water adjustment, pond quality monitoring.

<b>Learning Resources</b>	1. Andy King A., "Programming the Internet of Things: An Introduction to building integrated device-to-cloud IoT solutions", O'Reilly Media, Inc.", 2021. 2. Peter Waher, "Mastering Internet of Things: Design and create your own IoT applications using Raspberry Pi 3", Packet Publishing Ltd., 2018. 3. Anand Tamboli, "Build your own IoT platform: develop a fully flexible and scalable internet of things platform", 2nd edition, AK press, 2019. 4. Ahmed Bakir, "Program the Internet of Things with Swift for IOS - Learn How to Program Apps for the Internet of Things," AK press, 2018.		
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	10%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	30%	-	30%	-		
Level 4	Analyze	30%	-	35%	-	30%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Mohan Raj, Renault Nissan Technology & business Centre Private Limited, Chennai,	1. Dr. P.T.V.B. Bhuvaneswari, Professor, MIT Campus, Anna University.	1. Dr. Kayalvizhi R, SRMIST
2. Mr. S. Santosh Kumar, Associate Consultant, CGI, Bangalore,	2. Dr. S. Sudha, Associate Professor, Anna University, Chennai,	2. Dr. S. Ushasukanya, SRMIST

<b>Course Code</b>	21CSE471T	<b>Course Name</b>	FUNDAMENTALS OF CYBER SECURITY	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		Program Outcomes (PO)												<b>Program Specific outcomes</b>		
CLR-1:	Restate the basic terminology, concepts, and standards of cyber security	1	2	3	4	5	6	7	8	9	10	11	12			
<b>CLR-2:</b>	State the understanding on software application security	-	-	3	2	-	-	-	-	-	-	-	-	PSO-1	PSO-2	PSO-3
<b>CLR-3:</b>	Label the Concepts for secure information systems	-	-	3	2	-	-	-	-	-	-	-	-			
<b>CLR-4:</b>	Outline the Information Security Policies, Standards, and Cyber Law	-	-	3	2	-	-	-	-	-	-	-	-			
<b>CLR-5:</b>	Sense the modern theory on Security in Emerging Technology	-	-	3	2	-	-	-	-	-	-	-	-			
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
<b>CO-1:</b>	Describe the information, principles, standards of cyber security	-	-	3	2	-	-	-	-	-	-	-	-	3	2	
<b>CO-2:</b>	Practice the data security considerations in real time applications	-	-	3	2	-	-	-	-	-	-	-	-	3	2	
<b>CO-3:</b>	Illustrate security concerns in developing Secure Information Systems	-	-	3	2	-	-	-	-	-	-	-	-	3	2	
<b>CO-4:</b>	Analyze Information Security Policies, Standards, and Cyber Law	-	-	3	2	-	-	-	-	-	-	-	-	3	2	
<b>CO-5:</b>	Investigate the Security used in emerging technologies	-	-	3	2	-	-	-	-	-	-	-	-	3	2	

<b>Unit-1 - Introduction to Information Systems</b>	<b>9 Hour</b>
Introduction to Information Systems, Types of Information Systems, Development of Information Systems, Changing the Nature of Information Systems Introduction to information security, Need for Information Security, Threats to Information Systems, Information Assurance, Cybersecurity and Security Risk Analysis	
<b>Unit-2 - Cybersecurity Application Security:</b>	
Application Security, Data Security Considerations: Backups, Archival, Security Technology, Intrusion Detection, Denial-of-Service (DOS) Attack, Security Threats, Security Threats to E-Commerce, Electronic Payment Systems, Digital Signature, Cryptography	
<b>Unit-3 - Developing Secure Information Systems</b>	
Secure Information System Development, Application Development Security, Information Security Governance and Risk Management, Security Architecture and Design, Security Issues in Hardware, Data Storage, and Downloadable Devices, Physical Security of its Assets, Back-Up Security Measures	
<b>Unit-4 - Information Security Policies, Standards, and Cyber Law:</b>	
Security Policies, Policy Review Process, Information Security Standards, Cyber Laws in India, Intellectual Property Law, Semiconductor Law, Software Licenses	
<b>Unit-5 - Security in Emerging Technology:</b>	
Security of Big Data Analytics, Security of Cloud Computing, Security of Internet of Things (IoT), Security of Smart Grid, Security of Scada Control Systems, Security of Wireless Sensor Networks (WSNs)	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. C. P. Gupta and K. K. Goyal, "Cyber security: A Self-Teaching Introduction", 1st Edition, Mercury Learning, and Information Press, 2020.</li> <li>2. Charles P. Pfleeger, Shari Lawrence Pfleeger, and Jonathan Margulies, "Security in Computing", Fifth Edition, Prentice Hall, 2015.</li> <li>3. Charles J. Brooks, Christopher Grow, Philip Craig and Donald Short, "Cybersecurity Essentials," First Edition, John Wiley &amp; Sons publishers, 2018.</li> <li>4. William Stallings, "Cryptography and Network Security Principles and Practices," Seventh edition, Pearson, 2017</li> <li>5. Man, Ho Au, Raymond Choo, "Mobile Security and Privacy," Syngress Publications, 2016.</li> </ol>
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)	Life-Long Learning CLA-2 (10%)							
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	10%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	30%	-	30%	-		
Level 4	Analyze	30%	-	35%	-	30%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

#### Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. G. Pradeep, Intel @ FICE, Bangalore. 2. Mr. P.J Sanakaranarayanan, Security Analyst, Philips, Bangalore.	1. Dr. Sudeeptha Mishra, Indian Institute of Technology, Ropar, Punjab 2. Mr. Karthikeyan.C.M.T, Government College of Engineering, Bargur	1. Dr. N. Prasath SRMIST 2. Mr. J. Prabakaran, SRMIST

<b>Course Code</b>	21CSE472J	<b>Course Name</b>	FULL STACK DEVELOPMENT FOR IoT	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 0	P 2	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Restate the IoT components for full stack development												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	Identify the techniques for designing the prototype application																								
<b>CLR-3:</b>	Perceive the hardware and software for developing full stack																								
<b>CLR-4:</b>	Define the protocol communication from underlying network layer to User interface																								
<b>CLR-5:</b>	Solve real time application prototypes																								
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	List the components of IoT framework and open-source platforms												-	-	3	-	-	-	-	-	-	-	3	3	
<b>CO-2:</b>	Summarize the hardware design for the IoT prototype												-	-	3	-	2	-	-	-	-	-	-	3	3
<b>CO-3:</b>	Illustrate the software concepts into designed hardware components												-	-	2	-	2	-	-	-	-	-	-	3	3
<b>CO-4:</b>	Analyze the required protocol communication for data transmission												-	-	3	-	2	-	-	-	-	-	-	3	3
<b>CO-5:</b>	Construct a prototype with dashboard for real time problem statements and measure its performance.												-	-	3	-	2	-	-	-	-	-	-	3	3

<b>Unit-1 - IoT Application Development Overview</b>	<b>12 Hour</b>
Components of IoT framework- Creative Coding Platforms - Open-Source Platforms - Mobile phones and similar devices - Arm Devices - Basic Electronics (circuit theory, measurements, parts identification) Sensors and Software: Why full stack development? Interfacing to the Real World	
<b>Unit-2 - Prototype Hardware Development</b>	<b>12 Hour</b>
Transducers, Classification, Roles of sensors in IOT, Various types of sensors, designing with sensors and boards, special requirements for IOT sensors, Role of actuators, types of actuators-Different IoT protocols features and uses, Physical device – Arduino Interfaces, GPIO Basics, Programming, APIs / Packages	
<b>Unit-3 - Prototype Embedding</b>	
Preparing the development environment (Arduino IDE), Exploring the Arduino language (C/C++) syntax, Coding, compiling, and uploading to the microcontroller, Working with Arduino Communication Modules: Bluetooth Modules, WIFI Modules, Interfacing Arduino and Blynk via USB like LED Blinking, temperature monitoring applications	
<b>Unit-4 - Integrating WIFI/protocol Module</b>	
ESP8266 WIFI Serial Module: Overview, Setting Up the Hardware, Interfacing with Arduino, Creating an IoT Temperature and Humidity Sensor SystemESP32, Arduino, RaspberryPi: Introduction, RaspberryPi Board: Hardware Layout and Pinouts, Edge to Cloud Protocols, like MQTT	
<b>Unit-5 - Application development and Development</b>	
Checking Data communication with IoT cloud/edge computing, Creation and interface of Dashboard, Analytics, Addition of intelligence to the prototype, working on improving performance metrics	

<b>Lab Experiments</b>	
<ol style="list-style-type: none"> <li>1. Exploring the concepts IoT and edge with basic any two applications like Switching ON/OFF Light, monitoring temperature in a room</li> <li>2. Illustrate the IoT and M2M communication</li> <li>3. Integration of protocols and standards of IoT and Edge</li> <li>4. Development of IoT-Edge computing application like smart dustbin, smart water monitoring, smart door</li> <li>5. Extend the application from the integration of Edge to cloud</li> <li>6. Illustrate the protocols between IoT and cloud</li> <li>7. Integration of security mechanisms in the developed applications</li> <li>8. MySQL Database Installation in Raspberry Pi</li> </ol>	<ol style="list-style-type: none"> <li>9. Study of RaspberryPi and Beagle board</li> <li>10. Detect the Vibration of an Object Using Arduino</li> <li>11. Develop an application for Smart agriculture with full stack techniques</li> <li>12. Develop an application for Smart city with full stack techniques</li> <li>13. Develop an application for Industry 4.0 with full stack techniques</li> <li>14. Develop an application for Traffic control/parking with full stack techniques</li> <li>Develop an application for Object/Human detection with full stack techniques</li> </ol>

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Bernardo Ronquillo Japón, "Learn IoT Programming Using Node-RED: Begin to Code Full Stack IoT Apps and Edge Devices with Raspberry Pi, NodeJS, and Grafana", PBP Publishers, 2022</li> <li>2. Anand Tamboli, "Build Your Own IoT Platform Develop a Flexible and Scalable Internet of Things Platform", Second Edition, Apress, 2022.</li> </ol>	<ol style="list-style-type: none"> <li>3. D. Dharani, G. Sudha Sadasivam, K. Anitha Kumari and M. Niranjanamurthy, "Edge Computing: Fundamentals, Advances and Applications (Advances in Industry 4.0 and Machine Learning)", First Edition, CRC Press, 2021</li> <li>4. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, and Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press, 2017</li> </ol>
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Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	-	10%	15%	-		
Level 2	Understand	25%	-	-	25%	25%	-		
Level 3	Apply	30%	-	-	20%	30%	-		
Level 4	Analyze	30%	-	-	35%	30%	-		
Level 5	Evaluate	-	-	-	10%	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Goutham, Head, Innovation and Technology, Protohubs.IO, Head	1. Dr. K. Suganya Devi, National Institute of Technology, Silchar, Assam	1. Dr. Vaishnavi Moorthy, SRMIST
2. Mr. Dinesh Krishna- Senior System Design Engineer, IoT, Robotics & AI, Auxo Technology Labs	2. Dr. Ameer, National Institute of Technology, Calicut	2. Mrs. Ushasukhanya S, SRMIST

<b>Course Code</b>	21CSE473T	<b>Course Name</b>	DEEP LEARNING FOR IoT	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		Program Outcomes (PO)												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Restate the Fundamentals of Internet of Things and its technologies and Distributed processing techniques for IoT	1	2	3	4	5	6	7	8	9	10	11	12			
<b>CLR-2:</b>	Label the use of Machine Learning in IoT, DL framework and cloud platforms for IoT.	-	3	-	-	3	-	-	-	-	-	-	-	PSO-1	PSO-2	PSO-3
<b>CLR-3:</b>	Solve the deep learning applications for IoT Image Recognition, Speech/ Voice Recognition	-	3	-	-	3	-	-	-	-	-	-	-	3	3	3
<b>CLR-4:</b>	Identify the indoor localization and state detection techniques with available classifier.	-	3	-	-	3	-	-	-	-	-	-	-	3	3	3
<b>CLR-5:</b>	Perceive deep learning techniques in real time examples.	-	3	-	-	3	-	-	-	-	-	-	-	3	3	3

  

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Engineering Knowledge												<b>Program Specific outcomes</b>		
<b>CO-1:</b>	Describe the basic theory underlying in Internet of Things.	1	2	3	4	5	6	7	8	9	10	11	12			
<b>CO-2:</b>	Summarize Deep learning techniques in IoT and its limitations	-	3	-	-	3	-	-	-	-	-	-	-	3	3	3
<b>CO-3:</b>	Apply deep learning algorithms to solve problems of moderate complexity.	-	3	-	-	3	-	-	-	-	-	-	-	3	3	3
<b>CO-4:</b>	Analyze Indoor Localization and IoT based human psychological and psychological state detection using Deep Learning Techniques.	-	3	-	-	3	-	-	-	-	-	-	-	3	3	3
<b>CO-5:</b>	Scrutinize security attacks in IoT and detections, with real time examples.	-	3	-	-	3	-	-	-	-	-	-	-	3	3	3

<b>Unit-1- Introduction</b>	<b>9 Hour</b>
Internet of Things - Data Analytics, IoT analytics challenges, IoT data acquisition, Data Exploration and Pre-processing, IoT technologies, Architecture and Networking protocols, IoT Communication – Data Access and Distributed processing for IoT.	

<b>Unit-2- IoT Ecosystems, Deep Learning Techniques, and Frameworks</b>	<b>9 Hour</b>
The End-to-End Life Cycle of the IoT - IoT application domains- The key characteristics and requirements of IoT data – Realtime Examples - Deep Learning Architectures for IoT - A soft introduction to ML - ML tasks - Delving into DL - Artificial neural networks - Neural network architectures - DL frameworks and cloud platforms for IoT – Limitations of IoT devices, edge/fog computing, and cloud perspective.	

<b>Unit-3- Deep Learning Application for IoT</b>	<b>9 Hour</b>
Image Recognition in IoT - IoT applications and image recognition - Transfer learning for image recognition in IoT - CNNs for image recognition in IoT applications - Audio/Speech/Voice Recognition in IoT - Speech/voice recognition for IoT - DL for sound/audio recognition in IoT - CNNs and transfer learning for speech recognition in IoT applications.	

<b>Unit-4- Indoor Localization and State Detection</b>	<b>9 Hour</b>
Indoor Localization in IoT - An overview of indoor localization - Techniques for indoor localization - DL-based indoor localization for IoT - K-nearest neighbour (k-NN) classifier - AE classifier - Physiological and Psychological State Detection in IoT - IoT-based human physiological and psychological state detection - Deep learning for human activity and emotion detection in IoT - LSTM, CNNs, and transfer learning for HAR/FER in IoT applications - Data collection - Data exploration - Data pre-processing - Model training - Model evaluation.	

**Unit-5 - IoT Security****9 Hour**

Security attacks in IoT and detections - Anomaly detection and IoT security - DL for IoT security incident detection - DNN, autoencoder, and LSTM in IoT security incidents detection - Advanced Aspects and Analytics in IoT - Predictive Maintenance for IoT - DL for predicting RLU – Realtime Examples - Deep Learning in Healthcare IoT - CNN and LSTM in healthcare applications – Deep Learning for Smart Cities IoT- Deep Learning for Industrial IoT

<b>Learning Resources</b>	1. Mohammad Abdur Razzaque and Md. Rezaul Karim, "Hands on Deep Learning for IoT", First Edition, Packt Publishing Ltd, 2019. 2. Amita Kapoor, "Hands on Deep Learning for IoT", First Edition, Packt Publishing Ltd, 2019.	3. Vijay Madisetti and Arshdeep Bahga, "Internet of Things: A Hands-on Approach", University Press, 2014 4. Andrew Minter "Analytics for the Internet of Things (IoT) Intelligent Analytics for Your Intelligent Devices", Packt Publishing, 2017. 5. Cuno Pfister, "Getting Started with the Internet of Things," O'Reilly Media, 2011.
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**Learning Assessment**

Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	10%	-	15%
Level 2	Understand	25%	-	25%	-	25%
Level 3	Apply	30%	-	30%	-	30%
Level 4	Analyze	30%	-	35%	-	30%
Level 5	Evaluate	-	-	-	-	-
Level 6	Create	-	-	-	-	-
	Total	100 %		100 %		100 %

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. R. Lenin Babu, Conversight.Ai, USA. 2. Mr. U. Aravind Kumar, JPA Solutions, Bangalore,	1. Dr. K. Selvakumar, Professor, Annamalai University, 2. Dr. K. G. Srinivasa, Professor, NITTR Chandigarh,	1. Dr. N. Krishnaraj, SRMIST 2. Dr. P. Vigneshwaran, SRMIST

<b>Course Code</b>	21CSE474T	<b>Course Name</b>	IoT PRIVACY	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Distinguish the fundamentals, various attacks, trust models and importance of security aspects in IoT												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	State the basics of cryptographic algorithms required for IoT security																								
<b>CLR-3:</b>	Solve the techniques, protocols, and some ideas on security towards gaming model																								
<b>CLR-4:</b>	Articulate the relevance of Blockchain, its techniques towards IoT																								
<b>CLR-5:</b>	Perceive the essential components of IoT and its privacy challenges																								
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Describe the best practices learnt to identify the attacks and mitigate the same.												-	-	3	-	-	-	-	-	-	-	3	2	
<b>CO-2:</b>	Identify the role of cryptographic algorithms to achieve required IoT security.												-	-	3	-	-	-	-	-	-	-	3	2	
<b>CO-3:</b>	Analyze the security techniques and protocols during the design of IoT products and gaming designs.												-	-	3	-	-	-	-	-	-	-	3	2	
<b>CO-4:</b>	Classify about the skills learnt on ciphers and blockchains when appropriate												-	-	3	-	-	-	-	-	-	-	3	2	
<b>CO-5:</b>	Investigate the appropriate IoT devices for a real time case study												-	-	3	-	-	-	-	-	-	-	3	2	

**Unit-1 - Fundamentals of IoT security and its trust models** 9 Hour  
 Security requirements in IoT architecture, security in enabling technologies, security concerns in IoT applications, security architecture in the IoT, security requirements in IoT, insufficient authentication/authorization, insecure access control, threats to access control, privacy and availability, attacks specific to IoT. Vulnerabilities, attack, counter measures, and fault trees, the secure IoT system implementation lifecycle, Data trustworthiness in IoT, Human IoT trust relationship, Trust and reputation system, trust negotiation, IoT privacy preservation issues

**Unit-2 - Cryptographic fundamentals for IoT** 9 Hour  
 Cryptographic basics and its key role in IoT, mathematical foundations, Encryption and decryption, public-key cryptography, elliptic curve arithmetic, elliptic curve cryptography, message integrity, authentication algorithms, hash functions, Digital signature algorithms – Merkle Trees signature algorithms, crypto currencies, bitcoin P2P network, security credential management system (SCMS).

**Unit-3 - Privacy preservation for IoT** 9 Hour  
 Prevent unauthorized access to sensor data, M2M security, FRID security, cyber physical object security, Hardware security, Front-end system privacy protection, management, secure IoT databases, Networking function security, IoT networking protocols, Secure IoT lower layers, secure IoT higher layers, Secure communication, links in IoTs, Back-end security, secure resource, Game theory foundation, Mixed-strategy, Nash equilibrium, repeated games, Bayesian games, coalitional games.

**Unit-4 - Block chain in IoT security** 9 Hour  
 Introduction to Blockchain, Modelling faults and adversaries, Byzantine generals' problem, Consensus algorithms and their scalability problems, digital signatures, verifiable random functions, Zero-knowledge systems blockchain, the challenges and solutions, proof of work, proof of stake, alternatives to Bitcoin consensus, bitcoin scripting language and their us Ethereum and smart contracts, Smart contract languages and verification challenges, comparing Bitcoin scripting Vs. Ethereum smart contracts, Hyper ledger fabric, mechanisms in permissioned blockchain, pseudo-anonymity Vs. anonymity, Zcash and Zk-SNARKS for anonymity preservation, attacks on blockchains, Sybil attacks, selfish mining, 51% attacks.

**Unit-5 - IoT devices and its privacy****9 Hour**

Introduction of IoT devices, Difference among IoT devices, computers and embedded devices, Sensors and actuators in IoT, Accelerometer, photo resistor, buttons, motor, LED, vibrator, analog signal Vs. digital signal, Networking in IoT, Real-time communication, Bandwidth efficiency, data analytics in IoT- simple data analyzing methods, IoT architecture, component and technology, Case study- discussion on specific IoT applications and their design considerations, cyber security overview in IoT, general cyber security concepts in IoT security threads in IoT, data privacy in IoT, device/user authentication in IoT, data trustworthiness problem in IoT.

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. B. Russel and D. VanDuren, "Practical Internet of Things Security", Packt Publishing, 2016.</li> <li>2. FeiHJU, "Security and Privacy in Internet of Things (IoTs): Models Algorithms and Implementations", CRC Press, 2016.</li> <li>3. Narayanan, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction", Princeton University Press, 2016.</li> <li>4. Antonopoulos, "Mastering Bitcoin: Unlocking Digital Cryptocurrencies", O'Reilly, 2014.</li> <li>5. T.Alpcan and T.Basar, "Network Security: A Decision and Game-theoretic Approach", Cambridge University Press, 2011.</li> <li>6. Helena Rodrigues, Kristof Van Laerhoven and Rui José, "Security and the IoT ecosystem", Springer International Publishing, 2019.</li> <li>7. Baldini, Gianmarco, "Internet of Things: IoT Governance, Privacy and Security Issues", European Research Cluster, 2015</li> <li>8. Ollie Whitehouse, "Security of Things: An Implementers' Guide to Cyber-Security for Internet of Things Devices and Beyond", NCC Group, 2014.</li> <li>9. Josh Thompson, "Blockchain: The Blockchain for Beginnings, Guild to Blockchain Technology and Blockchain Programming", CreateSpace Independent Publishing Platform, 2017.</li> </ol>
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**Learning Assessment**

Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	10%	-	15%
Level 2	Understand	25%	-	25%	-	25%
Level 3	Apply	30%	-	30%	-	30%
Level 4	Analyze	30%	-	35%	-	30%
Level 5	Evaluate	-	-	-	-	-
Level 6	Create	-	-	-	-	-
	Total	100 %		100 %		100 %

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. R. Lenin Babu, Conversight. Ai, USA.	1. Dr. Ansumanmahapatra, National Institute of Technology, Puducherry	1. Mrs. G. Sujatha, , SRMIST
2. Mr. U. Aravind Kumar, JPA Solutions, Bangalore.	2. Dr. K. G. Srinivasa, Professor, NITTR Chandigarh,	2. Dr. T.Y.J. Naga Malleshwari SRMIST

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Volume – 11I

(Syllabi for Computer Science and Engineering w/s in  
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Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

# ACADEMIC CURRICULA

Professional Core Courses

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(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

<b>Course Code</b>	21CSC305T	<b>Course Name</b>	BLOCKCHAIN USING CRYPTOGRAPHY	<b>Course Category</b>	C	PROFESSIONAL CORE	L 3	T 0	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Understand the basic services and concepts related to Blockchain Networks												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	Define the role of cryptography in Blockchain network												-	-	-	2									
<b>CLR-3:</b>	Highlighting the services and techniques Ethereum and Cryptocurrency concept in Blockchain												-	-	-	3									
<b>CLR-4:</b>	Presenting the functions of Cryptocurrency in Blockchain Networks												-	-	-	1									
<b>CLR-5:</b>	Acquire knowledge in Networking concept and its part using Blockchain concepts												-	-	-	2									
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	comprehend the knowledge of communication in Blockchain												3	3	-	-	-	-	-	-	-	-	-	-	
<b>CO-2:</b>	Identify and design the different Cryptographical algorithms using Blockchain												3	2	1	-	-	-	-	-	-	-	-	-	
<b>CO-3:</b>	Design the network concepts and implement protocols using Blockchain												-	2	3	-	1	-	-	-	-	-	-	-	
<b>CO-4:</b>	Describe the role of Ethereum and Cryptocurrency using Blockchain												2	2	-	-	1	-	-	-	-	-	-	-	
<b>CO-5:</b>	Implement the various AI techniques in Blockchain												2	2	1	-	-	-	-	-	-	-	-	-	

**Unit-1 - Introduction** 9 Hour  
Distributed Database, Limitations of Distributed Database, Two General Problem- Byzantine General problem and Fault Tolerance- Introduction to Ledgers, Working of financial systems- Introduction about Block Chain technologies- Difference between block chain with database , History of Block Chain-Characteristics of Block Chain - Distributed Ledger and Block Chain - Comparison of Distributed Ledger and Block Chain-Types of Block Chain - Blockchain Network and Nodes - Overview of Blocks - Structure of Block – Examples

**Unit-2 - Blockchain Functionality** 9 Hour  
Hashing in Blockchain – techniques - Linking Box - Linking Box using SHA - Block Structures - Blockchain Functionality - Creating Blockchain - Digital Structures in Blockchain - Creating Identity – Examples - Signatures in transactions - Asset ownerships in transactions - Blockchain wallet - Crypto Exchange - Differences Between Crypto Wallets vs Exchanges

**Unit-3 - P2P Networking** 9 Hour  
Peer to Peer Networking - Working of Peer-to-Peer Networking - Measures to ensure the security of P2P networking systems - Introduction to Peer-to-Peer networking - History of Peer-to-Peer networking – Examples - Architecture of Peer-to-Peer networking - Network Discovery - Types of P2P networks in Blockchain - Examples of P2P networks in Blockchain - P2P Crypto Exchanges - P2P Marketplaces vs. OTC Exchanges - Building a sample blockchain using P2P network – Example - Creation of New block - Validation of New Block – Example

**Unit-4 - Introduction of Cryptocurrency** 9 Hour  
Introduction about Cryptocurrency - History of Cryptocurrency - Distributed Ledger - Bitcoin Protocols - Mining strategy and Rewards – Ethereum - Construction and working of Bitcoin - Construction and working of Ethereum - DAO, Smart contract - GHOST, Vulnerability Attacks, Side Chain, Name coin - Cryptocurrency Regulation: stakeholders-Roots of bitcoin - Legal Aspects - Cryptocurrency Exchange - Black market and Global Economy - Implementing Blockchain as service

**Unit-5 - Real Time Examples** 9 Hour

Implementing Blockchain as service using AI concepts - Enterprise Ethereum Alliance - Ethereum Alliance practical demo - Understanding Ethereum Jargon - Ethereum default Admin Site - Smart contracts in Aselpius - Developing smart contracts - Real Time Examples - Procedure to apply AI concept in Blockchain - Examples.

<b>Learning Resources</b>	1. Gulshan Shrivastava, Dac-Nhuong Le, Kavita Sharma "Cryptocurrencies and Blockchain Technology Applications" Wiley publishers, 2020. 2. Koushik Raj, "Foundation of Blockchain : The pathway to Cryptocurrencies and Decentralised blockchain applications ", Kindle Edition, 2019. 3. Daniel Dresher "Blockchain Basics A non technical Introduction in 25 steps" 2017 A press publishers				4. Arvind Narayanan, Joesph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder."Bitcoin and cryptocurrency technologies: A comprehensive Introduction" Princeton University Press, 2016 5. Cryptography Engineering: Design Principles and Practical Applications, Niels Ferguson, Bruce Schneier, and Tadayoshi Kohno, John Wiley & Sons Inc; 1st edition ,2010	

Learning Assessment						
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)		
		Theory	Practice	Theory	Practice	Theory
Level 1	Remember	15%	-	15%	-	15%
Level 2	Understand	25%	-	20%	-	25%
Level 3	Apply	30%	-	25%	-	30%
Level 4	Analyze	30%	-	25%	-	30%
Level 5	Evaluate	-	-	10%	-	-
Level 6	Create	-	-	5%	-	-
	Total	100 %		100 %		100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Imthyaz serif, Director IDEASSION Technology solutions, Chennai	1.Dr. L. Ramanathan, Associate Professor, VIT Vellore	1. Dr. SV.Sri Bharathi, SRMIST

# ACADEMIC CURRICULA

Professional Elective Courses

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**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

**(Deemed to be University u/s 3 of UGC Act, 1956)**

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

<b>Course Code</b>	21CSE231T	<b>Course Name</b>	FUNDAMENTALS OF BLOCKCHAIN	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the fundamentals of blockchain architecture												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Categorize cryptography techniques and blocks															
<b>CLR-3:</b>	Illustrate the principles consensus algorithms															
<b>CLR-4:</b>	Articulate different attacks															
<b>CLR-5:</b>	Relate hyper ledger and solidity in applications of block chain															
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>															
<b>CO-1:</b>	comprehend the knowledge on the fundamentals of block chain												3	3	-	
<b>CO-2:</b>	Interpret the ability to apply models and methods of classical cryptography												2	2	-	
<b>CO-3:</b>	Utilize the principles of consensus mechanisms in real time.												3	-	-	2
<b>CO-4:</b>	Categorize the attacks and its impacts.												3	3	-	
<b>CO-5:</b>	Appraise the block chain principles in real time applications												-	-	3	2

**Unit-1 - Introduction- Blockchain Architecture** 9 Hour  
 Backstory of Bitcoin - Blockchain – Distributed Ledger Technology - Centralized vs. Decentralized Systems- Centralized Systems - Decentralized Systems - Layers of Blockchain - Application Layer - Execution Layer -Semantic Layer - Propagation Layer - Consensus Layer – Importance of Blockchain -Limitations of Centralized Systems

**Unit-2 - Blockchain and Cryptography** 9 Hour  
 Peer to Peer Networking – Types of Blockchain: Public Blockchain - Private Blockchain – Consortium Blockchain - Cryptographic Hash Functions – Cryptographic Nonce – Transactions – Merkle Tree - Symmetric, Asymmetric Key Cryptography - Private Key Storage – Ledgers – Blocks - Chaining Blocks – Blockchain Wallets and its types

**Unit-3 - Consensus Mechanism** 9 Hour  
 Proof of Work Consensus Algorithm - Proof of Stake Consensus Algorithm - Delegated Proof of Stake - Round Robin Consensus Algorithm - Proof of Authority/Proof of Identity Consensus Algorithm - Proof of Elapsed Time Consensus Algorithm – Byzantine Fault Tolerance - Consensus Comparison Matrix, Ledger Conflicts and Resolution.

**Unit-4 - Basic Attacks** 9 Hour  
 Attacks - Sybil attack – DDOS – Eclipse Attack – Selfish Mining Attack – Finney attack – Race attack - Wallet Attacks – Zero knowledge proof – Non-interactive Zero Knowledge Proof – Ring Signature - Homomorphic Encryption

**Unit-5 - Decentralized Applications** 9 Hour  
 Ethereum – Smart contracts - Decentralized Applications – Basics: Hyperledger, Fabric, Corda, Solidity, RemixIDE, Ganache, Metamask, Truffle, NodeJS, and Blockchain Testnet. Blockchain in IoT, Cloud computing, Supply chain management, Healthcare, Automation, Finance. Case Study: Ethereum vs Ethereum classic

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. <i>Blockchain Consensus: An Introduction to Classical, Blockchain, and Quantum Consensus Protocols</i>, DOI:10.1007/978-1-4842-8179-6, 1st edition, Publisher: Apress, ISBN: 978-1-4842-8178-9, August 2022.</li> <li>2. <i>Pethuru Raj, Kavita Saini, Chellammal Surianarayanan, "Blockchain Technology and Applications"</i>, CRC Press, 2021.</li> <li>3. <i>Chandramouli Subramanian, "Blockchain Technology"</i>, Universities Press, 2020</li> <li>4. <i>Dannen, Chris. Introducing Ethereum and solidity. Vol. 1. Berkeley: Apress, 2017.</i></li> <li>5. <i>Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, decentralization, and smart contracts explained"</i>, 2nd Edition, Packt Publishing Ltd, March 2018.</li> </ol>
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Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Kishore Kumar K Senior Technical Consultant (Strategic Accounts) ManageEngine (A Division of Zoho Corporation)	1. Dr. K. Suresh, Associate Professor, Department of Information Technology, Sri Venkateswara College of Engineering Sriperumbuthur	1. Ms. S. Srividhya, SRMIST

<b>Course Code</b>	21CSE232T	<b>Course Name</b>	IoT AND BLOCKCHAIN	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Understand the basic services and concepts of IoT and Blockchain												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	Illustrate the role of cryptography in Blockchain network																								
<b>CLR-3:</b>	Acquire knowledge in Networking concept and its part using Blockchain concepts																								
<b>CLR-4:</b>	Exploring security challenges on Blockchain																								
<b>CLR-5:</b>	Exploring the tools, platforms, and techniques in Blockchain																								
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Apply the knowledge of communication in Blockchain												3	2	1	-	-	-	-	-	-	-	-	1	
<b>CO-2:</b>	Identify and design different Cryptographical algorithms using Blockchain												3	2	-	-	1	-	-	-	-	-	-	2	
<b>CO-3:</b>	Design the network concepts and implement protocols using Blockchain												3	1	-	-	-	-	-	-	-	-	-	3	
<b>CO-4:</b>	Identify how Industries adopting Baas for security												-	3	2	1	-	-	-	-	-	-	-	2	
<b>CO-5:</b>	Design and implement the various tools and techniques in Blockchain												-	-	1	3	-	-	-	-	-	-	-	2	

**Unit-1 - Introduction to IoT & Blockchain** 9 Hour  
 Introduction to Internet of Things (IoT)- Concepts and definitions of IoT-History of IoT –IoT vs Conventional Network-IoT Architecture- Introduction to Blockchain-Generations of Blockchain- Structure of Blockchain- Opportunities and challenges in IoT and Blockchain - IoT simulators: Tinker cad, Cisco Packet Tracer - Blockchain development frame works: Truffle, Hyperledger fabric

**Unit-2 - IoT Security** 9 Hour  
 IoT Layer Challenges – Sensing layer- Challenges in end nodes –Threat based on Network layer- Service layer-based threats-Application Interface layer –Cross layer Challenges-Challenge to implementation of IoT in Blockchain-IoT Device Integration challenges.

**Unit-3 - Consensus Algorithms** 9 Hour  
 Building Blocks of Blockchain-Database-Block-Hash-Minor-Transaction-Smart Contracts-Consensus Mechanisms-PoW-PoS-Characteristics of Blockchain-Types of Blockchain-Permissioned Blockchain-Permissionless Blockchain-Consortium Blockchain, MetaMask plugin to conduct transactions with Ether, cryptocurrency

**Unit-4 - Blockchain as a Service (Baas)** 9 Hour  
 Defining of Blockchain as a Service - IoT Cloud server security challenges- Cloud computing with BaaS-Hybrid Cloud server with BaaS for Remote Monitoring-Case study: Industries adopting BaaS for security.

**Unit-5 - Blockchain Use cases in IoT Sector** 9 Hour  
 Autonomous Decentralized peer to peer telemetry-Blockchain Enabled Security for Smart cities- Blockchain Enabled Smart Home Architecture-Blockchain based self-managed VANETs-Security and privacy of data

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>Koushik Raj, "Foundation of Blockchain: The pathway to Cryptocurrencies and Decentralised blockchain applications ", Kindle Edition, 2019.</li> <li>Daniel Dresher "Blockchain Basics A non-technical Introduction in 25 steps" 2017 A press publishers.</li> <li>Nishith Pathathk and Anurag bhandari "IoT, AI, and Blockchain for .NET Building a Next - Generation Application from the GroundUp" A Press Publisher.</li> <li>Ovidiu Vermesan, Peter Friess, "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems "River Publishers, 2013.</li> <li>Adrian McEwen Hakim Cassimally "Designing the Internet of Things", John Wiley &amp; Sons, 2014.</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>	
<i>Bloom's Level of Thinking</i>	<i>Formative CLA-1 Average of unit test (50%)</i>	<i>Life-Long Learning CLA-2 (10%)</i>					
		<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr.Jagadeesh.M.M , Senior DevOps Engineer,Ensono Technologies.	1. Dr.Sudhakar, Associate Professor, VIT, Andhra Pradesh 2. Dr.BalasingamUdayabalan, , Associate Professor, East Point College, Bangalore	1. Dr.J.Shobana, SRMIST 2. Dr.Ganesh Kumar, SRMIST

<b>Course Code</b>	21CSE233T	<b>Course Name</b>	DISTRIBUTED SYSTEMS AND APPLICATIONS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>	<i>The purpose of learning this course is to:</i>	Program Outcomes (PO)												<b>Program Specific outcomes</b>		
		1	2	3	4	5	6	7	8	9	10	11	12			
<b>CLR-1:</b>	recognize the characterization of distributed systems.															
<b>CLR-2:</b>	Gather knowledge on remote invocation and indirect communication.															
<b>CLR-3:</b>	comprehend the principles distributed objects and components.															
<b>CLR-4:</b>	Know about the security issues and principles of distributed file systems.															
<b>CLR-5:</b>	Analyse the distributed transactions.															
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
<b>CO-1:</b>	Recognize the characteristics of distributed systems.	2	1	-	-	-	-	-	-	-	-	-	-	2	-	2
<b>CO-2:</b>	Describe the concepts of remote invocation and indirect communication.	2	1	-	-	-	-	-	-	-	-	-	-	2	-	3
<b>CO-3:</b>	Explain about operating system support and distributed objects, components.	2	1	2	-	-	-	-	-	-	-	-	-	2	-	2
<b>CO-4:</b>	Recognize the security issues and principles of distributed file systems.	2	2	1	-	-	-	-	-	-	-	-	-	2	-	3
<b>CO-5:</b>	Describe the distributed transactions mechanism and applications of distributed multimedia systems.	2	1	2	-	-	-	-	-	-	-	-	-	2	2	3

#### **Unit-1 - Characterization of Distributed Systems** 9 Hour

Examples of distributed systems, Trends in distributed systems, Focus on resource sharing, Challenges - System Models: Physical models, Architectural models, Fundamental models - Interprocess Communication: The API for the Internet protocols, External data representation and marshalling.

#### **Unit-2 - Remote Invocation and Indirect Communication** 9 Hour

Request-reply protocols, Remote procedure call, Remote method invocation - Indirect Communication: Group communication, Publish-subscribe systems, Message queues

#### **Unit-3 - Operating System Support & Distributed Objects and Components** 9 Hour

Operating System Support: The operating system layer, Protection, Processes and threads, Communication and invocation, Operating system architecture, Virtualization at the operating system level - Distributed Objects and Components: Distributed objects, Case study: CORBA, From objects to components.

#### **Unit-4 - Security and Distributed File Systems** 9 Hour

Security: Overview of security techniques, Cryptographic algorithms, Digital signatures, Cryptography pragmatics - Distributed File Systems: File service architecture, Case study: Sun Network File System, Case study: The Andrew File System.

#### **Unit-5 - Distributed Transactions and Multimedia Systems** 9 Hour

Distributed Transactions: Introduction, Flat and nested distributed transactions, Atomic commit protocols, Concurrency control in distributed transactions, Distributed deadlocks, Transaction recovery - Distributed Multimedia Systems: Characteristics of multimedia data, Quality of service management, Resource management, Stream adaptation - Case studies: Tiger, BitTorrent and End System Multicast.

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>George Coulouris, Jean Dollimore, Tim Kindberg and Gordon Blair, <i>Distributed Systems - Concepts and Design, Fifth Edition</i>, Addison-Wesley (Pearson Education), 2012.</li> <li>Andrew S. Tanenbaum and Maarten van Steen, <i>Distributed Systems: Principles and Paradigms, Second Edition</i>, Pearson Education, 2017.</li> <li>Kenneth P. Birman, <i>Guide to Reliable Distributed Systems - Building High Assurance Applications and Cloud-Hosted Services</i>, Springer London, 2014.</li> <li>Ajay D. Kshemkalyani, Mukesh Singhal, <i>Distributed Computing - Principles, Algorithms, and Systems</i>, Cambridge University Press, 2011.</li> <li><i>Distributed Systems</i>, IIT Patna (Dr. Rajiv Misra): <a href="https://nptel.ac.in/courses/106106168">https://nptel.ac.in/courses/106106168</a></li> <li><i>Distributed Computing Systems</i>, IIT Madras (Prof. Ananthanarayana V.S.): <a href="https://nptel.ac.in/courses/106106107">https://nptel.ac.in/courses/106106107</a></li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. N. Mohanraj, Software Engineer PayPal Inc., Chennai.	1. Dr. M. Vinoth Kumar, Associate Professor, Department of Information Science and Engineering, Dayananda Sagar Academy of Technology & Management, Bengaluru.	1. Dr. M. Prakash, SRMIST

<b>Course Code</b>	21CSE234T	<b>Course Name</b>	PRINCIPLES OF CRYPTOGRAPHY	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	recognize the fundamentals of Classical Cryptography.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Articulate Symmetric Cryptography and its methods															
<b>CLR-3:</b>	know the principles Hash Functions and primitives															
<b>CLR-4:</b>	Relate Number Theory concepts for cryptography.															
<b>CLR-5:</b>	Learn Asymmetric Cryptography, Key Management System, Digital Signature Schemes and Public-Key Encryption															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12			
<b>CO-1:</b>	Acquire the knowledge on the fundamentals of cryptography	-	3	-	3	-	-	-	2	-	-	-	-	-	-	2
<b>CO-2:</b>	Describe the models and methods of classical cryptography	3	-	-	-	-	-	-	-	-	-	-	-	-	3	-
<b>CO-3:</b>	Utilize the principles of Hash Functions with Crypto system	3	-	2	-	2	-	-	-	-	-	-	-	-	2	-
<b>CO-4:</b>	Apply the knowledge of Number Theory and its applications in cryptography.	-	2	-	-	-	-	-	-	-	-	-	-	-	2	1
<b>CO-5:</b>	Analyse the ability of Key Management System in real time applications	-	3	-	-	2	-	-	-	-	-	-	-	-	2	-

**Unit-1 - Introduction** 9 Hour  
 Security Trends-The OSI Security Architecture, Security Attacks, Security Services and Security Mechanisms, A model for Network Security-Classical Encryption Techniques Modern - Cryptography – Historical Ciphers – Cryptanalysis - Formal Definitions - Proofs of Security - The One-Time Pad - Limitations of Perfect Secrecy - Shannon's Theorem.

**Unit-2 - Symmetric Cryptography Algorithm** 9 Hour  
 Symmetric Cryptography Private-Key Encryption- Defining Computationally Secure Encryption, - Constructing Secure Encryption Schemes - Constructing CPA-Secure Encryption Schemes - Modes of Operation - Chosen-Ciphertext Attacks - Message Authentication Codes - Message Integrity - CBC-MAC - Authenticated Encryption.

**Unit-3 - Hash Functions and Symmetric Key Construction** 9 Hour  
 Hash Functions and Application – Definitions - The Merkle-Damgård Transform - Message Authentication Using Hash Functions - Generic Attacks on Hash Functions - The Random-Oracle Model - Hash Functions – Applications Theoretical Constructions of Symmetric-Key - One-Way Functions - From One-Way Functions to Pseudo randomness - Constructing Pseudorandom Generators - Constructing Pseudorandom Functions - Assumptions for Private-Key Cryptography.

**Unit-4 - Number Theory** 9 Hour  
 Introduction to Divisibility theory and canonical decompositions - Division algorithm - Base - b representations Number patterns - Prime and composite numbers GCD - Euclidean algorithm - Fundamental theorem of arithmetic LCM - Diophantine equations and congruences - Linear Diophantine equations - Linear Congruence's - Modular exponentiation - Chinese remainder theorem.

**Unit-5 - Asymmetric Algorithms and Digital Signatures****9 Hour**

Asymmetric Cryptography- RSA - Cryptographic Assumptions in Cyclic Groups - Algorithms for Factoring and Computing Discrete Logarithms - Key Management - Public-Key Revolution, Encryption and Hybrid Encryption - RSA Encryption - CDH, DDH-Based Encryption - Digital Signature Schemes - Public-Key Encryption - Trapdoor Permutations - The Paillier Encryption Scheme - Secret Sharing - The Goldwasser – Micali Encryption Scheme - The Rabin Encryption Scheme.

<b>Learning Resources</b>	1. <i>Introduction to Modern Cryptography (2nd edition)</i> by J. Katz and Y. Lindell. 2. <i>Cryptography Theory and Practice</i> by Douglas Stinson (3rd Edition) by Douglas R Stinson <i>Cryptography: An Introduction</i> by Nigel Smart	3. Koshy, T., – <i>Elementary Number Theory with Applications</i> , Elsevier Publications, New Delhi, 2002. 4. <i>Statistical independence in probability, analysis, and number theory</i> By MARK KAC Professor of Mathematics Cornell University
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**Learning Assessment**

Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1 <i>Remember</i>	15%	-	15%	-	15%	-
Level 2 <i>Understand</i>	25%	-	20%	-	25%	-
Level 3 <i>Apply</i>	30%	-	25%	-	30%	-
Level 4 <i>Analyze</i>	30%	-	25%	-	30%	-
Level 5 <i>Evaluate</i>	-	-	10%	-	-	-
Level 6 <i>Create</i>	-	-	5%	-	-	-
Total	100 %		100 %		100 %	

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Kishore Kumar K Senior Technical Consultant (Strategic Accounts) ManageEngine (A Division of Zoho Corporation)	1. Dr. K. Suresh, Associate Professor, Department of Information Technology, Sri Venkateswara College of Engineering Sriperumbuthur	1. Ms. S. Srividhya, SRMIST

<b>Course Code</b>	21CSE331T	<b>Course Name</b>	CRYPTOCURRENCIES AND BLOCKCHAIN TECHNOLOGY	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	comprehend the basic services and concepts related to crypto currencies												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	analyse the role of cryptography in Blockchain network																								
<b>CLR-3:</b>	recognize the services and techniques Ethereum and Cryptocurrency concept in Blockchain																								
<b>CLR-4:</b>	know the functions of Cryptocurrency in Blockchain Networks																								
<b>CLR-5:</b>	Acquire knowledge in Ethereum concept and its part using Blockchain concepts																								
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Apply the knowledge of cryptocurrency in Blockchain													3	3	1	-	-	-	-	-	-	-	-	2
<b>CO-2:</b>	Identify and design the different Cryptographical algorithms using Blockchain													3	2	1	-	-	-	-	-	-	-	-	3
<b>CO-3:</b>	Design the network concepts and implement protocols using Blockchain													2	2	3	-	-	-	-	-	-	-	-	2
<b>CO-4:</b>	Describe the role of Ethereum and Cryptocurrency using Blockchain													2	2	1	-	-	-	-	-	-	-	-	1
<b>CO-5:</b>	Implement the various AI techniques in Blockchain													2	2	-	-	3	-	-	-	-	-	-	2

**Unit-1 - Introduction** 9 Hour  
 Introduction to cryptocurrency - Basics of crypto and cryptocurrencies: - Cryptographic Hash functions - Hash Pointers - Digital Signatures - Examples - Public Key as Identities - Mechanics of Bitcoin: Bitcoin Transactions Bitcoin Scripts - Applications of Bitcoin Scripts - Bitcoin Blocks - Bitcoin Network - Limitations and Improvements - Construction of a Cryptocurrency Portfolio - Understanding Crypto Trading - Wallets - Public Key -Private Key

**Unit-2 - Bitcoin Technology** 9 Hour  
 Bitcoin storage - Hot and Cold Storage - Splitting and Sharing Keys - Online wallets and Exchanges - Payment Services - Simplified Payment Verification (SPV) - Transaction Fees - Currency Exchange Markets - Managing secret keys of wallet - Hardware wallet - Paper wallet - Bitcoin Mining - Cryptocurrencies as investment option- Example - Analytical framework for crypto investment option - Fundamental Analysis and Technical analysis - Network Metrics as a price indicator

**Unit-3 - Blockchain Technology** 9 Hour  
 Basics of Blockchain Technology - Introduction to Ledgers, Working of financial systems -Difference between block chain with database , History of Block Chain - Characteristics of Block Chain - Distributed Ledger and Block Chain - Comparison of Distributed Ledger and Block Chain - Types of Block Chain- Public, Private, Consortium -Blockchain layers – Forks - Double Spending Problem - Byzantine Fault Tolerance protocol - Voting Protocol - Sybil resistance - Permissioned Consensus - Streamlet: A blockchain protocol - Nakamoto consensus protocol - Mining Incentives – Case Study: Bitcoin vs Bitcoin cash.

**Unit-4 - Decentralized Finance (DeFi)** 9 Hour  
 History of Decentralized Finance (DeFi) - DeFi Foundations – Characteristics - Advantages of DeFi - DeFi Primitives: Transaction Mechanisms - Fungible Token - Non-Fungible Token – Example -Supply and Ownership: Custody – supply Adjustment - incentives Exchanges: Centralized Exchange - decentralized exchange (DEX) - Use cases - Automated Market Makers (AMM) - Uniswap - Collateralized Loan – Flash Loans - Incentives for Liquidity providers

**Unit-5 - Cryptocurrency Techniques** 9 Hour

Privacy for cryptocurrency: Anonymity - Privacy of Digital Payments - Privacy of Digital Payments – demo - Understanding Ethereum - Privacy in Ethereum - Privacy in Bitcoin - Coin Mixing - Litecoin (LTC) - Altcoins – Example unidirectional, bi-directional and UTXO - Examples.

<b>Learning Resources</b>	1. Koushik Raj, "Foundation of Blockchain: The pathway to Cryptocurrencies and Decentralised blockchain applications ", Kindle Edition, 2019. 2. Arvind Narayanan, Joesph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder." Bitcoin and cryptocurrency technologies: A comprehensive Introduction" Princeton University Press, 2016. 3. Gulshan Shrivastava, Dac-Nhuong Le, Kavita Sharma "Cryptocurrencies and Blockchain Technology Applications" Wiley publishers. 4. Daniel Dresher "Blockchain Basics A non-technical Introduction in 25 steps" 2017 A press publishers.
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Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
Total		100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Imthyaz serif, Director IDEASSION Technology solutions, Chennai	1.Dr. L. Ramanathan, Associate Professor, VIT Vellore	1. Dr. SV.Shi Bharathi, SRMIST

<b>Course Code</b>	21CSE332T	<b>Course Name</b>	FUNDAMENTALS OF ETHEREUM	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		Program Outcomes (PO)												<b>Program Specific outcomes</b>			
1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3			
<b>CLR-1:</b> recognize the working of Bit coin and Ethereum																	
<b>CLR-2:</b> identify the different components of the Block chain system and interact with them securely																	
<b>CLR-3:</b> Design, build and deploy smart contracts and distributed applications																	
<b>CLR-4:</b> analyse the difference between proof-of-work and proof-of-concept																	
<b>CLR-5:</b> Assess the need of Enterprise Ethereum Block chain Platforms and Use Cases																	
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>																
<b>CO-1:</b> identify the design principles of Bit coin and Ethereum	3	1	2	-	-	-	-	-	-	-	-	-	-	-	1	-	3
<b>CO-2:</b> Interact with a block chain system by sending and reading transactions	3	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	2
<b>CO-3:</b> Design, build and deploy a distributed application	1	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	2
<b>CO-4:</b> Develop Ethereum consensus mechanism	2	-	3	-	1	-	-	-	-	-	-	-	-	-	-	-	3
<b>CO-5:</b> Familiarize with Ethereum, smart contracts and related technologies, and solidity language	3	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	3

**Unit-1 - Introduction to Ethereum** 9 Hour  
Ethereum, three parts of block chain, Ether as a Currency and Commodity, Crypto economics, and Security, EVM Architecture, Mist Browser, Wallets as Computing metaphor, Transactions in Ethereum, Encryption-Asymmetric and Public cryptography, Understanding Denominations, Introduction Solidity

**Unit-2 - The EVM and Introduction Solidity** 9 Hour  
Virtual machine, Ethereum protocols in banking, Applications of EVM, Smart contracts, State changes Gas-Importance, Specifications, opcodes in EVM, Solidity programming, Design rationale, Importance of formal Proofs Testing, Formatting and Statements, Expressions in solidity

**Unit-3 - Evaluating Ethereum and Block Chain** 9 Hour  
Ethereum for application, Installing Parity, MetaMask, Developing smart contracts, Contract Compilation and deployment , UI Setting, Fund Raiser Application-Overview, creating project, Intialising,setting beneficiary and custodian, Mappings , Donation Tests, Events, Withdrawing funds ,Fallback Functions

**Unit-4 - Mining Ether** 9 Hour  
Ether Source, Factors for Block validation, Use of ethereum stale blocks, Ethereum and bitcoin trees, Forking, Dapp deployment-contract data models, Meteor with Ethereum, Contracts, Interface, Prototyping, Creating Private chains, Optional flags, Private block chains,

**Unit-5 - Ethereum application & Crypto economics** 9 Hour  
Crypto economics - Rules, Ether Issuance Schemes, Attack scenarios Internet of Ethereum things - Retail and E-commerce, Community and government financing, Human and Organizational behaviour, Financial, Insurance Applications, Inventory and Accounting, Gaming, gambling and Investing

<b>Learning Resources</b>	<p>1. <i>Introducing Ethereum and Solidity</i>- Chris Dannen, Published: 18 March 2017, Apress Berkeley, CA</p> <p>2. <i>Hands-On Smart Contract Development with Solidity and Ethereum</i>- Kevin Solorio, Randall Kanna &amp; David H. Hoover, 25 November 2019, O'Reilly Media</p>	<p>3. <i>Mastering Ethereum Building smart contracts and Dapps</i>- Andreas M. Antonopoulos Dr. Gavin Wood, 15 December 2018 , O'Reilly</p> <p>4.. <i>Ethereum For Dummies</i>- Michael G. Solomon,28 March 2019</p> <p>5.The Basics of Bitcoins and Block chains: An Introduction to Crypto currencies and the Technology that Powers Them – Antony Lewis, September 15, 2018</p>
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)	Life-Long Learning CLA-2 (10%)							
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	30%	-	30%	-		
Level 4	Analyze	30%	-	30%	-	30%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1.B.Yuvraj Nandhan, Software Engineer, Bank of America	1. Dr.T.Suresh ,CSE, Annamalai University	1. Dr.R.Jayaraj SRMIST 2. Dr.S.Ganesh Kumar, SRMIST

<b>Course Code</b>	21CSE333T	<b>Course Name</b>	AI AND BLOCKCHAIN	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		Program Outcomes (PO)												<b>Program Specific outcomes</b>												
CLR-1:	List the basic principles of AI toward problem solving, inference, perception, knowledge representation, and learning												PSO-1	PSO-2	PSO-3											
CLR-2:	Illustrate state core Blockchain concepts, the benefits, and the limitations of blockchain technologies																									
CLR-3:	Experiment with technical underpinnings of AI and blockchain technology at sufficient depth to perform analysis																									
CLR-4:	Discover the current scope, potential, limitations, and implications of intelligent systems																									
CLR-5:	Examine real world challenges that blockchain technologies may assist in solving																									
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	
CO-1:	Comprehend the basics of artificial intelligence (AI) and its foundations												3	2	1	-	-	-	-	-	-	-	-	2	-	-
CO-2:	Summarize relevant legal, ethical, and privacy issues and how they might impact policy and actions of organizations or individuals												2	3	1	-	-	-	-	-	-	-	-	-	2	-
CO-3:	Build the decisions about the use of blockchain technology in systems, and support decisions with relevant arguments												2	1	3	-	-	-	-	-	-	-	-	-	-	2
CO-4:	Perceive an ability to share in discussions of AI, its current scope and limitations, and societal implications												3	2	-	-	2	-	-	-	-	-	-	-	-	2
CO-5:	Apply blockchain concepts to analyze examples, proposals, case studies, and preliminary blockchain system design discussions												2	2	-	-	2	-	-	-	-	-	-	-	-	3

#### **Unit-1 - Introduction to AI Landscape** 9 Hour

AI – key concepts - History of AI - AI winter - Types of AI : Weak AI , Strong AI ,Super AI- Forms of AI and approaches : Statistical and expert systems, Machine learning, Supervised learning, Unsupervised learning, Reinforcement learning - Neural networks - Evolutionary computation - Swarm computation - AI in digital transformation: Data extraction - Data transformation - Processing - Storyboarding - Data utilization, AI platforms and tools : Tensor Flow - Microsoft Cognitive Toolkit - IBM Watson

#### **Unit-2 - Overview of Blockchain** 9 Hour

Getting Started with Blockchain: Blockchain versus distributed ledger technology versus distributed databases - Comparing the technologies with examples - Public versus private versus permissioned Blockchain - Comparing usage scenarios - Privacy in Blockchain - Understanding Bitcoin - A brief overview of Bitcoin, Ethereum: A brief overview of Ethereum, Introduction to Hyperledger - Overview of the project - Hyperledger Fabric - Hyperledger Saw tooth - Other Hyperledger frameworks and tools

#### **Unit-3 - Blockchain and Artificial Intelligence** 9 Hour

Domain Specific Applications - Applying AI & Blockchain: Healthcare, Supply chain, Financial Services, Information Security, Document management, AI & Blockchain Driven Databases - Centralized versus distributed data, big data for AI analysis, Data Management in a DAO, Emerging patterns for Database Solutions

**Unit-4 - AI and Cryptocurrency** 9 Hour

Role of AI in Cryptocurrency - Cryptocurrency Trading: Issues & Considerations, Benefits of AI in Crypto Trading - Making Price Predictions with AI: Issues with Price Prediction, Benefits of AI in Prediction, Time series forecasting with ARIMA, Applications of algorithmic or quant trading in Cryptocurrency

**Unit-5 - Developing and Future of AI with Blockchains** 9 Hour

Applying SDLC practices in Blockchain: Introduction to DIApp - Architecture of a DIApp - Developing a DIApp - Testing a DIApp - Deploying DIApp - Monitoring a DIApp, Implementing DIApp - Evolution of decentralized applications, building a sample DIApp, Developing Smart Contracts, Solution approach with AI, Developing: Client code, Backend, Frontend, Future of converging AI & Blockchain in enterprises & Government.

<b>Learning Resources</b>	<p>1.Kumble, G. P. (2020). <i>Practical Artificial Intelligence and Blockchain: A guide to converging blockchain and AI to build smart applications for new economies</i>. Packt Publishing Ltd</p> <p>2.Smith, S. S. (2019). <i>Blockchain, artificial intelligence and financial services: Implications and applications for finance and accounting professionals</i>. Springer Nature</p> <p>3. Nishith Pathak, Anurag Bhandari .(2018).<i>IoT, AI and Blockchain for .NET</i></p>	<p>4. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, And Steven Goldfeder (2016). <i>BITCOIN AND CRYPTOCURRENCY TECHNOLOGIES</i></p> <p>5. Vikram Dhillon, David Metcalf, Max Hooper (2017).<i>Blockchain Enabled Applications</i></p>
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Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	30%	-	30%	-		
Level 4	Analyze	30%	-	30%	-	30%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. S.Gomathi Sankar , Technical Lead .LTIMindtree 2. Dhilip Velumani, Module Lead,LТИmindtree	1. Dr.Soma Prathibha , Sri Sai Ram Engineering College,Chennai 2. Dr.S.V.N Santhosh Kumar , VIT Vellore	1. Dr.A.Siva Kumar SRMIST 2. Dr.S.Ganesh Kumar SRMIST

<b>Course Code</b>	21CSE334T	<b>Course Name</b>	CONTAINER MANAGEMENT	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Comprehend fundamentals of cloud application development												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Deployment of Cloud Applications using Cloud Native Services															
<b>CLR-3:</b>	Design various Cloud Applications															
<b>CLR-4:</b>	Understand the Cloud Security and Cloud pricing models															
<b>CLR-5:</b>	Learn the purpose of stream processing and its basic components															

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning		
<b>CO-1:</b>	Comprehend Cloud fundamental Concepts	2	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-		
<b>CO-2:</b>	Understand virtualization foundations to cater the needs of elasticity, portability, and resilience by cloud service providers.	-	2	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-		
<b>CO-3:</b>	Compare operation and economic models of various trending cloud platforms prevailing in IT industry	-	3	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	
<b>CO-4:</b>	Learn why automation, culture, and metrics are essential to a successful DevOps	2	3	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-
<b>CO-5:</b>	Design a cloud framework with appropriate resource management techniques with its security.	-	2	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	

**Unit-1 - Introduction Cloud Computing** 9 Hour  
 Introduction-- Cloud Introduction –NIST Definition: Cloud service Models - IaaS/ PaaS / SaaS, Deployment Models –Public, Private, Hybrid and Community, Cloud Characteristics, Cloud Challenges –user, Service Provider end, Applications of Cloud, Cloud federation, Cloud Enabling Technology, - Challenges and Issues-

**Unit-2 - Virtualization** 9 Hour  
 Introduction to Hypervisors – Type 1 Hypervisors – Type 2 Hypervisors –, Basics of Virtualization - Types of Virtualizations - Understanding Hypervisors - Implementation Levels of Virtualization -Virtualization Structures - Tools and Mechanisms – Resource sharing and Resource pooling -Desktop Virtualization – Server Virtualization.

**Unit-3 - Containerization Using Dockers** 9 Hour  
 Docker, Containers, Usage of containers, Terminology, Docker Run Static sites, Docker Images, Docker File, Docker on AWS, Docker Network, Docker Compose, Development Workflow, and AWS EC Services.

**Unit-4 - Devops** 9 Hour  
 Introduction, Test Driven Development, Continuous Integration, Code coverage, Best Practices, Virtual Machines vs Containers, Rolling Deployments, Continuous Deployment, Auto Scaling. Case Study: Open Stack, Cloud based ML Solutions in Healthcare

**Unit-5 - Cloud Security** 9 Hour  
 Cloud Application Development – Cloud Application Execution, Applications using Containers - Testing the Cloud Application, Case study on Cloud Application – Cloud Security Concepts - Cloud Security Threats, Cloud Security Mechanisms: Encryption, Public Key Infrastructure, Identity and Access Management, Single Sign-On: Kerberos authentication, Mobile Cloud, Green Cloud.

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Rajkumar Buyya, James Broberg, Andrzej, M. Goscinski, <i>Cloud Computing: Principles and Paradigms</i>, Wiley, 1st Edition, 2013.</li> <li>2. Sosinsky, Barrie, <i>Cloud Computing Bible</i>, John Wiley &amp; Sons, 1 st Edition, 2011.</li> <li>3. Docker: <i>Up &amp; Running: Shipping Reliable Containers in Production</i>, Sean P. Kane, Karl Matthias, O'Reilly Media Inc, 2015.</li> <li>4. Thomas Erl, ZaighamMahmood, RichardoPuttini, "Cloud Computing: Concepts, Technology and Architecture", Fourth Printing, 2014, Prentice Hall/PearsonPTR, ISBN: 9780133387520.</li> <li>5. Buyya, Rajkumar, Christian Vecchiola, and S. Thamarai Selvi. <i>Mastering Cloud Computing: Foundations and Applications Programming</i>, Tata Mcgraw Hill, 1 st Edition, 2017.</li> <li>6. Ellis B, <i>Real-Time Analytics – Techniques to analyze and visualize streaming data</i>, 1st ed., John Wiley &amp; Sons Inc,2014</li> <li>7. Mark Wilkins, "Learning Amazon Web Services (AWS): A Hands-On Guide to the Fundamentals of AWS Cloud", 2019.</li> <li>8. <a href="https://cloudacademy.com/course/introduction-to-devops/intro-3/">https://cloudacademy.com/course/introduction-to-devops/intro-3/</a></li> </ol>
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	30%	-	30%	-		
Level 4	Analyze	30%	-	30%	-	30%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Rajarajan Sundaramurthy, Zealogics systems, Kakkanaid, Kerala	2. Dr. K. Pradeep, Assistant Professor, School of Computer Science and Engineering, VIT Chennai.	3. Dr.N.Manikandan, SRMIST

<b>Course Code</b>	21CSE335T	<b>Course Name</b>	ADVANCED CRYPTOGRAPHY	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	comprehend the fundamental knowledge of the cryptographical technologies												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	remember the mathematics behind Cryptography.															
<b>CLR-3:</b>	analyze the design of various cryptographic primitives															
<b>CLR-4:</b>	Apply the process of implementing the cryptographic algorithms															
<b>CLR-5:</b>	Evaluate the foundations of modern cryptography toward practical applications															
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Comprehend the principles of cryptography												-	1	3	2
<b>CO-2:</b>	realize the current rigorous approaches for evaluating the security of cryptographic constructions												-	3	-	3
<b>CO-3:</b>	Analyze cryptographic schemes												-	3	2	2
<b>CO-4:</b>	describe core concepts and terminology concerning use of cryptography												-	3	-	2
<b>CO-5:</b>	explain the concepts of encryption and authentication												-	1	-	3

<b>Unit-1 - Introduction to Cryptography</b>	<b>9 Hour</b>
Classic ciphers—Substitution techniques- Transposition Techniques-Stream Cipher-Properties of Stream Cipher - Model of a stream cipher -Block Cipher- Properties of Block Cipher- Model of a Block cipher	
<b>Unit-2 - Symmetric Key Ciphers</b>	<b>9 Hour</b>
Block Cipher principles- Data Encryption Standard (DES) - Triple 3DES - Advanced Encryption Standard (AES)- RC4- RC5-Blowfish	
<b>Unit-3 - Asymmetric Key Ciphers</b>	<b>9 Hour</b>
Principles of public key cryptography- Integer Factorization Schemes: Rivest-Shamir-Adleman (RSA)- Discrete Logarithm Schemes: Digital Signature Algorithm (DSA)- ElGamal- Elliptic Curve Cryptography (ECC)- Other public key algorithms. Cryptographic Protocols-Diffie-Hellman Key Agreement Protocols - Fiat-Shamir Identification Scheme	
<b>Unit-4 - Message Integrity and Hash Function</b>	<b>9 Hour</b>
Message Authentication Code (MAC)- CBC-MAC – HMAC- DAA-CMAC. Hash Function: Secure Hash Algorithm (SHA)-SHA1-SHA2-SHA3-Message digest-MD4-MD5	
<b>Unit-5 - Cryptographic Applications</b>	<b>9 Hour</b>
Securing the internet- Wireless local area networks- mobile telecommunications-Secure payment card transactions-video broadcasting-identity cards-anonymity-digital currency. The Future of Cryptography- quantum computing- postquantum cryptography- quantum cryptography	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. An Introduction to Cryptography, Second Edition (Discrete Mathematics and Its Applications), Richard A. Mollin, Taylor &amp; Francis, 2006</li> <li>2. Applied Cryptography, Second Edition: Protocols, Algorithms, and Source Code in C, Bruce Schneier, John Wiley &amp; Sons, Inc, 1996</li> <li>3. Cryptography: An Introduction (3rd Edition) Nigel Smart, McGraw-Hill College, 2003</li> <li>4. Cryptography Engineering: Design Principles and Practical Applications, Niels Ferguson, Bruce Schneier, and Tadayoshi Kohno, John Wiley &amp; Sons Inc; 1st edition, 2010</li> <li>5. Cryptography and Network security Principles and practice, William Stallings Seventh edition, Pearson, 2017</li> </ol>
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)	Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.V. Gopinath, Solution Architect, Tata Consultancy Service Ltd., Chennai	1. Dr. M. Sugumaran, Professor, Department of Computer Science and Engineering, Puducherry Technological University, Puducherry	1. Dr. Panimalar.K, SRMIST

<b>Course Code</b>	21CSE336T	<b>Course Name</b>	CLOUD COMPUTING WITH BLOCKCHAIN	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co-requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	comprehend the fundamentals of cloud computing and blockchain.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	recognize the protection of cloud resources.																								
<b>CLR-3:</b>	Know about blockchain as a service.																								
<b>CLR-4:</b>	Gain knowledge in cloud data management and smart contracts.																								
<b>CLR-5:</b>	Identify the uses of cloud computing and blockchain technology in the industry.																								
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Recognize the concepts of cloud computing and blockchain.	1	1																						
<b>CO-2:</b>	Describe the Features of cloud computing and implementation of smart contracts	1	2	3	-	-	-	-	-	-	-	-	-												
<b>CO-3:</b>	Identity various blockchain business models and its applications.	1	-	2	-	-	-	-	-	-	-	-	-												
<b>CO-4:</b>	Explain the cloud data management and implement the integrated services using smart contracts.	1	2	3	-	-	-	-	-	-	-	-	-												
<b>CO-5:</b>	Explain the uses of cloud and blockchain technology in the industry.	1	-	2	-	-	-	-	-	-	-	-	-												

<b>Unit-1 - Fundamentals of Cloud Computing and Blockchain</b>	<b>9 Hour</b>
Cloud Computing: Concepts, features, Cloud computing delivery services and network operations, Cloud deployment models, Models benefits and challenges – Blockchain: Concepts, features - Introduction to cryptocurrencies and blockchain-based solutions, Configuration of blockchain network.	
<b>Unit-2 - Cloud Resources &amp; Smart Contracts</b>	<b>9 Hour</b>
Features of cloud computing providers, provisioning of cloud computing, storage and networking resources, implementation of cloud-based solutions, Smart contracts functions and its uses, design, and implementation of smart contracts.	
<b>Unit-3 - Blockchain as a Service</b>	
Blockchain Business Models, Traditional business models-Types of Blockchain Business Models- Blockchain as A Service (BaaS)-Token Economy- Utility Token Business Model-Blockchain-Based Software Products, P2P Blockchain Business Model-Blockchain Professional Services. Block chain for Banking and Financial transactions, The development of portable, scalable, and extensible cloud resources applications (AWS).	
<b>Unit-4 - Cloud Data Management &amp; Integrated Services Using Smart Contracts</b>	
Cloud data protection. Data modernization, databases, and file storage cloud solutions, implement strategies for backup and data recovery, Blockchain offline storage, IPFS, Analyse, design, and implement distributed applications (DApps).	
<b>Unit-5 - Cloud Computing and Blockchain Technology in the Industry</b>	
Cloud development operations (DevOps) services, to propose a solution that integrates cloud services and blockchain technology to design and implement a hybrid architecture, Blockchain as a Service - Cloud server security challenges - Cloud computing with BaaS-Hybrid Cloud server with BaaS for Remote Monitoring-Case study: Industries adopting BaaS for security.	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Jai Singh Arun, Jerry Cuomo, Nitin Gaur, <i>Blockchain for Business - For Understanding transformation, growth and new models of Business</i>, First Edition, Pearson, 2019.</li> <li>2. Judith S. Hurwitz, Robin Bloor, Marcia Kaufman, Fern Halper, <i>Cloud Computing for Dummies</i>, Wiley, 2010.</li> <li>3. Andrzej M. Goscinski, James Broberg, Rajkumar Buyya, <i>Cloud Computing Principles and Paradigms</i>, Wiley, 2010.</li> <li>4. John W. Rittinghouse, James F. Ransome, <i>Cloud Computing - Implementation, Management, and Security</i>, CRC Press, 2017.</li> <li>5. <i>Blockchain Architecture Design and Use Cases</i>, IIT Kharagpur, Sandip Chakraborty, Praveen Jayachandran: <a href="https://nptel.ac.in/courses/106105184">https://nptel.ac.in/courses/106105184</a></li> <li>6. <i>Introduction to Blockchain Technology and Applications</i>, IIT Kanpur Prof. Sandeep Shukla: <a href="https://nptel.ac.in/courses/106104220">https://nptel.ac.in/courses/106104220</a></li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>	
<b>Bloom's Level of Thinking</b>	<b>Formative CLA-1 Average of unit test (50%)</b>	<b>Life-Long Learning CLA-2 (10%)</b>					
		<b>Theory</b>	<b>Practice</b>	<b>Theory</b>	<b>Practice</b>	<b>Theory</b>	<b>Practice</b>
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. N. Mohanraj, Software Engineer PayPal Inc., Chennai.	1. Dr. M. Vinoth Kumar, Associate Professor, Department of Information Science and Engineering, Dayananda Sagar Academy of Technology & Management, Bengaluru.	1. Dr. M. Prakash, SRMIST

<b>Course Code</b>	21CSE337T	<b>Course Name</b>	WEB3 DEVELOPMENT	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>													
<b>CLR-1:</b>	comprehend the basics of web technologies, XHTML, and HTML5												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>												
<b>CLR-2:</b>	explore CSS, and JavaScript																										
<b>CLR-3:</b>	Explore event handling techniques and Java Servlet																										
<b>CLR-4:</b>	Acquire knowledge on XML, AJAX, and JSP																										
<b>CLR-5:</b>	develop web services, working with Python, databases, anyone DB Connectivity, MongoDB, ReactJs																										
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning		
<b>CO-1:</b>	Apply the knowledge of web essentials, XHTML, and HTML5													3	-	2	-	-	-	-	-	-	3	-	-		
<b>CO-2:</b>	Apply CSS Styling, and interactive web design techniques while creating a web page													3	-	2	-	1	-	-	-	-	-	-	2	-	
<b>CO-3:</b>	Implement and analyze event handling techniques and Java Servlet for web application development													3	1	3	-	-	-	-	-	-	-	-	-	1	-
<b>CO-4:</b>	Create XML document, apply AJAX, and JSP for developing a web application													2	1	3	-	-	-	-	-	-	-	-	-	3	-
<b>CO-5:</b>	Develop web services, apply the basic knowledge of Python, database, anyone DB Connectivity, MongoDB, and NodeJs													1	-	3	-	3	-	-	-	-	-	-	1	-	-

**Unit-1 - Web Essentials** 9 Hour  
Clients, Servers, Communication, The Internet-Basic Internet Protocols -The World Wide Web, Comparison web1.0, Web2.0 and web3.0 and its tool, HTTP request message, Response Message, Web Clients, Web Servers, XHTML. An Introduction to HTML History, Versions, XHTML Syntax and Semantics, Fundamental HTML Elements, Relative URLs-Lists-tables-Div-Frames-Forms, HTML5 : Responsive web design, developing a web page using URLs, imgs, and Lists, developing a web page using HTML tables, divs/frames, creating a HTML Form for maintaining course details.

**Unit-2 - Cascading Style Sheets** 9 Hour  
Introduction to Cascading Style Sheets- Features-Core, Syntax-Style Sheets and HTML Style, Cascading, Inheritance, Text Properties, Box Model Normal Flow Box Layout, Beyond the Normal Flow, Client- Side Programming, The JavaScript Language, JavaScript in Perspective-Syntax Variables, Implementation of CSS Inheritance, Implementation of Text properties, Implementation of Box model to display distinct paragraphs in three different boxes, Applying JavaScript to create an interactive web page for performing arithmetic calculations.

**Unit-3 - Event Handling** 9 Hour  
Host Objects, Browsers and the DOM-Introduction to the Document Object Model, DOM History and Levels, Event Handling—Accommodating Noncompliant Browsers, Java Servlet- Architecture, Overview-A Servlet, Generating Dynamic Content, Life Cycle- Parameter Data, Sessions and Cookies, URL Rewriting-Other Capabilities, Data Storage Servlet and Concurrency.

**Unit-4 - XML, AJAX, XSLT, and JSP** 9 Hour  
XML REPRESENTATION, Representing Web Data, XML-Documents and Vocabularies, Versions and Declaration, Namespaces JavaScript and XML, Ajax-Event Oriented Parsing, SAX-Transforming XML Documents, XPATH-Template based Transformation, XML Schema-Communicating Object Data, XSLT-Displaying XML Documents in Browsers, JSP Technology Introduction-JSP and Servlet, Running JSP Applications, JavaBeans Classes and JSP Tag Libraries. Applying XML & XSLT to display product information.

**Unit-5 - Web Services, and Advanced concepts in Web Development** 9 Hour

JAX-RPC-Concepts, writing a Java Web Service, consuming a RESTfull Web Service, WSDL- Representing Data Types, SOAP Related Technologies, Software Installation, Working with Python, Basic concepts in Databases, DB Connectivity, working with MongoDB, Working with ReactJs.

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Deitel , Deitel and Nieto, "Internet and World Wide Web – How to program",4th Edition, Pearson Education Publishers, 2009</li> <li>2. Jeffrey C Jackson "Web Technologies" , Pearson Education,2006</li> <li>3. Eric Freeman, Elisabeth Robson, "HTML5 Programming", first edition, O'Reilly Publishers, 2011.</li> <li>4. Robert. W.Sebesta, "Programming the world wide web", Fourth Edition, Pearson Education, 2007</li> <li>5. Bates "Developing Web Applications", Wiley 2006</li> <li>6. Marty Hall and Larry Brown, "Core web Programming ", Pearson education, 2001</li> <li>7. Jobinsh Purushothaman, "RESTful Java Web Services" Second Edition, Packt Publishing, 2015</li> <li>8. <a href="https://www.computer-pdf.com/web-programming/javascript/851-tutorial-reactjs-notes-for-professionals-book.html">https://www.computer-pdf.com/web-programming/javascript/851-tutorial-reactjs-notes-for-professionals-book.html</a></li> <li>9. <a href="https://www.tutorialspoint.com/mongodb/mongodbTutorial.pdf">https://www.tutorialspoint.com/mongodb/mongodbTutorial.pdf</a></li> <li>10. <a href="https://www.stat.berkeley.edu/~spector/python.pdf">https://www.stat.berkeley.edu/~spector/python.pdf</a></li> </ol>
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<b>Learning Assessment</b>							
<i>Bloom's Level of Thinking</i>		Continuous Learning Assessment (CLA)				<i>Summative Final Examination (40% weightage)</i>	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice		
Level 1	Remember	15%	-	15%	-	15%	
Level 2	Understand	25%	-	25%	-	25%	
Level 3	Apply	30%	-	30%	-	30%	
Level 4	Analyze	30%	-	30%	-	30%	
Level 5	Evaluate	-	-	-	-	-	
Level 6	Create	-	-	-	-	-	
	Total	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Hari hara sudhan M, Tech Lead, Infosys Ltd. 2. Irrai anbu Jayaraj, Business analyst, CSL pvt ltd	1. Dr. A. Tamizhselvi, Associate Professor, SJCE 2. Dr. S. Kannimuthu, Professor and Head, AI & DS, KCE	1. Dr. K. Dhanasekaran, SRMIST

<b>Course Code</b>	21CSE338T	<b>Course Name</b>	TRUST BASED COMPUTING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Gain knowledge about fundamental technologies behind Trusted Computing												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	comprehend trusted Platform Modules (TPMs) are and what capabilities they can provide both at an in-depth technical level and in an enterprise context															
<b>CLR-3:</b>	learn about how other technologies such as the Dynamic Root of Trust for Measurement (DRTM) and virtualization can both take advantage of TPMs and be used to enhance the TPM's capabilities															
<b>CLR-4:</b>	apply for use cases related to trusted computing, including machine authentication, data protection, and attestation															
<b>CLR-5:</b>	Study various software resources that exist today to support TPMs, give a high-level overview of related research and development projects															

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CO-1:</b>	Realize the concept of Trust, Security and Game theory												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CO-2:</b>	Obtain general understanding of trust and alternative operations															
<b>CO-3:</b>	Learn about the importance of systems and cryptographic hash functions															
<b>CO-4:</b>	Learn about bitcoin, blockchain and trust lifecycle.															
<b>CO-5:</b>	Analyze risk, trust and control using case studies.															

**Unit-1 – Introduction to Trust** **9 Hour**  
 Analysing Our Trust Statements - Agency - Trust and Security - Trust as a Way for Humans to Manage Risk - Risk, Trust, and Computing - Defining Correctness in System Behaviour - The Role of Monitoring and Reporting in Creating Trust - Game theory - The Prisoner's Dilemma - Reputation and Generalised Trust - Institutional Trust

**Unit-2 – Trust Operations and Alternatives** **9 Hour**  
 Trust Actors, Operations, and Components - Reputation, Transitive Trust, and Distributed Trust - Agency and Intentionality - Alternatives to Trust - Legal Contracts - Enforcement - Verification - Assurance and Accountability - Trust of Non-Human or Non-Adult Actors - Expressions of Trust - Relating Trust and Security - Misplaced Trust

**Unit-3 – Importance of Systems** **9 Hour**  
 System Design - The Network Stack - Linux Layers - Virtualisation and Containers: Cloud Stacks - Other Axes of System Design - "Trusted" Systems - Trust Within the Network Stack - Trust in Linux Layers - Trust in Cloud Stacks - Hardware Root of Trust - Cryptographic Hash Functions - Measured Boot and Trusted Boot - Certificate Authorities - Internet Certificate Authorities - Local Certificate Authorities - Root Certificates as Trust Pivots

**Unit-4 – Block Chain and Trust** **9 Hour**  
 Bitcoin and Other Blockchains - Permissioned Blockchains - Trust without Blockchains - Blockchain Promoting Trust - Permissionless Blockchains and Cryptocurrencies - The Importance of Time - Decay of Trust and Lifecycle - Software Lifecycle - Trust Anchors, Trust Pivots, and the Supply Chain - Direct trust and indirect trust.

**Unit-5 – Case Studies and Applications****9 Hour**

Analysis of risk, trust, and control in cloud computing - Trust in Computational Intelligence Systems - Individual Trust Development in Computer Mediated Collaboration Teams - Development of Trust in a Business Relation - supply chain use case – banking use case– mini projects.

<b>Learning Resources</b>	1. <i>Trust in Computer Systems and the Cloud</i> , Mike Bursell, ISBN: 978-1-119-69232-4, Wiley, Dec 2021. 2. <i>Trusted Computing</i> , by Dengguo Feng, Tsinghua University Press, December 2017, Publisher : De Gruyter, ISBN: 9783110476095. 3. <i>A Practical Guide to Trusted Computing</i> , by David Challener, Kent Yoder, Ryan Catherman, David Safford, Leendert Van Doorn, IBM Press, 27 December 2007.	4. <i>Data Privacy and Trust in Cloud Computing, Building trust in the cloud through assurance and accountability</i> , Edited by Theo Lynn · John G. Mooney Lisa van der Werff · Grace Fox, palgrave macmillian, ISBN 978-3-030-54660-1, 2021. 5. <i>Trusted Computing Platforms: TCPA Technology in Context</i> , by Siani Pearson, Boris Balacheff, Prentice Hall Professional, 2003
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)	Life-Long Learning CLA-2 (10%)							
		Theory	Practice	Theory	Practice				
		15%	-	15%	-	15%	-		
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	30%	-	30%	-		
Level 4	Analyze	30%	-	30%	-	30%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Ishan Roy, Director, Metabasu Technologies Private Limited 2. Mr. Rex Aantonny, Founder & CEO, Rex Cyber Solutions Pvt Ltd	1. Dr.S. Ganapathy, Associate Professor, Vellore Institute of Technology, Chennai. 2. Dr. S. Muthurajkumar, Assistant Professor / Computer Technology, Madras Institute of Technology Campus, Anna University, Chrompet, Chennai - 600044.	1. Dr. Prabhu kavin.B, SRMIST

<b>Course Code</b>	21CSE431T	<b>Course Name</b>	BUILDING PRIVATE BLOCKCHAIN	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>			
<b>CLR-1:</b>	comprehend the basics of distributed database and cryptography												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>		
<b>CLR-2:</b>	Integrate ideas from Blockchain Technology																
<b>CLR-3:</b>	Design, build and deploy smart contracts and distributed applications																
<b>CLR-4:</b>	know the Cloud Security and Cloud pricing models																
<b>CLR-5:</b>	Learn the purpose of stream processing and its basic components																
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>																
<b>CO-1:</b>	Explain the basic concepts of Database systems												-	1	-	2	-
<b>CO-2:</b>	Explore the design principles of Bitcoin and Ethereum												-	2	-	1	-
<b>CO-3:</b>	Describe emerging abstract models for Blockchain Technology												-	3	-	1	-
<b>CO-4:</b>	Implement Hyperledger Fabric and Ethereum platform to Block chain Application												-	3	-	1	-
<b>CO-5:</b>	Design, build, and deploy a distributed application												-	2	-	1	-

<b>Unit-1 - Introduction</b>	<b>9 Hour</b>
Distributed Database – Hadoop Distributed File System – Distributed Hash Table – ASIC resistance – Cryptography: Hash function – Digital signature – Memory Hard Algorithm	
<b>Unit-2 - Blockchain</b>	<b>9 Hour</b>
Introduction to Blockchain – Advantage over conventional distributed database – Blockchain Network – Mining Mechanism – Distributed Consensus – Merkle Patricia Tree – Gas Limit – Transactions and Fee – Anonymity – Reward – Chain Policy – Life of Blockchain application – Soft & Hard Fork – Private and Public blockchain	
<b>Unit-3 - Distributed Consensus</b>	
Nakamoto consensus – Proof of Work – Proof of Stake – Proof of Burn – Difficulty Level – Sybil – Attack – Energy utilization and alternate.	
<b>Unit-4 - Cryptocurrency</b>	<b>9 Hour</b>
History – Distributed Ledger – Bitcoin – Bitcoin protocols – Mining strategy and rewards – Ethereum – Construction – DAO – Smart Contract – GHOST – Vulnerability – Attacks – Sidechain – Namecoin.	
<b>Unit-5 - Cloud Security</b>	
Internet of Things – Medical Record Management – Application of Blockchain in Government – Blockchain use cases – Finance.	

<b>Learning Resources</b> <ul style="list-style-type: none"> <li>1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, <i>Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction</i>, Princeton University Press, 2016.</li> <li>2. Xu, Xwei, Weber, Ingo, Staples, Mark, <i>Architecture for Blockchain Applications</i>, Springer, 2019.</li> <li>3. Andreas M. Antonopoulos, "Mastering Bitcoin: Programming the Open Blockchain", Second Edition, O'Reilly, 2017</li> <li>4. Pradip Dey, Manas Gosh, "Programming in C", First Edition, Oxford University Press, 2018</li> </ul>	<ul style="list-style-type: none"> <li>5. Albert Szmigelski, <i>Bitcoin Essentials</i>, 2016</li> <li>6. Daniel Forrester , Mark Solomon, <i>Bitcoin Exposed:Today's Complete Guide to Tomorrow's Currency</i></li> <li>7. Antony Lewis, <i>The Basics of Bitcoins and Blockchains An Introduction to Cryptocurrencies and the Technology that Powers Them</i> ,2018</li> </ul>
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Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	30%	-	30%	-		
Level 4	Analyze	30%	-	30%	-	30%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
Total		100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Rajarajan Zelogic Systems	1. Dr.K.Pradeep, VIT	1. Dr.N.Manikandan, SRMIST

<b>Course Code</b>	21CSE432T	<b>Course Name</b>	BLOCKCHAIN TECHNOLOGY WITH HYPERLEDGER	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 3	T 0	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Realize the block chain in industry perspective												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Apply the concepts of hyperledger fabric component designs															
<b>CLR-3:</b>	Apply the hyperledger trade network concepts in business networks															
<b>CLR-4:</b>	Apply the concepts of smart contract transactions and ledger data structures															
<b>CLR-5:</b>	Develop smart contracts for any use case															
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>															
<b>CO-1:</b>	comprehend the enterprise block chain and the basic of hyperledger fabric												3	3	3	
<b>CO-2:</b>	Apply the concepts of hyperledger fabric component designs												3	3	1	
<b>CO-3:</b>	Apply the hyperledger trade network concepts in business networks												3	3	2	
<b>CO-4:</b>	Apply the concepts of smart contract transactions and ledger data structures												3	3	2	
<b>CO-5:</b>	Build smart contracts for real time use cases												-	-	2	

<b>Unit-1 - Blockchain – An Enterprise and Industry Perspective</b>	<b>9 Hour</b>
Blockchain in the enterprise - Good fit applications - Enterprise blockchain business evaluation considerations - Enterprise view blockchain - Integrating a blockchain infrastructure for the whole enterprise - Enterprise design principles - Business considerations for choosing a blockchain framework - Exploring Hyperledger Fabric - Building on the foundations of open computing - Fundamentals of the Hyperledger project - Hyperledger frameworks, tools, and building blocks	
<b>Unit-2 - Transactions and Business Networks</b>	
<b>9 Hour</b>	
Hyperledger Fabric component design - Hyperledger Fabric – the journey of a sample transaction - Actors and components in a Hyperledger Fabric network - CAP theorem - new features - Business Networks - A busy world of purposeful activity - Language for business networks - Defining a business network - Participants - Assets - Transactions – Events - Business network technology	
<b>Unit-3 - Setting the Stage with a Business Scenario</b>	
<b>9 Hour</b>	
Trading and letters of credit - Business scenario and use case - Designing and configuring a Hyperledger Fabric trade network - Launching a sample trade network - Configuring our development environment for network operations	
<b>Unit-4 - Designing Smart Contract Transactions and Ledger Data Structures</b>	
<b>9 Hour</b>	
Architecture of the trade solution - Starting the contract development - Creating a contract - Access control - Implementing contract functions - Testing a contract - Advanced contract designs - Transaction mechanisms - Logging output	

<b>Unit-5 - Developing Smart Contracts and Use Cases</b>	<b>9 Hour</b>
Developing Smart Contracts - Use case 1: Blockchain in trade/supply chain: (i) Provenance of goods, visibility, trade/supply chain finance, invoice management discounting, etc., - Use case 2: Blockchain for Government: (i) Digital identity, land records and other kinds of record keeping between government entities, (ii) public distribution system social welfare systems Blockchain Cryptography, Privacy and Security on Blockchain Practical Component Building a Network and Deploying Smart Contract & Security	

<b>Learning Resources</b>	1. <i>Blockchain with Hyperledger Fabric - Second Edition-</i> Nitin Gaur, Anthony O'Dowd, Petr Novotny, Luc Desrosiers, Salman A. Baset, November 2020, Packt, ISBN 9781839218750	4. <i>Blockchain for Business with Hyperledger Fabric (English, Undefined, Shah Nakul)</i>
	2. <i>Hyperledger Fabric In-Depth: Learn, Build and Deploy Blockchain Applications Using Hyperledger Fabric, 1st Edition,</i> Ashwani Kumar	5. <i>Hyperledger Cookbook: Over 40 recipes implementing the latest Hyperledger blockchain frameworks and tools Paperback – Import, 30 April 2019 by Xun (Brian) Wu, Chuanfeng Zhang, Andrew Zhang</i>
	3. <i>Hands-On Smart Contract Development with Hyperledger Fabric V2: Building Enterprise Blockchain Applications,</i> Matt Zand	6. <a href="https://hyperledger-fabric.readthedocs.io/en/latest/tutorials.html">https://hyperledger-fabric.readthedocs.io/en/latest/tutorials.html</a>

<b>Learning Assessment</b>						
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)		
		Theory	Practice	Theory	Practice	Theory
Level 1	Remember	15%	-	15%	-	15%
Level 2	Understand	25%	-	25%	-	25%
Level 3	Apply	30%	-	30%	-	30%
Level 4	Analyze	30%	-	30%	-	30%
Level 5	Evaluate	-	-	-	-	-
Level 6	Create	-	-	-	-	-
	Total	100 %		100 %		100 %

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
Ms. Divya, Member Technical staff- Senior Developer, ZOHO	1. Dr.S.P. Siddique Ibrahim, Assistant Professor, VIT-AP University.	2. Dr G. Elangovan, SRMIST

<b>Course Code</b>	21CSE433T	<b>Course Name</b>	BLOCKCHAIN BUSINESS MODELS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Learn the basics of Blockchain and apply cryptography algorithms												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Learn the consensus methods for an application															
<b>CLR-3:</b>	Use blockchain for business models															
<b>CLR-4:</b>	Apply data structures for blockchain															
<b>CLR-5:</b>	Understand how to develop blockchain business models															
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Discuss the basics of Blockchain business models															
<b>CO-2:</b>	Apply the cryptography techniques in blockchain															
<b>CO-3:</b>	Identify the appropriate consensus methods for application															
<b>CO-4:</b>	Describe the technology stack for Blockchain															
<b>CO-5:</b>	Apply the blockchain for business models															

<b>Unit-1 – Introduction to Blockchain Technologies</b>	<b>9 Hour</b>
History of Blockchain-Terminologies in Blockchain-Types of Blockchain-Applications of Blockchain- How blockchain works-Ingredients of Blockchain. Case Study: Create Survey report of various types of Blockchain and its real time use cases	
<b>Unit-2 - Cryptography</b>	<b>9 Hour</b>
Introduction to cryptography-Encryption and Decryption-Ciphers-Cryptography using arithmetic modulo primes-hashing algorithms-SHA-256 algorithm-Application of SHA algorithm. Case Study: Implement program to convert given text into hashes using SHA 256 algorithm.	
<b>Unit-3 – Consensus Mechanisms</b>	
Introduction to Consensus Methods-Proof of Work (PoW)-Proof of Stake (PoS)-Proof of Burn (PoB)- Proof of Activity (PoA)-Proof of Elapsed Time (PoET)-Simplified Byzantine fault Tolerance-Mining. Case Study: Prepare comparison study report of various Consensus methods for financial transaction.	
<b>Unit-4 – Data Structure of Blockchain</b>	<b>9 Hour</b>
Data structures for Blockchain-Merkle Trees-Shared data- Protocols—Fat Protocols-Platforms- DAPPS-Smart Contracts. Case Study: Create simple smart contract for User identity management using Solidity language.	
<b>Unit-5 – Blockchain Business Models</b>	<b>9 Hour</b>
Introduction to Blockchain Business Models-Need for Blockchain business models- Traditional business models-Types of Blockchain Business Models- Blockchain as A Service (BaaS)-Token Economy- Utility Token Business Model-Blockchain-Based Software Products- P2P Blockchain Business Model-Blockchain Professional Services. Block chain for Banking and Financial transactions. Case Study: Create simple wallet transaction from one account to another account using Metamask.	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. <i>Blockchain for Business, 1st edition, Published by Addison-Wesley Professional (May 9th 2019) - Jai Singh Arun, Jerry Cuomo, Nitin Gaur.</i></li> <li>2. <i>Blockchain Business Models, A Complete Guide, Gerardus Blokdyk, March 2021.</i></li> <li>3. <i>Blockchain Development for Finance Projects, by Ishan Roy, January 2020, Packt Publishing, ISBN: 9781838829094</i></li> <li>4. <i>The Internet of Money: A collection of talks by Andreas M. Antonopoulos, November 2019.</i></li> <li>5. <i>The Blockchain Developer - A Practical Guide for Designing, Implementing, Publishing, Testing, and Securing Distributed Blockchain-based Projects, by Elad Elrom, Apress, July 2019, ISBN:9781484248478.</i></li> <li>6. <i>The Metaverse: And How It Will Revolutionize Everything, Book by Matthew Ball, July 2022.Publisher : Liveright</i></li> </ol>
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<b>Learning Assessment</b>		<i>Continuous Learning Assessment (CLA)</i>				<i>Summative Final Examination (40% weightage)</i>			
<i>Bloom's Level of Thinking</i>		<i>Formative CLA-1 Average of unit test (50%)</i>		<i>Life-Long Learning CLA-2 (10%)</i>					
		<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>				
		<i>15%</i>	<i>-</i>	<i>15%</i>	<i>-</i>	<i>15%</i>	<i>-</i>		
Level 1	<i>Remember</i>	<i>15%</i>	<i>-</i>	<i>15%</i>	<i>-</i>	<i>15%</i>	<i>-</i>		
Level 2	<i>Understand</i>	<i>25%</i>	<i>-</i>	<i>25%</i>	<i>-</i>	<i>25%</i>	<i>-</i>		
Level 3	<i>Apply</i>	<i>30%</i>	<i>-</i>	<i>30%</i>	<i>-</i>	<i>30%</i>	<i>-</i>		
Level 4	<i>Analyze</i>	<i>30%</i>	<i>-</i>	<i>30%</i>	<i>-</i>	<i>30%</i>	<i>-</i>		
Level 5	<i>Evaluate</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>		
Level 6	<i>Create</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>		
	<i>Total</i>	<i>100 %</i>		<i>100 %</i>		<i>100 %</i>			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. Ishan Roy, Director, Metabasu Technologies Private Limited 2. Mr. Rex Aantony, Founder & CEO, Rex Cyber Solutions Pvt Ltd	1. Dr.S. Ganapathy, Associate Professor, Vellore Institute of Technology, Chennai. 2. Dr. S. Muthurajkumar, Assistant Professor / Computer Technology, Madras Institute of Technology Campus, Anna University, Chompet, Chennai - 600044.	1. Dr. Prabhu kavin.B, SRMIST

<b>Course Code</b>	21CSE434T	<b>Course Name</b>	DISTRIBUTED LEDGER TECHNOLOGY	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understanding the fundamentals & basic tools used for DLT regulatory framework												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Employ knowledge in Hyperledger Fabric and Cryptographic Approaches for Hyperledger															
<b>CLR-3:</b>	Demonstrate the services and techniques in Smart Contracts and Communication Technologies															
<b>CLR-4:</b>	Implement and analyze the different Leading Blockchain and DLT Protocols															
<b>CLR-5:</b>	Categorize the different Case studies related to DLT															
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>															
<b>CO-1:</b>	Recognize the knowledge of Distributed ledger technology												3	2	-	
<b>CO-2:</b>	Design and illustrate the Hyper ledger Fabric and cryptographic approaches												3	2	-	
<b>CO-3:</b>	Analyze the characteristics of End-to-End Encryption in Hyper ledger												3	3	-	
<b>CO-4:</b>	Choose the DLT protocols & deploying smart contracts on block chain												3	3	-	2
<b>CO-5:</b>	Manipulate Block chain applications with Hyper ledger applications												3	3	-	3

<b>Unit-1 – Fundamentals of DLT</b>	<b>9 Hour</b>
Introduction to Distributed ledger technology, DLT designs and its types, Key features of DLT, Blockchain – DAG, Hash Graph, Holo Chain – Tempo (Radix), Permission less Distributed Ledgers vs. Permissioned Distributed Ledgers, Advantages of DLT, Challenges Related to DLT, Risks Related to DLT.	
<b>Unit-2 - Hyperledgers Fabric and Cryptographic Approaches</b>	
Hyperledgers Fabric and Cryptographic Approaches for Hyperledger, Hyperledger Fabric - Architecture, Functionalities, Hyperledger Fabric Model, Hyperledger Fabric Network, Identity, Security-hole in Hyperledger, End-to-End Encryption in Hyperledger, Hash functions, Digital Signatures.	
<b>Unit-3 - Smart Contracts and Communication Technologies</b>	
Introduction to Smart Contracts, Ledger Development-Endorsement, Valid transactions, Channels, Intercommunication, System chain code, Networking protocol, Various communication frameworks, Communication in IoT, Smart contract templates	
<b>Unit-4 – DLT Protocols, Architecture and Testing</b>	
Leading Blockchain and DLT Protocols, Quorum - Ripple, MultiChain, Symbiont, OpenChain, Cardano, IOTA, EOS - HashGraph, Corda Architecture, Installation - Development, Deployment Unit, and Functional Testing.	
<b>Unit-5 – DLT Case Studies and Applications</b>	
DLT Case Study, Blockchain applications with Hyperledger applications, Agriculture, Healthcare and the Life Sciences, Financial Sector and Banking, Digital Identity, Media and Entertainment, Supply Chain, Law, Government and Real estate, Telecom domain, Healthcare—Corda and Ethereum Hybrid Use Case.	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Alexander Lipton and Adrien Treccani, <i>Blockchain and Distributed Ledgers: Mathematics, Technology, and Economics</i>, World Scientific Edition, 2022.</li> <li>2. Horst Treiblmaier and Trevor Clohessy, <i>Blockchain and Distributed Ledger Technology Use Cases: Applications and Lessons Learned</i>, Springer, 1st edition, 2020.</li> <li>3. Imran Bashir, <i>Mastering Blockchain: Deeper insights into decentralization, cryptography, Bitcoin, and popular Blockchain frameworks</i>, 2018 - Packt Publishing, ISBN-10: 1788839048.</li> <li>4. Roger Wattenhofer, <i>Distributed Ledger Technology - The Science of the Blockchain</i>, Second Revised Edition, 2017, Inverted Forest Publishing, ISBN-13 978-1544232102.</li> <li>5. Focus Group on Application of Distributed Ledger Technology, <a href="Https://www.itu.int/en/ITUT/focusgroups/dlt/Pages/default.aspx">Https://www.itu.int/en/ITUT/focusgroups/dlt/Pages/default.aspx</a></li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>			
	<i>Bloom's Level of Thinking</i>	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	30%	-	30%	-		
Level 4	Analyze	30%	-	30%	-	30%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	<b>Total</b>	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. Vinod Potty, Project Manager / Infosys	1. Dr. M. Subramaniam, Professor/CBIT	1. Dr. T. Nadana Ravishankar, SRMIST

<b>Course Code</b>	21CSE435T	<b>Course Name</b>	SMART CONTRACTS AND APPLICATION DEVELOPMENT	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 3	T 0	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		Program Outcomes (PO)												<b>Program Specific outcomes</b>											
CLR-1:	Understand and evaluate the stack of protocols that will form the future Web 3.0 and its decentralized nature												PSO-1	PSO-2	PSO-3										
CLR-2:	Demonstrate a local Ethereum Network with Geth, and get familiar with a various development environment																								
CLR-3:	Organize the inner workings of smart contracts as means for developing decentralized applications																								
CLR-4:	Examine a set of technologies that support the backbone decentralized storage network																								
CLR-5:	Evaluate the components of blockchain-based technologies which support Turing-complete languages																								
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
CO-1:	Recall to Construct decentralized applications using the Web3 stack	3	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2		
CO-2:	Outline the smart contract development lifecycle	1	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2		
CO-3:	Identify to reuse common implementation patterns, like modifiers and contract driven development	-	1	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2		
CO-4:	Discover smart contracts using the Solidity programming language	-	2	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2		
CO-5:	Determine the deep understanding of the Ethereum model and applications of blockchain	-	3	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3		

**Unit-1 - Blockchain Concepts** 9 Hour  
Blockchain Evolution- Blockchain Structure- Blockchain Characteristics- Blockchain Application Example: Escrow- Blockchain Stack- From Web 2.0 to the Next Generation Decentralized web- Domain Specific Blockchain Applications- Blockchain Benefits & Challenges.

**Unit-2 - Smart Contracts** 9 Hour  
Structure of a Contract- Setting up and Interacting with a Contract using Geth Client- Gas- Logs- Events- Setting up and Interacting with a Contract using Mist Wallet- Smart Contract Examples- Smart Contract Patterns.

**Unit-3 - Blockchain Application Templates & Ethereum Development Tools** 9 Hour  
Blockchain Application Components- Design Methodology for Blockchain Applications- Blockchain Application Templates- Ethereum Clients- Go-Ethereum Client (geth)- Python Ethereum Client (pyethapp)- Ethereum Languages- TestRPC- Mist Ethereum Wallet- MetaMask- Truffle- External Owned Account (EOAs)- Contract Account- Keypairs- Working with EOA Accounts- Working with Contract Accounts

**Unit-4 - Decentralized Applications, Mining & Swarm** 9 Hour  
Implementing Dapps- Case Studies- Consensus on Blockchain Network- Mining- Block Validation- Setting up Mining Node- State Storage in Ethereum- Swarm Architecture and Concepts- Incentive Mechanisms in Swarm- Swarm Setup- Working with Swarm- Case Study: Stock Photos Dapp.

**Unit-5 - Advanced Topics on Blockchain** 9 Hour  
Double-Spending Problem- Byzantine Fault Tolerance- Proof-of-Work vs Proof-of-Stake, - Consistency, Availability & Partition Tolerance (CAP)- Turing Completeness- G reedy Heaviest- Observed Sub-Tree (GHOST)- Sybil Attack- Mining Pools and Centralization- Smart Contracts Vulnerabilities- Blockchain Scalability

<b>Learning Resources</b>	1. Narayanan, A., Bonneau, J., Felten, E., Miller, A., & Goldfeder, S. (2016). Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University Press. 2. Antony Lewis, <i>The Basics of Bitcoins and Blockchains An Introduction to Cryptocurrencies and the Technology that Powers Them</i> , 2018 3. Andreas M. Antonopoulos, <i>Mastering Bitcoin Programming the Open Blockchain</i> , 2017	4. Singhal, B., Dhamija, G., & Panda, P. S. (2018). Beginning Blockchain: A Beginner's guide to building Blockchain solutions. Apress. 5. Albert Szmigelski, <i>Bitcoin Essentials</i> , 2016
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	30%	-	30%	-		
Level 4	Analyze	30%	-	30%	-	30%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. S.Gomathi Sankar , Technical Lead .LTIMindtree 2. Dhilip Velumani, Module Lead,LTIMindtree	1. Dr. Soma Prathibha Sri Sai Ram Engineering College,Chennai 2. Dr.S.V.N. Santhosh Kumar VIT Vellore	1. Dr.A.Siva Kumar SRMIST 2. Dr.S. Ganesh Kumar SRMIST

<b>Course Code</b>	21CSE436T	<b>Course Name</b>	BITCOIN ESSENTIALS AND USE CASES	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 3	T 0	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand what Bitcoin is, how it works and how to start using it safely and effectively.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	understand the mechanism of Bitcoin with both hardware and software															
<b>CLR-3:</b>	analyze how to store and use bitcoin															
<b>CLR-4:</b>	Evaluate the use cases of Blockchain today with a deep dive on cryptocurrencies like Bitcoin															
<b>CLR-5:</b>	evaluate the use of bitcoin in various applications															

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CO-1:</b>	Understand the fundamentals of Bitcoin												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CO-2:</b>	Deal with the methods of Bitcoin transactions															
<b>CO-3:</b>	Gain knowledge about various operations associated with bitcoin mining															
<b>CO-4:</b>	Learn and educate about bitcoin use cases															
<b>CO-5:</b>	Gather knowledge on Bitcoin storage and protocols															

<b>Unit-1 - Bitcoin (BTC) Introduction</b>	<b>9 Hour</b>
features- Bitcoin's Predecessors- Roots of bitcoin -Bitcoin's Ecosystem- Bitcoin wallets- Types of wallets- Building A Bitcoin payment system: Getting started with Bitcoin, Building a payment gateway	
<b>Unit-2 - Bitcoin Network</b>	<b>9 Hour</b>
Store and use bitcoins- Hot and Cold storage--Getting bitcoin- Spending Bitcoin-Saving bitcoin- Investing Bitcoin-Protecting bitcoin- Transferring Bitcoin-Accepting bitcoin- Decentralization in Bitcoin- Bitcoin protocol limitations and improvements-Distributed consensus- Incentive Mechanism-Block Reward-Transaction fee	
<b>Unit-3 - Bitcoin Mining</b>	
Bitcoin Mining Hardware- Bitcoin Mining software-CPU Mining-GPU Mining-FPGA Mining -ASIC Mining -Solo Mining- Pool Mining- Large scale mining-Energy consumption and ecology	
<b>Unit-4 - Mechanics of Bitcoin</b>	<b>9 Hour</b>
Bitcoin transactions- Bitcoin Transaction Standards- Constructing a transaction- Types of transaction- Bitcoin scripts- applications of bitcoin scripts- Bitcoin blocks- Bitcoin Security- Bitcoin addresse	
<b>Unit-5 - Bitcoin use case</b>	
Bitcoin as a Platform- Bitcoin as an append-only log- Bitcoins as "smart property"- Secure multiparty lotteries in bitcoin- Bitcoin as a public randomness source- Prediction markets and real-world data feeds- Bitcoin as a Currency- Bitcoin as an Investment. Future of bitcoin: Decentralized Institution	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Narayanan, A., Bonneau, J., Felten, E., Miller, A., and Goldfeder, S. (2016). <i>Bitcoin and cryptocurrency technologies: a comprehensive introduction</i>. Princeton University Press.</li> <li>2. Andreas M. Antonopoulos, <i>Mastering Bitcoin Programming the Open Blockchain</i>, 2017</li> <li>3. Pedro franco, <i>Understanding Bitcoin Cryptography. Engineering and Economics</i>, 2015</li> <li>4. Albert Szmigelski, <i>Bitcoin Essentials</i>, 2016</li> <li>5. Daniel Forrester, Mark Solomon, <i>Bitcoin Exposed: Today's Complete Guide to Tomorrow's Currency</i></li> <li>6. Antony Lewis, <i>The Basics of Bitcoins and Blockchains an Introduction to Cryptocurrencies and the Technology that Powers Them</i>, 2018</li> </ol>
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	30%	-	30%	-		
Level 4	Analyze	30%	-	30%	-	30%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr.V. Gopinath, Solution Architect, Tata Consultancy Service Ltd., Chennai	Dr.R.Manoharan, Professor, Department of Computer Science and Engineering, Puducherry Technological University, Puducherry,	1. Dr. Panimalar.K, SRMIST

<b>Course Code</b>	21CSE437T	<b>Course Name</b>	DECENTRALIZED APPLICATIONS ON BLOCK CHAIN	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Discover the fundamentals & basic technologies used for DAPP												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Acquire knowledge in Smart contracts and Ethereum technologies															
<b>CLR-3:</b>	Exploring the services and techniques in Ethereum Technologies															
<b>CLR-4:</b>	Analyze and implement the different leading DAPP's															
<b>CLR-5:</b>	Compare & contrast the different Case studies related to DAPP's															
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>															
<b>CO-1:</b>	Summarize the knowledge of Decentralized Applications (DAPPs)												3	-	-	
<b>CO-2:</b>	Interpret the features and technologies of DAPP												3	2	-	
<b>CO-3:</b>	Analyze and design smart contracts & Geth.												3	3	2	
<b>CO-4:</b>	Generate DAPP's using Ethereum platform												3	3	-	
<b>CO-5:</b>	Design and synthesize Decentralized Block chain applications												3	3	2	

<b>Unit-1 – Basics of Decentralized Applications</b>	<b>9 Hour</b>
Introduction to decentralized application, bitcoin, Features of DAPP, History of DAPP, Dapps Vs. Conventional centralized applications, Anatomy of a Dapp, Basic terminologies, Enabling technologies, Good and bad DAPPs, A five-minute Dapp implementation.	
<b>Unit-2 – Flourishing DAPP Ecosystem</b>	
Decentralized - data, wealth, Identity, Computing, Bandwidth, Decentralized markets for Decentralized assets, Practical decentralization, A deeper look at Decentralized applications, Block chain technologies and Ethereum technologies.	
<b>Unit-3 – Ethereum Platform</b>	
Connecting to Ethereum through the wallet, Smart contracts; the brain of DAPPs, Connecting to Ethereum with geth, managing accounts with geth, Revisiting simple coin's contract.	
<b>Unit-4 – Building Your First DAPP</b>	
Decentralized architecture, Introduction to IPFS, DAPP building, setup, Routing, Data storage and retrieval, DAPP economics, Private networks, Human-readable names.	
<b>Unit-5 – Platforms and Case Studies</b>	
Basics of Ethereum ecosystem, Managing life cycle, Security considerations, OpenBazaar, LightHouse, and La'Zooz.	

<b>Learning Resources</b>	1. Shahid Shaiikh, "Building Decentralized Blockchain Applications", 2021, BPB Publications, ISBN: 978-9389898620 2. Roberto Infante, "Building Ethereum DApps_ Decentralized Applications on the Ethereum Blockchain", 2019, Manning Publications. 3. Elad Elrom, "The Blockchain Developer", 2019, Apress Publication, ISBN: 9781484248478.	4. Siraj Raval, "Decentralized Applications Harnessing Bitcoin's Blockchain Technology", 2016, O'Reilly, ISBN: 9781491924549. 5.. Free to use forum rusted and used by top Blockchain projects. <a href="https://www.dapp.com/app/eos-forum">https://www.dapp.com/app/eos-forum</a>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)						<b>Summative Final Examination (40% weightage)</b>			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)							
		Theory	Practice	Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-				
Level 2	Understand	25%	-	25%	-	25%	-				
Level 3	Apply	30%	-	30%	-	30%	-				
Level 4	Analyze	30%	-	30%	-	30%	-				
Level 5	Evaluate	-	-	-	-	-	-				
Level 6	Create	-	-	-	-	-	-				
Total		100 %		100 %		100 %					

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mrs. Malathy Selvaraj, Team Lead / TCS	1. Dr. R. Shriram, Professor / VIT Bhopal	1. Dr. T. Nadana Ravishankar SRMIST

<b>Course Code</b>	21CSE438T	<b>Course Name</b>	WEB SECURITY	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 3	T 0	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

Course Learning Rationale (CLR):	<i>The purpose of learning this course is to:</i>	Program Outcomes (PO)												Program Specific outcomes			
		1	2	3	4	5	6	7	8	9	10	11	12				
<b>CLR-1:</b>	<i>Identify the basics of Web Security and detailed exploration of computers, communication links and that makeup the web</i>																
<b>CLR-2:</b>	<i>Understand the science of Cryptography and the Web and specifically looks at the encryption algorithms.</i>																
<b>CLR-3:</b>	<i>Explore the privacy protecting techniques to increase the privacy while using the web</i>																
<b>CLR-4:</b>	<i>Address the physical security for web servers to protect the Computer Hardware</i>																
<b>CLR-5:</b>	<i>Understand the access control of the web content in the web server.</i>																
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>																
<b>CO-1:</b>	<i>Identify the basics of Web Security and detailed exploration of World Wide Web</i>	3	-	-	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
<b>CO-2:</b>	<i>Understand the science of Cryptography with emphasis on Public Key Algorithms</i>	3	-	3	-	2	-	-	-	-	-	-	-	-	1	-	-
<b>CO-3:</b>	<i>Explore the techniques to increase your privacy while using the web</i>	-	3	-	2	3	-	-	-	-	-	-	-	-	-	3	-
<b>CO-4:</b>	<i>Addressing physical security for web servers for protecting the Computer Hardware</i>	-	2	2	-	-	-	-	1	-	-	-	-	-	-	-	2
<b>CO-5:</b>	<i>Focuses on issuing security to the web content of the web server</i>	2	-	-	3	-	-	-	2	-	-	-	-	-	-	2	-

<b>Unit-1 - Basics of Web Security</b>	<b>9 Hour</b>
<i>The Web Security landscape: The Security Problem-Securing the Web Server-Securing Information in Transit-Securing the User's Computer-Risk Analysis and Best Practices-The Architecture of the World Wide Web: History and Terminology-Building Terminology-Weaving the Web-The Domain Name Service-Who owns the Internet: Your Local Internet Service Provider- Network Access Points and Metropolitan Area Exchanges- The Root and Top-Level Nameservers- The Domain Registrars- Internet Number Registries</i>	
<b>Unit-2 - Cryptography in Web Security</b>	
<i>Understanding Cryptography: Roots of Cryptography- Symmetric Key Algorithms- Public Key Algorithms-Public Key Algorithms-Message Digest Functions-Cryptography and Web Security-Understanding SSL and TLS-Digital Identification I: Passwords, Biometrics, and Digital Signatures-Digital Identification II: Digital Certificates, CAs, and PKI</i>	
<b>Unit-3 - Privacy and Security for Web Users</b>	
<i>The Web's War on Your Privacy-Log Files-Understanding Cookies-Web Bugs- Privacy-Protecting Technologies-Backups and Antitheft-Mobile Code I: Plug-Ins, ActiveX, and Visual Basic-Mobile Code II: Java,- JavaScript-Flash-Shockwave</i>	
<b>Unit-4 - Web Server Security</b>	
<i>Physical Security for Servers: Protecting your Computer Hardware, Protecting Your Data, Case Study: A Failed Site Inspection-Host Security for Servers: Securing the Host Computer, Operating Securely, , Secure Remote Access and Content Updating, Firewalls and the Web - Securing Web Applications-. Deploying SSL Server Certificates-Securing Your Web Service-Computer Crime</i>	

**Unit-5 - Security for Content Providers** 9 Hour

Controlling Access to Your Web Content-Client-Side Digital Certificates-Code Signing and Microsoft's Authenticode-Pornography, Filtering Software, and Censorship-Privacy Policies, Legislation, and P3P- Case Study: Securing Web Applications, Web Vulnerability Scanners: A Case Study.

<b>Learning Resources</b>	1. Izzat Alsmadi "The NICE Cyber Security Framework" Springer, ISBN: 978-3-030-02359-7, 2019	4. William Stallings "Cryptography and Network Security" 6th Edition, PEARSON, ISBN-13: 978-0-13-335469-0, 2013
	2. Richard Fox, Wei Hao, "Internet Infrastructure, Networking Web Services and Cloud Computing" CRC Press, ISBN-13: 978-1-1380-3991-9, 2017	5. Peter Morville, Louis Rosenfeld "Information Architecture" 3rd Edition, O'REILLY, ISBN-13: 978-0-596-52734-1, 2006
	3. John Paul Mueller, "Security for Web Developers" 1st Edition, O'REILLY, ISBN: 978-1-491-92864-6, 2015.	6. Simson Garfinkel, Gene Spafford "Web Security, Privacy and Commerce" 2nd Edition, O'REILLY, ISBN: 978-0-596-00045-5, 2002

**Learning Assessment**

Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%
Level 2	Understand	25%	-	25%	-	25%
Level 3	Apply	30%	-	30%	-	30%
Level 4	Analyze	30%	-	30%	-	30%
Level 5	Evaluate	-	-	-	-	-
Level 6	Create	-	-	-	-	-
	Total	100 %		100 %		100 %

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Winston Nesayyan, Senior Associate Software Engineer, JP Morgan, Philadelphia	1. Dr Dheeba J, Associate Professor, Department of Analytics, Vellore Institute of Technology Vellore	1. Dr Jeba Sonia J, SRMIST

**ACADEMIC CURRICULA**

**UNDERGRADUATE/ INTEGRATED POST  
GRADUATE DEGREE PROGRAMMES**

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume – 11J

(Syllabi for Computer Science and Engineering w/s in  
Gaming Technology Programme Courses)



**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

# ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021



**SRM**

INSTITUTE OF SCIENCE & TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

<b>Course Code</b>	21CSC306J	<b>Course Name</b>	SOFTWARE ENGINEERING PERSPECTIVES IN COMPUTER GAME DEVELOPMENT	<b>Course Category</b>	C	PROFESSIONAL CORE	L 2	T 0	P 2	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the games and software engineering research												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Utilize the game jam organization															
<b>CLR-3:</b>	Apply the casual games and development process															
<b>CLR-4:</b>	Implement the evaluation and design of games															
<b>CLR-5:</b>	Analyze the mixed reality game cards															

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Acquire knowledge on fundamentals of games and software engineering research	3	1	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<b>CO-2:</b>	Perform the game jam organization and evaluate it	2	2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	
<b>CO-3:</b>	Perform casual games process	-	2	3	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<b>CO-4:</b>	Identify evaluation and design framework	-	3	-	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	
<b>CO-5:</b>	Understand how reality game cards implemented	-	2	3	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	

<b>Unit-1 - Introduction</b>	<b>12 Hour</b>
The Interdisciplinary Nature of Computer Games- A Brief History of Computer Games- Recent Advances in Games and Software Engineering Research	
<b>Unit-2 – Software Engineering Perspective</b>	<b>12 Hour</b>
Case Studies and Practices in Local Game Jam Software Development Organization: A Software Engineering Perspective- Introduction- Organizational Forms for Local Game Jams and Related Game Creation Events- Local Game Jam and Game Production Field Studies- Observations, Lessons Learned, And Learnable Lessons for Game Jam Organizational Forms- Game Software Development Competitions	
<b>Unit-3 – Game Development Process</b>	
Building Casual Games and APIs for Teaching Introductory Programming Concepts- Introduction- GAMES AND CS1/2 Classes- API Design Guidelines- The Development Processes- GTCS Foundations Game Engine- The Space Smasher API- The Corrupted API.	
<b>Unit-4 – Game Design Framework</b>	<b>12 Hour</b>
Evolution of a Model for The Evaluation of Games for Software Engineering Education- MEEGA- Learning with The Body: A Design Framework for Embodied Learning Games and Simulations- The Embodiment Problem-Toward A Design Framework for Embodied Learning Games and Simulations- Applying the Design Framework	
<b>Unit-5 – Case Study and Future Research</b>	<b>12 Hour</b>
Using Ideation Cards for Designing Mixed Reality Games- ideation cards- mixed reality game cards- Design Lessons for Ideation Cards- Theme Cards- Role-Playing Game to Exergame- Survey on Software Architecture, Creativity, And Game Technology- Future Research Opportunities	

<b>Lab Experiments</b>	
1. Formal Game Development Proposal Stage-1 Includes the Steps Game 2. Description Overview, Background Story, and Design Decision 3. Formal Game Development Proposal Stage-2 Includes Technical 4. Achievement, Development Schedule, Layered Task Breakdown, Functional 5. Minimum, Task List, Timeline and Assessment 6. Prototype setup for the game described 7. Testing - prototype's playing experience 8. Prototype's experience findings and conclusion	9. Report on development progress, challenges, and future work 10. Alpha release after partial game development progress, challenges, and future work 11. Conduct playtesting session with different play test methods 12. Record the play testing questions and comments 13. Design revisions based on play test 14. Results, experience, and conclusions 15. Reports on personal impressions

<b>Learning Resources</b>	1. Software Engineering Perspectives in Computer Game Development, Kendra M. L. Cooper, 2021. 2. Scacchi, Walt. "Case Studies and Practices in Local Game Jam Software Development Organization: A Software Engineering Perspective." Software Engineering Perspectives in Computer Game Development. Boca Raton and London: CRC Press, 2020. 37-57. 3. Chau, Brian, et al. "Building Casual Games and APIs for Teaching Introductory Programming Concepts." FDG. 2015. 4. Wang, Alf Inge, and Njål Nordmark. "Survey on Software Architecture, Creativity, and Game Technology." Software Engineering Perspectives in Computer Game Development. Chapman and Hall/CRC, 2021. 253-278.
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>	
	<i>Bloom's Level of Thinking</i>	Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice		
Level 1	Remember	15%	-	-	15%	15%	
Level 2	Understand	25%	-	-	20%	25%	
Level 3	Apply	30%	-	-	25%	30%	
Level 4	Analyze	30%	-	-	25%	30%	
Level 5	Evaluate	-	-	-	10%	-	
Level 6	Create	-	-	-	5%	-	
	Total	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr Jai Naresh, South Region Head, Media Entertainment Cell, and council 2. Mr Ajay Kumar, Consultant, Scopik edutech private limited.	1. Dr.S. Venkatesan,IITM,Alahabad	1. Dr. A. Murugan, SRMIST

<b>Course Code</b>	21CSC307T	<b>Course Name</b>	DEEP LEARNING IN GAMING AND APPLICATION	<b>Course Category</b>	C	PROFESSIONAL CORE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the basics of Deep Learning and Neural networks.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Build, train, and test basic Convolutional and Recurrent Networks.															
<b>CLR-3:</b>	Relate the working knowledge on GAN for Games.															
<b>CLR-4:</b>	Examine Reinforcement Learning tasks and the core principals behind the Deep Reinforcement Learning.															
<b>CLR-5:</b>	Recognize the applications of deep learning in Gaming development.															

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
<b>CO-1:</b>	Identify the importance of deep learning architecture and its applications.	3	1	-	-	3	-	-	-	-	-	-	-	-	-	-
<b>CO-2:</b>	Appreciate the importance of Convolutional and Recurrent Networks in game development.	3	2	2	-	3	-	-	-	-	-	-	-	-	-	3
<b>CO-3:</b>	Identify and apply foundational theories and approaches of GANs for Game development.	2	2	3	-	1	-	-	-	-	-	-	-	-	-	2
<b>CO-4:</b>	Implement Code common algorithms in Deep Reinforcement Learning.	3	3	2	2	3	-	-	-	-	-	-	-	-	-	2
<b>CO-5:</b>	Apply the power of Deep Learning to build complex reasoning tasks.	2	3	3	3	3	-	-	-	-	-	-	-	-	2	1

**Unit-1 - Deep Learning for Games** 9 Hour  
The Past, Present and Future of DL-Neural Networks the Foundation- Multilayer Perceptron in TensorFlow- TensorFlow Basics- Training Neural Networks with Back propagation – The Cost Function – Partial differentiation and the chain rule – Building an autoencoder with Keras – Training the model – Examining the output

**Unit-2 - Convolutional and Recurrent Networks** 9 Hour  
Convolutional neural networks – Monitoring training with Tensor Board – Understanding Convolution – Building a self-driven CNN- Spatial Convolution and pooling – The need for Dropout – Memory and recurrent networks – Vanishing and exploding gradients rescued by LSTM – Playing Rock, Paper, Scissors with LSTMs.

**Unit-3 - GAN for Games** 9 Hour  
Introducing GANs – Coding a GAN in Keras – Training a GAN – Optimizers – Generating textures with a GAN – Batch Normalization – Leaky and other ReLUs – A GAN for creating music – Training the music GAN – Generating Music via an alternative GAN.

**Unit-4 - Deep Reinforcement Learning** 9 Hour  
Introduction to Deep Reinforcement learning – The multi-armed bandit – Contextual bandits – RL with the Open AI Gym – A Q-Learning model – Markov decision process and the Bellman equation – Q-learning – Q-learning and exploration – Frist DRL with Deep Q-learning – RL experiments – Keras RL.

**Unit-5 - Building a Deep Learning Gaming Chatbot** 9 Hour  
Neural Conversational Agents-General conversational Models-Sequence to Sequence Learning-Building the chatbot server-Running the chatbot in Unity-Case studies related to Development of Games using Deep Learning

<b>Learning Resources</b>	1. <i>Hands-On Reinforcement Learning for Games: Implementing self-learning agents in games using artificial intelligence techniques</i> , Michael Lanham, Packt Publishing, and Year: 2020. 2. <i>Hands-On Deep Learning for Games</i> , Michael Lanham, Packt Publishing, Year: 2019 3. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2016 (available at <a href="http://www.deeplearningbook.org">http://www.deeplearningbook.org</a> )	
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<b>Learning Assessment</b>		<b>Continuous Learning Assessment (CLA)</b>				<b>Summative Final Examination (40% weightage)</b>			
	<i>Bloom's Level of Thinking</i>	<i>Formative CLA-1 Average of unit test (50%)</i>		<i>Life-Long Learning CLA-2 (10%)</i>					
		<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>				
Level 1	<i>Remember</i>	15%	-	15%	-	15%	-		
Level 2	<i>Understand</i>	25%	-	20%	-	25%	-		
Level 3	<i>Apply</i>	30%	-	25%	-	30%	-		
Level 4	<i>Analyze</i>	30%	-	25%	-	30%	-		
Level 5	<i>Evaluate</i>	-	-	10%	-	-	-		
Level 6	<i>Create</i>	-	-	5%	-	-	-		
	<i>Total</i>	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr Jai Naresh, South Region Head, Media Entertainment Cell, and council 2. Mr Ajay Kumar, Consultant, Scopik edutech private limited	1. Dr. Anbuchelian - Ramanujan Computing Center, Anna University	1. Ms.S. Sindhu, SRMIST

# ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021



**SRM**  
INSTITUTE OF SCIENCE & TECHNOLOGY  
(Deemed to be University u/s 3 of UGC Act, 1956)

**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

**(Deemed to be University u/s 3 of UGC Act, 1956)**

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

<b>Course Code</b>	21CSE235T	<b>Course Name</b>	GAME DESIGN, PROTOTYPING AND DEVELOPMENT	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Identify the basic concepts of game prototypes and design												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Describe the key components and making a prototype around it															
<b>CLR-3:</b>	Illustrate the programming skills, Identify the fun and the goal of the game, Design the content and rules of the game															
<b>CLR-4:</b>	Analyze and identify the bugs of the game															
<b>CLR-5:</b>	Predict how game development is a combination of Design, Engineering, and Production															

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>
<b>CO-1:</b>	Recognize knowledge in prototyping, designing, and testing	-	3	3	-	-	-	-	-	-	-	-	-	-	-	-
<b>CO-2:</b>	Apply the knowledge of programming	-	-	3	2	-	-	-	-	-	-	-	-	-	-	-
<b>CO-3:</b>	Identify the array of game development techniques	-	3	2	2	-	-	-	-	-	-	-	-	-	-	-
<b>CO-4:</b>	Prepare creatively in every level of game and present interactive game concepts with clarity	-	3	3	2	-	-	-	-	-	-	-	-	-	-	3
<b>CO-5:</b>	Employ the techniques used in the design, development, and documentation of games	-	-	3	3	-	-	-	-	-	-	-	-	-	-	2

<b>Unit-1 - Introduction to Game Development</b>	<b>9 Hour</b>
Game Development Overview and Introduction, Game Design and Paper Prototyping: Thinking like a designer, Game Analysis Frameworks, Game Analysis Frameworks, Overview of Layers and Design Goal, Inscribed Layer, Dynamic Layer, Cultural Layer and cultural impact of a game, Game Design Document: GDD to unity, giving controls to user, Prototyping Non player characters, UI coordinate systems: Choosing the correct coordinate system, Building UI Canvas, UI Scripting, Profiling and Localization	

<b>Unit-2 - Game Testing</b>	<b>9 Hour</b>
Why Playtest, Methods of Playtesting, Importance of Playtesting, many faces of testing, Testing life cycle, Design, prototype, alpha, beta testing, Math and Game Balance, Installing Apache OpenOffice Calc, Examining Dice Probability with calc, Math of Probability, Randomizer technologies in paper games, Weighted distributions, permutations, positive and negative feedback.	

<b>Unit-3 - Game Design</b>	<b>9 Hour</b>
Scott Kim on Puzzle Design, Puzzle examples in action Games, Guiding the player, Direct Guidance, Methods in Direct Guidance, Indirect Guidance, Methods in Indirect Guidance, Guiding Skills and concepts, Digital Game Industry, About DGI, Game Education, Getting into the Industry	

<b>Unit-4 - Prototyping</b>	<b>9 Hour</b>
Digital Prototyping: Thinking in digital systems, Systems Thinking: Game Analysis Learning Development Environment, Introducing C#: variables and components, Boolean Operations and conditionals Loop, List and Arrays, Functions and Parameters, Debugging, Classes, Object Oriented Thinking, Agile Software Development, Scrum Methodology, Burn down charts	

<b>Unit-5 - Testing</b>	<b>9 Hour</b>
Game Testing Disciplines, Bugs: Bugs Severity Levels, Balance testing, Decision Makers: Overview, Game Producers, Game Testers, Bug Categories, Documentation, Test Plan, Bug Spotting/ Hunting, Reports and Verifications, Mobile Games Testing-Process of Testing Mobile Games and Phases of Mobile Game Testing	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Jeremy Gibson Bond, "Introduction to Game Design, Prototyping, and Development: From Concept to Playable Game with Unity and C#". 2nd Edition, 2017.</li> <li>2. Stephen Gose, " Phaser Game Prototyping: Building 100s of games using Game Prototyping templates in HTML5 and Phaser JavaScript Framework", 2017</li> <li>3. Luis Levy, Jeannie Novak, " Game Development Essentials: Game QA &amp; Testing", Cengage Learning, Inc, 2009.</li> <li>4. <a href="https://www.gamedesigning.org/learn/unity/">https://www.gamedesigning.org/learn/unity/</a></li> <li>5. <a href="https://www.testbytes.net/blog/game-testing-tutorial/">https://www.testbytes.net/blog/game-testing-tutorial/</a></li> </ol>
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Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
Total		100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr.D.Saravanan, Senior Manager, Cashkaro.com	1. Dr.P. Siddique Ibrahim, VIT, AP	1. Dr.D.Rajeswari, SRMIST

<b>Course Code</b>	21CSE236T	<b>Course Name</b>	GPU PROGRAMMING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Identify the fundamentals of GPUs & its basic architecture												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	Illustrate the Data Parallelism and CUDA and its execution model																								
<b>CLR-3:</b>	Study the CUDA Memories, floating point, and performance consideration																								
<b>CLR-4:</b>	Understand and Learn OpenCL programming for parallel processing																								
<b>CLR-5:</b>	Analyze the parallel patterns problem and heterogeneous computing																								
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Study on the fundamentals of GPU, Architecture and APIs												-	-	-	-	-	-	-	-	-	-	2	-	
<b>CO-2:</b>	Analyze the knowledge and functions on CUDA C and acquire the ability to use parallelism												1	2	-	-	2	-	-	-	-	-	-	-	
<b>CO-3:</b>	Obtain the knowledge on CUDA memory types and floating-point operations												2	-	-	-	2	-	-	-	-	-	-	-	
<b>CO-4:</b>	Apply OpenCL programs for designing parallel programs with CUDA												-	2	2	-	2	-	-	-	-	-	-	-	
<b>CO-5:</b>	Illustrate the knowledge gained on parallel patterns and heterogeneous computing clusters towards application development												1	2	3	-	3	-	-	-	-	-	-	2	

**Unit-1 - Basic of GPU** 9 Hour  
 Introduction to GPU, Heterogeneous Parallel Computing, Architecture of a Modern GPU, Need of speed, Speeding Up Real, Applications, Parallel Programming Languages and Models, Overarching Goals, History of GPU Computing, GPGPU - GPU Computing, Scalable, Recent Developments, Future Trends, Introduction APIs, CUDA C, OpenCL ,Brook, OpenACC, APIs

**Unit-2 - Data Parallelism and CUDA Structure** 9 Hour  
 Introduction to Data Parallelism and CUDA C, CUDA Program Structure, A vector addition kernel, Device Global Memory, Programming Exercise – Hello World, Data Transfer, Kernel Functions and Threading Example, Data Parallel Execution Model – CUDA Thread Organization, Mapping Threads to Multidimensional Data, Matrix Multiplication, Synchronization, Transparent Scalability, Assigning Resources to Blocks, Querying Device Properties, Thread Scheduling and Latency Tolerance- example

**Unit-3 - CUDA Memory Concepts** 9 Hour  
 CUDA Memories and its efficiency, Importance of Memory Access, CUDA Device Memory Types, Comparison with Von Neumann and shared buffers, A Strategy for Reducing Global Memory Traffic, Carpooling Example, A Tiled Matrix - Matrix Multiplication Kernel., Illustration, Memory as a Limiting Factor to Parallelism, Performance Consideration – Warps and Thread Execution, Example, Global Memory Bandwidth, Illustration.

**Unit-4 - Open CL Program** 9 Hour  
 OpenCL basics, Introduction, Platform model, Execution mode, Kernels and OpenCL programming model, Vector addition using OpenCL, Image rotation and convolution, using OpenCL, The kernel execution domain, Work Item, Workgroups, NDRange, Application: Image clustering using OpenCL

<b>UNIT-5 - MPI Concepts</b>	<b>9 Hour</b>
Parallel Patterns, Convolution, Prefix sum, Sparse Matrix, Vector Multiplication, Application: Advanced MRI reconstruction, A running example, MPI basics MPI point –to- point Communication types, programming a heterogeneous computing cluster, Overlapping Computation and Communication, MPI Collective Communication	

<b>Learning Resources</b>	1. David B. Kirk, Wen-mei W. Hwu, Programming Massively Parallel Processors – A Hands-on Approach, Third Edition, Morgan Kaufmann, 2016 2. Shane Cook, CUDA Programming: –A Developer's Guide to Parallel Computing with GPUs (Applications of GPU Computing), First Edition, Morgan Kaufmann, 2012	3. David R. Kaeli, Perhaad Mistry, Dana Schaa, Dong Ping Zhang, –Heterogeneous Computing with OpenCL, 3rd Edition, Morgan Kauffman, 2015
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr Jai Naresh, South Region Head, Media Entertainment Cell, and council	1. Assistant Professor in Computer Science and Engineering at National Institute of Technology Srinagar Venington K	1. Dr.M.Ramprasath, SRMIST
2. Mr Ajay Kumar, Consultant, Scopik edutech private limited	2. Dr.K.Sitara Assistant Professor in Computer Science and Engineering at National Institute of Technology, Trichy	2. Dr. R. Rajkumar, SRMIST

<b>Course Code</b>	21CSE237T	<b>Course Name</b>	ART CREATION FOR GAMES	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Introduce the skills needed by game designer												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Illustrate the idea needed for a game															
<b>CLR-3:</b>	Analyze the most common types of game balance															
<b>CLR-4:</b>	Explain the interest curves and shadows and colors															
<b>CLR-5:</b>	Create the 2D and 3D animations															

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	understand the game design, production, and development	3	-	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	-
<b>CO-2:</b>	Identify navigation and manipulating objects	2	-	2	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	-
<b>CO-3:</b>	Introduce to camera properties	3	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2
<b>CO-4:</b>	Create material and apply texturing	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>CO-5:</b>	Animate and Manipulate materials	3	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

**Unit-1 - Introduction to Game Design and Production** 9 Hour

What is game development, Different type of game and use cases (FPS, RPG, Racing, Fighting, Casual, and Money spinner, Casino, Massively Multiplayer Online (MMO) These games are played over a LAN (local area network) or via the Internet? Simulations. Adventure. Real-Time Strategy (RTS). Puzzle. Action. Stealth Shooter. Combat) Revert Settings, Launching Your First Project, importing a Project, Switching Between Projects, Customizing The UI

**Unit-2 - Objects Navigation and Manipulating** 9 Hour

How to do Navigation, Manipulating Objects -Taking different type of objects, how to create invisible object that hides objects behind it, How to position Game Objects, How to place Light Probes

**Unit-3 - Introduction to Camera** 9 Hour

Adjusting camera target, Camera Tracking, different types of camera-dolly, camera colour filter, camera zoom extend, switching cameras, get current camera, set as active camera, look around

**Unit-4 - Material and Texturing** 9 Hour

Creating simple shadows- creating planar shadows- creating projected shadows-Using grid in viertools-creating grid collision-Creating a background-creating a background colour using a background image

**Unit-5 - Animating and Manipulating Material** 9 Hour

Basic texture animation-creating pseudo-3D characters using sprites, animating material movement,2Dinterface, creating a 2D sprite-creating a 2D frame

<b>Learning Resources</b>	1. Fundamentals of Game Design, 3e Paperback – 2015 by Adams (Author) 2. Drawing Basics and Video Game Art: Classic to Cutting-Edge Art Techniques for Winning Video Game Design by Chris Solarsk	3. <a href="https://www.udemy.com/unitycourse">https://www.udemy.com/unitycourse</a>
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Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.K.Selvakumar, Team Lesd, TCS	1. Dr.N.Bhalaji,Asso.Prof, SSNCE	1. Dr.A.Chinnasamy, SRMIST

<b>Course Code</b>	21CSE238T	<b>Course Name</b>	STORYTELLING FOR MARKETING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the fundamentals of Storytelling												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Analyze the uses of various Marketing															
<b>CLR-3:</b>	Analyze the Storytelling Methods															
<b>CLR-4:</b>	Evaluate the Business Applications of Storytelling															
<b>CLR-5:</b>	Create the Storytelling as a Marketing Tools and its goal															

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Understand Historical & Scientific Context of Storytelling	2	-	-	2	-	-	-	-	-	-	-	-	2	2	-									
<b>CO-2:</b>	understand audience relationship in storytelling and marketing	2	-	-	2	-	-	-	-	-	-	-	-	2	2	-									
<b>CO-3:</b>	Recognize storytelling frameworks & techniques	2	-	-	2	-	-	-	-	-	-	-	-	2	2	3									
<b>CO-4:</b>	apply business applications of storytelling	2	-	2	2	-	-	-	-	-	-	-	-	2	-	-									
<b>CO-5:</b>	implement marketing applications of storytelling	-2	-	2	2	-	-	-	-	-	-	-	-	2	2	-									

<b>Unit-1 - Introduction to Historical &amp; Scientific</b>	<b>9 Hour</b>
Context of Storytelling, Oral Tradition of Storytelling: Definition, History & Examples, Role of Storytelling in Human Development, The Power of Storytelling for Building Business Relationships, The Neuroscience of Storytelling, Relatability & Psychology of Storytelling, Novelty in Storytelling: Significance & Impact	
<b>Unit-2 - The Audience Relationship in Storytelling Marketing</b>	
Relating to Your Business' Target-Market Audience, Story Matrix: Components & Marketing Application, Story-Relationship Funnel: Concept & Application, Storytelling Flywheel: Create, Connect & Optimize, How to Build Deep Audience Relationships Through Storytelling	
<b>Unit-3 - Storytelling Frameworks &amp; Techniques</b>	
The Hero's Journey: Campbell's Archetype, Harmon's Story Circle: Explanation & Example, Ben Franklin's Deconstruction & Reconstruction Method, Conciseness in Writing: Definition & Meaning	
<b>Unit-4 - Business Applications of Storytelling</b>	
Using Storytelling to Enhance Business Relationships, Using Storytelling to Build Effective Business Presentations, What is Idea Generation? - Definition, Process & Techniques, Creating a Culture of Storytelling at Work	
<b>Unit-5 - Marketing Applications of Storytelling</b>	
Storytelling as a Marketing Tool, Developing Goals & Strategies for Digital Content Marketing, Creating a Product Image Through Storytelling, Storytelling for Non-Profit Marketing, What is Viral Marketing? - Definition, Techniques & Examples, Experiential Marketing: Definition, Strategies & Example, What is Movement Marketing? - Definition & Examples	

<b>Learning Resources</b>	1. Storytelling in business NYU Stern School of Business Ron Shacha MBA Summer 2019
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)	Life-Long Learning CLA-2 (10%)							
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Dr.K.C.Suresh,Projectb Head, mindtree technologies private limited	1. Dr.P.Selvakumari, Asso.Prof, CIT	1. Mr.C.Arun, SRMIST
		2. Dr.A. Chinnasamy SRMIST

<b>Course Code</b>	21CSE339T	<b>Course Name</b>	GAME ARTIFICIAL INTELLIGENCE	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Learn the basics of Artificial Intelligence and challenging factors in developing games												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Understand the different algorithms for game development															
<b>CLR-3:</b>	Observe the methodology of path finding															
<b>CLR-4:</b>	Summarize the commands and tools to develop the game															
<b>CLR-5:</b>	Design games using artificial intelligence techniques															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
<b>CO-1:</b>	Explain the basic concepts of artificial intelligence and its challenging factors												3	-	-	-
<b>CO-2:</b>	Describe the various algorithms in game development												2	3	3	-
<b>CO-3:</b>	Illustrate the different methodologies of path finding												-	2	2	-
<b>CO-4:</b>	Choose the suitable tool for game design												-	2	2	-
<b>CO-5:</b>	Select the appropriate design for artificial intelligence games												-	-	3	-

<b>Unit-1 - Introduction to Game AI</b>	<b>9 Hour</b>
Introduction of AI and Games, models of game AI, Kinds of AI Games, complexity, and constraint, Speed, Memory, AI Engine	
<b>Unit-2 - Movement Techniques</b>	<b>9 Hour</b>
Basics of Movement Algorithms, Steering Behaviors, Combining Steering Behaviors, Predicting physics, Motor Control, Movement in the Third Dimension	
<b>Unit-3 - Pathfinding Methods</b>	<b>9 Hour</b>
Basic Pathfinding and waypoints, Graphs -Dijkstra, A*, Representation, Continuous Time path finding, Movement Planning	
<b>Unit-4 - Decision Making and Diagnostic tools</b>	<b>9 Hour</b>
Decision Making, Finite state Machine, Fuzzy Logic, Rule based AI, AI Commands, AI diagnostic Tools, Building an AI Diagnostic Tools, A Data-Driven Architecture for Animation Selection	
<b>Unit-5 - Designing Game AI</b>	<b>9 Hour</b>
Designing Game AI- The Design- Shooters- Driving- Real-Time Strategy- Sports- Turn-Based Strategy Games, case study: heuristic cost calculation for 4 queens, tic tac toe problem	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>Paul Roberts Artificial Intelligence in Games, 1st Edition), Published by CRC Press, July 28, 2022 ISBN 9781032033228</li> <li>Ian Millington, John Funge, Artificial intelligence for Games, Third edition, CRC Press publishers, 2019, ISBN: 9781351053280</li> <li>Georgios N. Yannakakis, and Julian Togelius, Artificial Intelligence and Games, (1st Edition), Springer, 2018, ISBN 978-3-319-63519-4</li> <li>AI Game Programming Wisdom, Thomson Learning, Inc. – a series of books on various aspects of game development</li> <li>David M. Bourg, Glenn Seemann, AI for Game Developers, O'Reilly Series, 2004, ISBN: 9780596005559.</li> </ol>
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)	Life-Long Learning CLA-2 (10%)							
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr Jai Naresh, South Region Head, Media Entertainment Cell, and council 2. Mr Ajay Kumar, Consultant, Scopik edutech private limited.	1. Dr.B.Surendiran, NIT, Pondicherry	1. Dr.G.Premalatha, SRMIST

<b>Course Code</b>	21CSE340T	<b>Course Name</b>	ANALYTICS AND DECISION MAKING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the fundamental terms, concepts and theories associated with the phases of Decision Support Systems												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Highlight the uses of various mathematical models, data warehousing and mining															
<b>CLR-3:</b>	Gather the skills in analysis, design, and implementation of group support															
<b>CLR-4:</b>	Link expert system as a subsystem of DSS															
<b>CLR-5:</b>	Track the knowledge representation methods.															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
<b>CO-1:</b>	Explain the fundamental terms, concepts and theories associated with the phases of decision support systems												2	-	-	-
<b>CO-2:</b>	Describe the uses of various mathematical models, data warehousing and mining												-	3	2	-
<b>CO-3:</b>	Discuss and develop skills in the analysis, design, and implementation of group support												2	2	-	3
<b>CO-4:</b>	Illustrate expert system as a subsystem of DSS												2	2	-	-
<b>CO-5:</b>	Present the knowledge representation methods.												2	2	-	-

<b>Unit-1 - Introduction</b>	Managerial decision making, system modeling and support – preview of the modeling process, phases of decision-making process.	<b>9 Hour</b>
<b>Unit-2 - Analysis</b>	DSS components- Data warehousing, access, analysis, mining, and visualization-modeling and analysis-DSS development.	<b>9 Hour</b>
<b>Unit-3 - Support Systems</b>	Group support systems- Enterprise DSS- supply chain and DSS – Knowledge management methods, technologies, and tools.	<b>9 Hour</b>
<b>Unit-4 - Expert System</b>	Artificial intelligence and expert systems - Concepts, structure, types - Knowledge acquisition and validation - Difficulties, methods, selection.	<b>9 Hour</b>
<b>Unit-5 - Semantic Network</b>	Representation in logic and schemas, semantic networks, production rules and frames, inference techniques, intelligent system development, implementation, and integration of management support systems.	<b>9 Hour</b>

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. S.Christian Albright, Wayne L.Winston <i>Business Analytics: Data Analysis and Decision Making</i>, 5<sup>TH</sup> edition, Cengage Learning, 2015.</li> <li>2. Vicki L. Sauter, "Decision Support Systems for Business Intelligence", 2nd Edition, Wiley 2012.</li> <li>3. 23 Efraim Turban and Jay E Aronson, "Decision Support and Business Intelligent Systems", PHI, Eighth edition, 2010.</li> <li>4. Elain Rich and Kevin Knight, "Artificial intelligence", TMH, 1993.</li> <li>5. S S Mitra, "Decision support systems, tools and techniques", John Wiley, 1996.</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>			
	<i>Bloom's Level of Thinking</i>	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr Jai Naresh, South Region Head, Media Entertainment Cell, and council 2. Mr Ajay Kumar, Consultant, Scopik edutech private limited.	1. Dr.Selvakumar, NIT Trichy	1. Dr.G.Premalatha, SRMIST

<b>Course Code</b>	21CSE341T	<b>Course Name</b>	COMPUTER GRAPHICS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Gain knowledge about graphics hardware devices and software used												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Understand the two/ three-dimensional graphics and their transformations															
<b>CLR-3:</b>	Get knowledge about various object representation methods and visible surface detection methods															
<b>CLR-4:</b>	Understand the clipping techniques															
<b>CLR-5:</b>	Understand the illumination and color models															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12			
<b>CO-1:</b>	Illustrate the importance of generating various output primitives												3	3	-	
<b>CO-2:</b>	Possess the ability to represent various curves and surfaces												3	2	-	
<b>CO-3:</b>	understand various visible surface detection algorithms and color models												3	2	-	
<b>CO-4:</b>	Apply the knowledge to install and explore the interfaces of Unity												3	2	-	
<b>CO-5:</b>	Possess the ability to design and implement Surface Detection using Unity												2	2	-	

**Unit-1 - Introduction** 9 Hour  
 Computer Graphics Applications - Graphics System Overview - Raster scan systems, Random scan systems - Input, Output devices - Line drawing Algorithm-DDA - Line drawing Algorithm- Bresenham's - Midpoint Circle Algorithm - Pixel addressing - Filled area primitives - Boundary Fill algorithms - Flood fill algorithms

**Unit-2 - 2D Transformations** 9 Hour  
 Geometric Transformations - Matrix Representation - Homogenous and Composite - 2D Viewing- pipeline and coordinate reference - window to viewport transformation - 2D Viewing function - Clipping - Point Line - Cohen Sutherland - Liang Barsky, NLN, Polygon Clipping - Sutherland Hodgeman - Weiler-Atherton - Curve, Text, Exterior Clipping - Exterior Clipping

**Unit-3 - 3D Transformations** 9 Hour  
 3D Concepts - Object representation - Polygon surfaces and tables - Plane equations and meshes - Parallel Projection, Perspective Projection - Depth Cueing - Curved line & surfaces - Quadratic surfaces - Blobby objects - Spline representation - Beizer Curves and surfaces - B-Spline Curves and surfaces - Quadratic surfaces

**Unit-4 - 3D geometric Transformations** 9 Hour  
 3D geometric and modeling transforms - 3D Viewing - Viewing Pipeline - Viewing Coordinates & Projections - 3D Clipping - Visible Surface Detection methods - Back face detection - Z-buffer method, A-buffer method - A Scan line method, Painter's algorithms - Area subdivision method - Octree - Ray casting method – BSP

**Unit-5 - Illumination Effects** 9 Hour  
 models of illumination - Halftone- Dithering techniques - Constant Intensity Shading-Gouraud Shading - Phong Shading – Ray Tracing Methods - Properties of Light - RGB, CMY Color Model - YIQ Color Model - HLS Color Model - HSV Color Model - Color selection - Computer Animation

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Gabriel Gambetta, " Computer graphics from scratch: a programmer's introduction to 3D rendering" San Francisco, California: No Starch Press, Inc., [2021], ISBN :1718500777</li> <li>2. Samit Bhattacharya, "Computer Graphics, 2015. Oxford University Press, ISBN13:978-0-19-809619-1</li> <li>3. JohnF.Hughes, Andries VanDam, Morgan McGuire, DavidF.Sklar, James D.Foley, Steven K.Feiner, KurtAkeley,  Computer Graphics: Principles and Practicell,3rdEdition, Addison-Wesley Professional, 2013</li> <li>4. Donald Hearn &amp; M. PaulineBaker, —Computer Graphics C Versionll,2nd Edition, Pearson Education, 2010, ISBN 978-93-325-3587-9</li> <li>5. Peter Shirley, Michael Ashikhmin and Steve Marschner, "Fundamentals of Computer Graphics", 3rd Edition, 2009, ISBN: 9781568814698</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. Deepan Chakravarthy, Project Manager, Temnos	1. Dr.S. Muthuraj kumar, Associate Professor, Anna university	1. Dr. Anand M, SRMIST

<b>Course Code</b>	21CSE342T	<b>Course Name</b>	GAMING STUDIO FOR BUSINESS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		Program Outcomes (PO)												<b>Program Specific outcomes</b>																	
CLR-1:	Experience the roles and structure of a game development team as you realize your own games from brainstorming to final delivery.																														
CLR-2:	Learn the application of game design concepts to generate a new product																														
CLR-3:	Outline the development processes of rapid prototyping and iterative design																														
CLR-4:	Explore the structure, methods, and economics of the games industry for decision-making and development.																														
CLR-5:	Develop entertaining games and analyse with marketing tools																														
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3															
CO-1:	Identify the plan and functionalities for game studio setup															2															
CO-2:	Practice the game design concepts to generate a new product															1															
CO-3:	Choose the suitable approaches for game production															3															
CO-4:	Evaluate the games with different testing strategies															2															
CO-5:	Describe the team, resources, finances, marketing, community of players, operations, and development processes															-															

<b>Unit-1 - Introduction to Game Development</b>	<b>9 Hour</b>
Development Tools and Resources- Game Development Systems- Unity- GameMaker Studio- Unreal Engine 4- Game Salad- App Game Kit, Art and Design Resources, Audio Resources, Outsourcing, Development Tools, and Resources- Microsoft BizSpark- Adobe Creative Cloud	
<b>Unit-2 - Introduction to prototype Design</b>	<b>9 Hour</b>
Creating the Prototype- Laying the groundwork-stakeholder mapping, milestones -milestone plan, Case Study—Creating a Prototype in Unity- Developing First Unity Game	
<b>Unit-3 - Game publishers on Different OS</b>	<b>9 Hour</b>
Self-Publishing- Base Game Projects, Publishing on PC- Playable Free Alpha Demo- Early Access Release- Installers- Selling a PC Game, Publishing on Apple and Android, Partnering with Games Publishers	
<b>Unit-4 - Testing on Usability</b>	<b>9 Hour</b>
Making the game-user experience (UX)- Audio-Localization-QA testing-QA Bug Tracking -Bug Tracking Software- Working with External QA- Language Translations- Age Ratings, PR and Reaching Out to the Press-Copywriting Tips- Press Releases- Press Distribution Services	
<b>Unit-5 - Case Study</b>	<b>9 Hour</b>
Marketing, Analytics- App Annie- Flurry- Swrve- Apmetrix, Advertising, Websites, Forums and Source Control, Funding, Tax, Legal and Other Odds and Ends.	

<b>Learning Resources</b>	1. <i>The Game Production Toolbox</i> By Heather Maxwell Chandler · 2020, CRC Press 2. <i>The Indie Game Developer Handbook</i> , Richard Hill-Whittall 2017	3. <i>The Game Production Handbook</i> By Heather Maxwell Chandler 2009, Infinity Science Press
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)	Life-Long Learning CLA-2 (10%)							
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr Jai Naresh, South Region Head, Media Entertainment Cell, and council 2. Mr Ajay Kumar, Consultant, Scopik edutech private limited.	1. Dr.B.Surendiran, NIT, Pondicherry	1. Dr.G.Diva, SRMIST

<b>Course Code</b>	21CSE343T	<b>Course Name</b>	WEB SERVICES DEVELOPMENT FOR GAMES	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Identify the architecture and building blocks of web services												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	understand SOAP messages and XML															
<b>CLR-3:</b>	Illustrate the UDDI and WSDL for web services															
<b>CLR-4:</b>	Demonstrate the rust and web assembly for game development															
<b>CLR-5:</b>	Identify the animation, collision detection for endless runner															
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>															
<b>CO-1:</b>	Distinguish the different web service and its architecture												-	-	-	-
<b>CO-2:</b>	Create SOAP messages and XML for communication												-	2	-	-
<b>CO-3:</b>	Evaluate UDDI and WSDL for web services												-	3	-	-
<b>CO-4:</b>	Develop games using rust and web assembly												-	3	-	2
<b>CO-5:</b>	Evaluate animation, collision detection for creating endless runner												-	2	-	3

<b>Unit-1 - Web Service Architecture</b>	<b>9 Hour</b>
Web Service Architecture – Web services Architecture and its characteristics, core building blocks of web services, standards, and technologies available for implementing web services, web services communication, and basic steps of implementing web services. Describing Web Services – WSDL introduction, nonfunctional service description, WSDL1.1 Vs WSDL 2.0, WSDL document, WSDL elements, WSDL binding, WSDL tools, WSDL port type, limitations of WSDL	

<b>Unit-2 - Overview of XML</b>	<b>9 Hour</b>
XML Document structure, XML namespaces, Defining structure in XML documents, Reuse of XML schemes, Document navigation and transformation. SOAP: Simple Object Access Protocol, Inter-application communication and wire protocols, SOAP as a messaging protocol, Structure of a SOAP message, SOAP envelope, Encoding, Service Oriented Architectures, SOA revisited, Service roles in a SOA, Reliable messaging, The enterprise Service Bus, SOA Development Lifecycle, SOAP HTTP binding, SOAP communication model, Error handling in SOAP	

<b>Unit-3 - Registering and Discovering Services</b>	<b>9 Hour</b>
Registering and Discovering Services: The role of service registries, Service discovery, Universal Description, Discovery, and Integration, UDDI Architecture, UDDI Data Model, Interfaces, UDDI Implementation, UDDI with WSDL, UDDI specification, Service Addressing and Notification, Referencing and addressing Web Services, Web Services Notification	

<b>Unit-4 - Introduction to Rust, Web Assembly</b>	<b>9 Hour</b>
Web assembly, A Rust project skeleton, drawing to the canvas, rendering a sprite- Loading images, Canvas coordinator, Drawing Images, JavaScript callbacks, Async Rust, Sprite sheets – Loading JSON, Parsing JSON, Drawing with cookie cutter, Adding Animation.	

<b>Unit-5 - Creating Endless Runner</b>	<b>9 Hour</b>
Creating a game loop- Request Animation Frame, Loading assets, Cleaner drawing, Integrating the game loop, State machine – definition, types, Managing Animation – Transitioning between states, managing, integrating the state machine, Adding running state, Transitioning to sliding and back again, Creating a real scene, Axis aligned bounding boxes, Trimming the sprite sheet, Colliding with an obstacle, Refactoring for endless running.	

<b>Learning Resources</b>	1. Eric Smith, <i>Game Development with Rust and WebAssembly</i> , Packt Birmingham, 2022 2. Kelvin Sung, Jebediah Pavleas, Fernando Arnez, and Jason Pace, <i>Build Your Own 2D Game Engine and Create Great Web Games</i> , Apress, 2015. 3. <i>Web Services &amp; SOA Principles and Technology</i> , Second Edition, Michael P. Papazoglou, 2012.	4. XML, Web Services, and the Data Revolution, F.P.Coyle, Pearson Education, 2002. 5. Building web Services with Java, 2nd Edition, S. Graham and others, Pearson Education, 2004. 6. Java Web Services, D.A. Chappell & T. Jewell, O'Reilly, SPD, 2002.
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Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
Total		100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr.P.Mohan, Project Lead, Aspire Systems	1. Dr.V. Ilayaraja, VIT, Vellore	1. Dr. Rajeswari, SRMIST

<b>Course Code</b>	21CSE344T	<b>Course Name</b>	3D GAME DEVELOPMENT WITH UNITY	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the Game development fundamentals												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Explore the game objects in User interface															
<b>CLR-3:</b>	Introduce scripting with unity basic features															
<b>CLR-4:</b>	Apply various 3D models in UNITY															
<b>CLR-5:</b>	Create C# code with optimization															
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>															
<b>CO-1:</b>	Study the threatening genre and user interface												2	-	-	
<b>CO-2:</b>	Explore the unity scripting												2	-	-	
<b>CO-3:</b>	Design the environment in UNITY												3	-	-	
<b>CO-4:</b>	Analyse the functionality in UNITY												2	2	2	
<b>CO-5:</b>	Create the maze and menus in UNITY												3	3	3	

<b>Unit-1 - Genre and UI Basics</b>	<b>9 Hour</b>
Graphical Adventure - Intriguing locations - Compartmentalizing environments - Parallax - Animation -, Genre - Unity UI Basics - Layout - Tool bar - Selecting and Focus - Transform Objects - 3D Objects.	
<b>Unit-2 - Unity Scripting</b>	<b>9 Hour</b>
Installing Unity - Versions of Unity - New Project - New Scene - The Layout - Game Window - Components of Script - Anatomy of a function - Picking objects - Mouse Picks - Conditionals and state - Order of Evaluation.	
<b>Unit-3 - Test Environment</b>	<b>9 Hour</b>
Terrain Generation - Fly through Scene Navigation - Topography - Paint Texture - Paint Details - Creating own terrain assets - Terrain Settings - Shadows - Fog.	
<b>Unit-4 - Navigation and Functionality</b>	<b>9 Hour</b>
Navigation - Arrow Navigation and input - Fun with Platforms - Plan - Collision Walls - Object names - Defining Boundaries - Cursor control - Custom Cursors - GUI Layer - Plot - Walk-through - Items - Flow Chart - Interaction and State	
<b>Unit-5 - Maze and Menus</b>	<b>9 Hour</b>
Relationship with Crypto - Top crypto and metaverse projects - NFT Games - Virtual real estate - NFT impact on Metaverse - Virtual real estate trend, Physical and virtual real estate - Cryptocurrencies.	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. <i>Game Development Patterns with Unity 2021: Explore practical game development using software design patterns and best practices in Unity and C#, 2nd Edition, 30 July 2021, by David Baron.</i></li> <li>2. <i>Julia Naomi Rosenfield Boeira, Lean Game Development Apply Lean Frameworks to the Process of Game Development, ISBN: 978-1-4842-3216-3, 2017.</i></li> <li>3. <i>Alan Thorn, Pro Unity Game Development with C#, Apress Springer, 2014.</i></li> <li>4. <i>Game Development Essentials: Game Interface Design Misc. Supplies – 1 April 2017, by Jeannie Novak (Author), Kevin Saunders</i></li> <li>5. <i>Game Engine Architecture, Third Edition 3rd Edition, by Jason Gregory (Author) Advanced Game Design: A Systems Approach, 22 December 2017, by Michael Sellers.</i></li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>			
	<i>Bloom's Level of Thinking</i>	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	<i>Remember</i>	15%	-	15%	-	15%	-		
Level 2	<i>Understand</i>	25%	-	20%	-	25%	-		
Level 3	<i>Apply</i>	30%	-	25%	-	30%	-		
Level 4	<i>Analyze</i>	30%	-	25%	-	30%	-		
Level 5	<i>Evaluate</i>	-	-	10%	-	-	-		
Level 6	<i>Create</i>	100%	-	5%	-	-	-		
	Total	100%		100%		100%			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. Sudara Raman, Scopik Ltd, Chennai.	1. Prof. Indrakishor, Department of Computer Science and Engineering, Poornima Institute of Engineering & Technology, Jaipur, Rajasthan.	1. Dr. R. Rajkumar, SRMIST

<b>Course Code</b>	21CSE345T	<b>Course Name</b>	GAME SYSTEM INTEGRATION	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Study fundamentals of Lean game design												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Work with product design															
<b>CLR-3:</b>	Integrate the different gaming systems															
<b>CLR-4:</b>	Design the games and its challenges															
<b>CLR-5:</b>	Develop the game development platform															

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Study about Game Development	2	1	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
<b>CO-2:</b>	Explore the Minimum Viable Product in Game Development	2	2	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	
<b>CO-3:</b>	Extract the continuous integration	3	2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<b>CO-4:</b>	Analyse the performance measure of games	2	2	2	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	
<b>CO-5:</b>	Create game development using C#	3	3	3	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	

<b>Unit-1 - Lean Game Development</b>	9 Hour
Lean Inception - Lean DevOps - Kanban -, Test Driven Development - Lean and Games - An Inception in Practice - Anatomy of Inception - Developing Personas - Brainstorming - Creating Hypothesis	
<b>Unit-2 - Minimum Viable Product</b>	9 Hour
MVP - Building Prototypes - Thinking Simplest First - Splitting the MVG - Generating Hypotheses - Test driven Development - Applying TDD to Games - Making TDD Better.	
<b>Unit-3 - Continuous Integration</b>	9 Hour
Team responsibilities regarding Continuous Integration - Code Versioning - Automated Build - Design and Build - A little bit of build - Test, Code - Test - Coding Game Artwork - Test Automation.	
<b>Unit-4 - Measuring and Analysis</b>	9 Hour
Feedback - Ways of Measuring - Analyzing - Measuring Hypotheses - Creating Ideas for Iterating - First Ideation - Second Ideation - Limitations on Game Development.	
<b>Unit-5 - Metaverse Investments</b>	9 Hour
Designing and Preparing - Event Handling - Power - Ups and Singletons - Player Controller - Weapons - Anime -, Graphical User Interfaces - Refinement and Improvements.	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. <i>Game Development Patterns with Unity 2021: Explore practical game development using software design patterns and best practices in Unity and C#, 2nd Edition, 30 July 2021</i>, by David Baron.</li> <li>2. Alan Thorn, <i>Pro Unity Game Development with C#</i>, Apress Springer, 2019.</li> <li>3. Julia Naomi Rosenfield Boeira, <i>Lean Game Development Apply Lean Frameworks to the Process of Game Development</i>, ISBN: 978-1-4842-3216-3, 2017.</li> <li>4. <i>Game Development Essentials: Game Interface Design Misc. Supplies – 1 April 2018</i>, by Jeannie Novak (Author), Kevin Saunders</li> <li>5. <i>Game Engine Architecture, Third Edition 3rd Edition</i>, by Jason Gregory (Author) <i>Advanced Game Design: A Systems Approach</i>, 22 December 2017, by Michael Sellers</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>			
	<i>Bloom's Level of Thinking</i>	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	100%	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. Ravikumar, CEO at Hackwit Technologies Pvt Ltd, Chennai.	1. Prof. Indrakishor, Department of Computer Science and Engineering, 2. Poornima Institute of Engineering & Technology, Jaipur, Rajasthan	1. Dr. R. Rajkumar, SRMIST

<b>Course Code</b>	21CSE346T	<b>Course Name</b>	DESIGN ART AND THEORY	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Introduce the skills needed by game designer												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Illustrate the idea needed for a game.															
<b>CLR-3:</b>	Determine the most common types of game balance															
<b>CLR-4:</b>	Explain the interest curves and patterns within patterns															
<b>CLR-5:</b>	Determine the concepts of aesthetics															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CO-1:</b>	Apply the skills needed by game designer to handle approaches for game design												3	2	1	PSO-1
<b>CO-2:</b>	Analyze ideas behind game design												3	2	2	PSO-2
<b>CO-3:</b>	Apply the common types of game balance to make the goal easily understood.												3	2	1	PSO-3
<b>CO-4:</b>	Acquire knowledge on interest curves and what comprise interests												3	2	-	
<b>CO-5:</b>	Utilize the concepts of aesthetics to govern the design												1	2	-	

**Unit-1 - Introduction** 9 Hour  
 Introduction, Skills needed by Game designer, five kinds of listening, Three practical approaches to designing games, Introspection: Power, Perils and Practice, Dissect one's feelings, Essential Experience, Definitions, What is a game? Four Basic elements, Unifying themes, Resonance

**Unit-2 - Overview of Idea** 9 Hour  
 Game begins with an idea - Inspiration, Problem Statement, The silent partner, Choosing an idea, Eight filters, Rule of the loop, Short history of software engineering, Risk assessment and prototyping, eight tips for productive prototyping, Closing the loop, Einstein's violin, Project yourself, Demographics, Psychographics, Modeling, Focus, Empathy, Imagination, Motivation, Judgement, Space, Nested spaces, Object, attributes, states, Actions, Rules, Skill

**Unit-3 - Types of Game Balance** 9 Hour  
 Twelve most common types of game balance - fairness, Challenge vs Success, Meaningful choices, Skill vs Chance, Head vs Hands, Short vs Long, Rewards, Punishment, Freedom vs Controlled Experience, Simple vs Complex, Detail vs Imagination, The Puzzle of puzzles, Good puzzles, Puzzle principles - Make the goal easily understood, Make it easy to get started, Give a sense of progress, Give a sense of solvability, Increase difficulty gradually, Parallelism lets the player rest, Pyramid structure, Hints, Answer, Perceptual shifts, Loop of interaction, Channels of information, List information, channels, Map information, Review dimensions, Modes

**Unit-4 - Game Interest** 9 Hour  
 Interest curves, Pattern inside patterns, What comprise interests, Interest factor examples, Story/Game duality, Myth of passive entertainment, dream, reality, problems, dream reborn, story tips of game designers, feeling of freedom, Indirect methods, Collusions, Transmedia worlds, power of pokemon, Transmedia worlds properties, Nature of game characters, Avatars, Creating compelling characters, Purpose of architecture, Organizing game space, Christopher Alexander's ideas, Real vs Virtual architecture, Level design

**Unit-5 - Aesthetics****9 Hour**

Value of aesthetics, Learning to see, Let aesthetics govern the design, Use Audio, Balancing art and technology, Why we play with others, Tips for strong communities, Challenge of Griefing, Secret of successful teamwork, Designing together, Team communication, Purpose of design documents, Document types, Engineering, Management, Writing, Players, Playtesting, questions- why, who, where, what, how, Technology at last, Foundational vs Decorational, Hype cycle, Innovator's dilemma, Singularity, Look into crystal ball

<b>Learning Resources</b>	1. Kramarzewski, Adam, and Ennio De Nucci. Practical game design: learn the art of game design through applicable skills and cutting-edge insights. Packt Publishing Ltd, 2018. 2. Burgun, Keith. Game design theory: A new philosophy for understanding games. CRC Press, 2012. 3. Schell, Jesse. The Art of Game Design: a Book of Lenses. Amsterdam; Boston: Elsevier/Morgan Kaufmann, 2008.1.	4. Hiwiller, Zack. Players making decisions: Game design essentials and the art of understanding your players. New Riders, 2015. 5. Rouse III, Richard. Game Design: Theory and Practice. Jones & Bartlett Learning, 2004.
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**Learning Assessment**

Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1 <i>Remember</i>	15%	-	15%	-	15%	-
Level 2 <i>Understand</i>	25%	-	20%	-	25%	-
Level 3 <i>Apply</i>	30%	-	25%	-	30%	-
Level 4 <i>Analyze</i>	30%	-	25%	-	30%	-
Level 5 <i>Evaluate</i>	-	-	15%	-	-	-
Level 6 <i>Create</i>	-	-	5%	-	-	-
Total	100 %		100 %		100 %	

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Bhaskar Sahu, Schneider Electric Ltd, 2. Dr.S.Paramasivam, ESAB,	1. Dr. K. S. Swarup, IIT Madras 2. Dr.S.Chandramohan ,Professor, CEG, Anna university	1. Dr.P.C.Karthik, SRMIST 2. Dr.A. Murugan SRMIST

<b>Course Code</b>	21CSE439T	<b>Course Name</b>	VIRTUAL REALITY AND AUGMENTED REALITY	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<i>The purpose of learning this course is to:</i>	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Illustrate the fundamentals concepts of VR													PSO-1	PSO-2	PSO-3	
CLR-2:	Remember about standard Color models																
CLR-3:	Discuss about VR Environment Concepts																
CLR-4:	Apply and use of 3D Manipulation and interaction																
CLR-5:	Understand the usage of Augmented Reality																

<b>Course Outcomes (CO):</b>		<i>At the end of this course, learners will be able to:</i>	1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
CO-1:	Discuss Virtual Reality Fundamentals	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
CO-2:	Illustrate various color models concepts	1	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	
CO-3:	Apply the knowledge in VR Environment	1	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2	
CO-4:	Identify the concepts of 3D features	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CO-5:	Apply Virtual Reality applications	2	-	-	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	

<b>Unit-1 - Introduction to VR</b>	<b>9 Hour</b>
Historical development of VR, Scientific landmarks Computer Graphics, Real-time computer graphics, Flight simulation, Virtual environments, Requirements for VR, Visual Displays, Auditory Displays, Haptic Displays, Choosing Output Devices, Building Objects, Complex Shapes. Generation of fractal curves and landscapes using algorithms, Illustrate the aliasing and anti-aliasing techniques, Generation of Mandelbrot and Julia set fractals.	

<b>Unit-2 - Color Models</b>	<b>9 Hour</b>
Standard Primaries and the Chromaticity Diagram, Intuitive Color Concepts, RGB and CMY color models, HSV Colour Model, Colour Selection and Applications, World Space, World Coordinate, World Environment example, VR Environment Example. Construct the primitives with different color models and simulate the conversion from one model to another, Develop a new texture and apply various mapping on 3D objects Implementation of ray tracing concepts with the collection of 3D models	

<b>Unit-3 - Basic of VR Data Base</b>	<b>9 Hour</b>
R Database, Tessellated Data, LODs, Lights and Cameras, Cullers, Occluders, Scripts, Graphical User Interface, Control Pane, VR toolkits, Software's for VR, Available operating systems, Available software, Example, illustration	

<b>Unit-4 - Basic of 3D Task</b>	<b>9 Hour</b>
3D Manipulation tasks, Example and Case study, Manipulation Techniques, Input Devices, Interaction Techniques for 3D Manipulation, 3D Travel Tasks, Environment Centered Wayfinding Support, Theoretical Foundations of Wayfinding, Overview of Augmented Reality, Tracking for Augmented Reality, Augmented Reality Interaction, Collaborative Augmented Reality	

<b>Unit-5 - Basic of Augmented Reality</b>	<b>9 Hour</b>
3D Augmented Reality Interfaces, Augmented Surfaces, and Tangible Interfaces, Agents in AR, Transitional AR-VR Interfaces, Heterogeneous user interfaces, Mobile Augmented Reality, annotating environment, Annotating environment, Applications, Optical AR, Video AR, Heterogeneous AR, Mixed Reality case studies: Electronic circuit, Virtual class room, interior design, healthcare etc.	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Virtual Reality Systems, By John Vince, Pearson Education 2002</li> <li>2. Virtual Reality Technology, 2nd, by Grigore C. Burdea (Author), Philippe Coiffet (Author), Wiley Publications. June 2003</li> <li>3. Augmented Reality: Principles &amp; Practice Paperback – 12 Oct 2016 by Schmalstieg/Hollerer (Author)</li> <li>4. Virtual &amp; Augmented Reality for Dummies by Paul Mealy, Publication by John Wiley &amp; Son July 2018</li> <li>5. Daniela, Linda. "New perspectives on virtual and augmented reality." Available at: <a href="https://www.taylorfrancis.com/books/edit/10.4324/9781003001874/new-perspectives-virtual-augmented-reality-lindadaniela">https://www.taylorfrancis.com/books/edit/10.4324/9781003001874/new-perspectives-virtual-augmented-reality-lindadaniela</a>, 2020.</li> <li>6. Steve Aukstakalnis , "Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR" 2016, Publisher(s): Addison-Wesley Professional</li> <li>7. Course on Virtual Reality, IIT Madras <a href="https://nptel.ac.in/courses/106/106/106106138/">https://nptel.ac.in/courses/106/106/106106138/</a></li> <li>8. Foundation Course on Virtual Reality and Augmented Reality, IIT Madras, NPTEL <a href="https://elearn.nptel.ac.in/shop/iit-workshops/completed/foundation-course-on-virtual-reality-and-augmented-reality/">https://elearn.nptel.ac.in/shop/iit-workshops/completed/foundation-course-on-virtual-reality-and-augmented-reality/</a>, 3rd ed, Pearson, 2016</li> </ol>
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<b>Learning Assessment</b>		<b>Continuous Learning Assessment (CLA)</b>				<b>Summative Final Examination (40% weightage)</b>	
<b>Bloom's Level of Thinking</b>		<b>Formative CLA-1 Average of unit test (50%)</b>		<b>Life-Long Learning CLA-2 (10%)</b>			
		<b>Theory</b>	<b>Practice</b>	<b>Theory</b>	<b>Practice</b>	<b>Theory</b>	<b>Practice</b>
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
<b>Total</b>		100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr Jai Naresh, South Region Head, Media Entertainment Cell, and council	1. Mr.Veningston K Assistant Professor in Computer Science and Engineering at National Institute of Technology Srinagar	1. Dr. M. Ramprasath, SRMIST
2. Mr Ajay Kumar, Consultant, Scopik edutech private limited.	2. Dr.K.Sitara Assistant Professor in Computer Science and Engineering at National Institute of Technology, Trichy	2. Dr. Athira M Nambiar, SRMIST

<b>Course Code</b>	21CSE440T	<b>Course Name</b>	COMPUTER ANIMATION AND SIMULATION	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Illustrate concepts, approaches, and issues in the field of Animation & Simulation												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Increase the awareness of the students to the questions raised in the disciplines of computer science, Animation, Simulation															
<b>CLR-3:</b>	Focus on the interaction of these disciplines in approaching the study of gaming															
<b>CLR-4:</b>	Make specialization on topics central to Installation, Editing, navigation, animation & simulation.															
<b>CLR-5:</b>	Learn other Simulation techniques in gaming technology.															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
<b>CO-1:</b>	Understand the game graphics	1	2	2	2	-	-	-	-	-	-	-	-	-	-	1
<b>CO-2:</b>	Analyze the editing, navigation, and workspaces	1	2	1	2	-	-	-	-	-	-	-	-	-	-	-
<b>CO-3:</b>	Evaluate the techniques of Animation & Simulation	3	3	-	-	-	-	-	-	-	-	-	-	-	2	-
<b>CO-4:</b>	Create Animation & simulation	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-
<b>CO-5:</b>	Apply Computer Animation & simulation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2

**Unit-1 - Understanding the Interface** 9 Hour  
Download & Installation - Understanding the Interface - The Blender Screen (GUI - Headers- How to Quit Blender- How to Start Over-3D View Editor- Sidebar – Object Properties Panel- The Manipulation and Tool- Outliner Editor- The Properties Editor- Editor Types- The User Preferences Editor- Overlays in the 3D View Editor- Scene Manipulation)

**Unit-2 - Editors, Workspaces, Navigation** 9 Hour  
Editor Types- Resizing Editors- Splitting Editors- Cancel an Editor- Workspaces- Multiple Scenes- Files and Folders- Saving a File- Window File Explorer- Blender File Browser- Navigation- Editor Features- Make a New Folder- Saving Your Work- The Concept of Files- The Append or Link Command- Importing Objects- Activating Import File Types- Packing Data

**Unit-3 - Editing Tools** 9 Hour  
The Tool Panel- The Add Cube Tool- The Last Operator Panel- Extrusion- The Extrude Region Tool- Inset Faces- The Inset Faces Tool- The Bevel Tool- Edge and Loop Selection- The Loop Cut Tool- The Knife Tool- The Poly Build Tool- The Spin Tool- Creating a Spin Profile- Spin Duplication- The Screw Tool- The Smooth Tool- The Edge Slide Tool- The Shrink Fatten Tool- The Rip Region Tool

**Unit-4 - Animation** 9 Hour  
The Animation Screen- Movement in the 3D View Editor- Planning the Animation- Keyframes Time and Interpolation- Animation Speed and Length- Inserting Keyframes- Playing the Animation- Automatic Keyframing- Controlling the Animation- The Graph Editor- Editing the Graph- Other Types of Curves- The Curve Properties Panel- Animating Rotation- Rotation Using F-Curves- Animating Other Features- Keying Sets- Animation Follow Path- Displacement Sound Animation- Sound Effect and Cast Modifier.

**Unit-5 - Physics and Simulation** 9 Hour  
Modifiers and Physics- Force Field- Collision Physics- Cloth Physics- Soft Body Physics- Fluid Simulation- Fluid Simulation Examples- Fluid Particles

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. <i>The Complete Guide to Blender Graphics Computer Modeling &amp; Animation CRC press Fifth Edition by John.M. Blain,2019</i></li> <li>2. <i>Game Graphics Programming by Allen Sharrod 2008 edition</i></li> <li>3. <i>Hands-On C++ Game Animation Programming: Learn Modern Animation Techniques from Theory to Implementation with C++ and OpenGL by Gabor Szauer 2020 edition.</i></li> <li>4. <i>Fundamentals of Construction and Simulation Game Design by Ernest Adams</i></li> <li>5. <i>Simulation and Serious Games for Education Yiyu Cai, Sui Lin Goei, Wim Trooster 2016 Edition.</i></li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>	
<i>Bloom's Level of Thinking</i>	<i>Formative CLA-1 Average of unit test (50%)</i>	<i>Life-Long Learning CLA-2 (10%)</i>					
		<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>
Level 1	<i>Remember</i>	15%	-	15%	-	15%	-
Level 2	<i>Understand</i>	25%	-	20%	-	25%	-
Level 3	<i>Apply</i>	30%	-	25%	-	30%	-
Level 4	<i>Analyze</i>	30%	-	25%	-	30%	-
Level 5	<i>Evaluate</i>	-	-	10%	-	-	-
Level 6	<i>Create</i>	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr Jai Naresh, South Region Head, Media Entertainment Cell, and council 2. Mr Ajay Kumar, Consultant, Scopik edutech private limited.	1. Dr M Kumaraesan Professor / CSE, Jain University	1. Dr.Monica Bhavani M , SRMIST

<b>Course Code</b>	21CSE441T	<b>Course Name</b>	MOBILE GAME DEVELOPMENT	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the solid foundation in software engineering for mobile games												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	understand UNITY, C# and its tools and plugins															
<b>CLR-3:</b>	Familiarize themselves with mobile usability and design concerns															
<b>CLR-4:</b>	Implement several individual game project prototypes															
<b>CLR-5:</b>	Implement a larger, demo-able game project in a team environment															
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>															
<b>CO-1:</b>	Acquire the knowledge on the fundamentals of game development techniques												3	3	1	
<b>CO-2:</b>	Acquire the ability to apply the tools and plugins												3	2	2	
<b>CO-3:</b>	Utilize the design and mobile usability on various problems												3	2	-	
<b>CO-4:</b>	Acquire the ability to prototype the game project												3	2	-	
<b>CO-5:</b>	Apply the knowledge gained on larger game projects												2	2	-	

<b>Unit-1 - Introduction</b>	<b>9 Hour</b>
Game Design and Paper Prototyping - Game Analysis Frameworks - Inscribed Layer, Dynamic Layer - Cultural Layer, Design Goals - Paper Prototyping, Puzzle Design - The Digital Game Industry, Digital Prototyping - Introducing Our Development Environment: Unity - Thinking in Digital Systems - Introducing Our Language: C# - Variables and Components - Boolean Operations and Conditionals - Lists and Arrays, Classes, Functions and Parameters	
<b>Unit-2 - Game Objects</b>	
9 Hour	
Basics of Game Development - Scenes, Objects, Components - Working with Unity 2D & 3D - 2D graphics, Camera - Sprites a Texture Atlases - Animation - Scrolling - Overview of vector math - Physics principles - 3D math primer - Basics of 3D World, 3D rendering essentials - Using Unity for 3D development	
<b>Unit-3 - Game Interface</b>	
9 Hour	
Mobile Game Input - Designing for Mobile - Basic Touch - Multi Touch Gestures - Accelerometer, Virtual joypads - Usability - Designing for the impatient gamer, Audio - Particle Effects - Alternate Game Development Solutions - Cross-platform game engines - Platform specific game creation tools	
<b>Unit-4 - Game Prototype</b>	
9 Hour	
Game Designing and Prototyping - MDA: Mechanics - Dynamics, Aesthetics - Formal, Dramatic - Dynamic Elements - The Elemental Tetrad - The Layered Tetrad - Artificial Intelligence, Tile maps - AI behavior - Pathfinding - Augmented - Virtual Reality Games	
<b>Unit-5 - Advanced Graphics Development</b>	
9 Hour	
Advanced Graphics - Native Development - Shaders on mobile - Advanced 3D effects - Plugins - Publishing - Advanced Deploying on the App Store - Software Engineering for Games - Game Architecture and Implementation Patterns - Optimization - Pipelines and Tools - Profiling, Build Systems, Testing	

<b>Learning Resources</b>	<p>1. John P. Doran, "Unity 2020 Mobile Game Development Discover Practical Techniques and Examples to Create and Deliver Engaging Games for Android and iOS", 2nd Edition, Packt Publishing, 2020, ISBN: 9781838980993</p> <p>2. Paris Buttfield-Addison, Jon Manning, Tim Nugent, "Unity Game Development Cookbook: Essentials for Every Game" O'Reilly Media, 2019. ISBN: 9781491999127</p> <p>3. Jonathon Manning, Paris Buttfield-Addison, "Mobile Game Development with Unity: Build Once, Deploy Anywhere", O'Reilly Media Inc., 2017</p> <p>4. Jeremy Gibson, "Introduction to Game Design, Prototyping, and Development: From Concept to Playable Game with Unity and C#" ISBN-10:0321933168. 2014</p> <p>5. Sanjay Madhav, "Game Programming Algorithms and techniques", Addidon-Wesley, 2013</p>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>			
	<i>Bloom's Level of Thinking</i>	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. Deepan Chakravarthy, Project Manager, Temnos	1. Dr.S.Muthuraj kumar, Associate Professor, Anna University	1. Dr. Anand M, SRMIST

<b>Course Code</b>	21CSE442T	<b>Course Name</b>	GAME MONETIZATION TECHNIQUES	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the basic concepts of gaming in social life												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Analyze Industry terminologies, metrics in social games															
<b>CLR-3:</b>	Apply game Users and Monetization model															
<b>CLR-4:</b>	Understand Virtual Goods and Currency in game play															
<b>CLR-5:</b>	Analyze game Users and Monetization model															

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Identify gaming concepts and social games	3	3	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	
<b>CO-2:</b>	Determine the Industry terminologies, metrics in social games	3	3	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	
<b>CO-3:</b>	Differentiate type of game Users and Monetization models	2	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	
<b>CO-4:</b>	Implement Virtual Goods in games and Currency in game play	3	3	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	
<b>CO-5:</b>	Apply game Feedbacks and AI Characters in game design	3	3	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	

<b>Unit-1 - Introduction</b>	<b>9 Hour</b>
The changing tide- What Is A Social Game- Are mobile games social- history of game monetization- what do we mean by monetization-a brief history of game monetization-the three grand eras of gaming- social and mobile games put a lot of power in the hands of the developers-social games make the developer responsible- social games give power to the users-used retail game sales - Monetize your Game or App with Ads	

<b>Unit-2 - Industry and Social Games</b>	<b>9 Hour</b>
Industry Terms and Metrics- Measuring Player Population-Measuring Monetization- Social Network Advertising- Mobile Terms- General Terms- Why These Metrics Matter- Case Study: Ravenwood Fair And The Use of Metrics In Game Design- Science of Social Game Design- Social Network: Make any Game Social- The Average Social Gamer- The Average- Mobile Gamer- Popular Social Networks Today- Games Are Global- It's All About Scale- Using Social Networks To Extend Traditional Games- Creating Social Networks As A Platform Holder - Monetize your Game or App with In-App Purchases	

<b>Unit-3 - Users and Monetization</b>	<b>9 Hour</b>
Acquire, Keep and Regain Users: Build It So They'll Come- The Purchase Funnel- Acquisition: How To Get Players- Acquiring New Users on Facebook- Acquiring New Users on Mobile Platforms- Advertising Efficiently- The Rising Cost of CPI- Virality- Redirecting Users For Increased Virality- How to Retain Users- Tracking Retention- Using Leaderboards And Messaging To Add Stickiness- Using Messages To Remind Users To Return- Only The Last Inch Matters-Monetization Strategies: Show Us The Money- Classic Premium Download Model- Subscriptions- Freemium- Play The Numbers- Combinations- Case Study: Hunters Episode One And Different Monetization Methods - Avoid Giving Players Real Money- Transitioning Models - Which Models Fit Best For Which Type of Game - Make your first Downloads - Tips & Tricks	

<b>Unit-4 - Virtual Goods and Currency</b>	<b>9 Hour</b>
Virtual Goods: fake estates- selling premium goods- functional advantages- game balance considerations- aesthetic "vanity" items- rarity Currency: Greenspan for the win- single currency models- dual currency models- closed and open economies- addressing the matter of "honest" gameplay- Web 3 Gaming: Crypto- Play to Earn- NFT - Upload your Game or App on Google Play and Apple Store	

**Unit-5 - Feedbacks and AI Characters****9 Hour**

*Input and Feedback Mechanisms: Mouse And Keyboard- Controllers- Gestures- Eye Tracking As Input- Cameras- Drones- Finger Taps- More Advanced Anatomically Integrated Input- Thought Control- Speech-Haptic Feedback-Displays- Glasses And VR Headsets Contacts And Retina Projection, Artificially Intelligent Characters :Virtual Characters Take over The World Soon-On AI Characters- Building AI Companions-The Character Visuals- The Dialog- Text To Speech- Indistinguishable From Real Humans-Avatars- The Future of Avatars Artificial And Intelligent Characters - Motivating Players to Buy*

<b>Learning Resources</b>	1. Fields, Tim. <i>Mobile &amp; Social Game Design: Monetization Methods and Mechanics</i> , Second Edition. United Kingdom, Taylor & Francis, 2014. 2. Fields, Tim. <i>Game Development 2042: The Future of Game Design, Development, and Publishing</i> . United Kingdom, CRC Press, 2022. 3. Fields, Tim, and Cotton, Brandon. <i>Social Game Design: Monetization Methods and Mechanics</i> . Netherlands, CRC Press, 2011.	4. <i>Advances in Human Factors in Wearable Technologies and Game Design: Proceedings of the AHFE 2019 International Conference on Human Factors and Wearable Technologies, and the AHFE International Conference on Game Design and Virtual Environments, July 24-28, 2019, Washington D.C., USA</i> . Germany, Springer International Publishing, 2019.
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Learning Assessment						
Bloom's Level of Thinking	Continuous Learning Assessment (CLA)					Summative Final Examination (40% weightage)
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%
Level 2	Understand	25%	-	20%	-	25%
Level 3	Apply	30%	-	25%	-	30%
Level 4	Analyze	30%	-	25%	-	30%
Level 5	Evaluate	-	-	10%	-	-
Level 6	Create	-	-	5%	-	-
	Total	100 %		100 %		100 %

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr Jai Naresh, South Region Head, Media Entertainment Cell, and council 2. Mr Ajay Kumar, Consultant, Scopik edutech private limited.	1. Dr M Kumaraesan Professor / CSE, Jain University	1. Dr P. Saravanan, SRMIST

<b>Course Code</b>	21CSE443T	<b>Course Name</b>	GAME PRODUCTION AND PUBLISHING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Recognize various steps involved in game production.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Explore the different kinds of prototyping in game production															
<b>CLR-3:</b>	Introduce the game pitch and steps in process															
<b>CLR-4:</b>	Elaborate the Developer and publisher overview in game publishing															
<b>CLR-5:</b>	Recognize the steps in testing and expose to various case studies in real time Game production.															

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Predict the trends in game development cycle.	3	1	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
<b>CO-2:</b>	Identify and apply various prototyping in Game development	2	2	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<b>CO-3:</b>	Apply the process of pitching in game development.	-	2	3	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	
<b>CO-4:</b>	Design Game plan and Publishing	-	3	-	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	
<b>CO-5:</b>	Plan and produce their own video game in a conscientious manner.	-	2	3	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	

<b>Unit-1 - Introduction</b>	<b>9 Hour</b>
Game production Overview-SWOT analysis-Production Cycle-Pre-production-Game Concept-Game Requirements-Game Plan—Production-Plan Implementation-tracking progress-Task Completion-Production Checklist-Testing-Plan Validation-Code Release-Testing checklist-Post Production-Learn from experience-Archive plan-post production checklist-Different Roles on the Team	
<b>Unit-2 - Prototyping</b>	
Eight kinds of prototype-Paper Prototype-Physical Prototype-Playable prototype-Art and sound prototype-Interface Prototype-Code/Tech Prototypes-Core Game Prototypes-Complete Game Prototypes-Documenting the prototypes.	
<b>Unit-3 - Pitching your game</b>	
Preparing for the pitch-Elevator Pitch-Executive Summary-Demo-Trailer-Developer Backgrounds-Market Research-Production Plan-Making the pitch-Contract Negotiation-Vetting process	
<b>Unit-4 - Developer and Publisher Overview</b>	
Introduction-Function of Developer-Art-Design-Engineering-Audio-User Experience (UX)-Quality Assurance-Function of producer-Background and Training-Career Progression-Types of Producers-Function of publisher-Background and Training- Career Progression-Types of Producers-Publishing your Game-Self Publishing-Publishing Partner-Publishing Relationship.	
<b>Unit-5 - Moving from Design to production</b>	
Testing process-Informal Playtesting-Design process Testing-QA Testing-Automated Testing-Public facing testing-Case Studies-The Metagame-The Path-Johann Sebastian Joust-How to know when the design is done-Getting Ready for production	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. <i>A Playful Production Process: For Game Designers (and Everyone)</i> by Richard Lemarchand, October 2021, MIT Press.</li> <li>2. <i>The Game Production Toolbox Paperback 2020</i>, by Heather Chandler, CRC Press.</li> <li>3. <i>Introduction to Game Design, Prototyping, and Development: From Concept to Playable Game with Unity and C#</i>, Jeremy Gibson Bond, 2017, Pearson Education.</li> <li>4. <i>Games, Design and Play A Detailed Approach to Iterative Game Design</i> By Colleen Macklin, John Sharp, 2016, Addison-Wesley.</li> <li>5. <i>Fundamentals of Game Development</i> by Heather Chandler, Rafael Chandler, August 2011, Jones &amp; Bartlett Learning</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>			
<i>Bloom's Level of Thinking</i>		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr Jai Naresh, South Region Head, Media Entertainment Cell, and council 2. Mr Ajay Kumar, Consultant, Scopik edutech private limited.	1. Dr. Anbuchelian - Ramanujan Computing Center, Anna University	1. Ms.S. Sindhu, SRMIST

<b>Course Code</b>	21CSE44T	<b>Course Name</b>	APPLIED GAMIFICATION	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		Program Outcomes (PO)												<b>Program Specific outcomes</b>																																																		
<b>CLR-1:</b>	Understand game design principles and frameworks												<b>CLR-2:</b>	Explain gamification in learning strategies												<b>CLR-3:</b>	recognize gamification in Physiotherapy, sentiment analysis and recycling practice												<b>CLR-4:</b>	Design novel gamification approaches												<b>CLR-5:</b>	Analyze problems on gamification and implementation											
Engineering Knowledge	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3																																																	
Problem Analysis	1	2	2	-	-	-	-	-	-	-	-	-																																																				
Design/development of solutions	2	2	2	-	-	-	-	-	-	-	-	-																																																				
Conduct investigations of complex problems	2	3	2	-	-	-	-	-	-	-	-	-																																																				
Modern Tool Usage	-	3	2	-	-	-	-	-	-	-	-	-																																																				
The engineer and society																																																																
Environment & Sustainability																																																																
Ethics																																																																
Individual & Team Work																																																																
Communication																																																																
Project Mgt. & Finance																																																																
Life Long Learning																																																																

<b>Unit-1 - Game Design Principles</b>	<b>9 Hour</b>
Gamification Standardization: Gamification Frameworks- Gamification Systematic Study- Use of Gamification on Enterprises: Human Resource Management- Gamification In Human Resources- Gamification Applied To Human Resources- Case Study: Genre Differences in Soft Skills Perception	

<b>Unit-2 - Learning Gamification Strategies</b>	<b>9 Hour</b>
Strategy to Implement Gamification In LMS: Serious Games- Gamification of Learning- Pedagogical Approaches- Theories and Models- Serious Games in Learning Management Systems- Model for Structural Gamification of Learning. Case Study: Gamification of E-Learning In African Universities- Theoretical Foundation And Hypothesis- Gamified Learning: Gamification Mechanisms- The Theory of Gamified Learning- Studying The Influence of Gamification on Learning Outcomes- Solutions And Recommendations	

<b>Unit-3 - Serious Games and Apps</b>	<b>9 Hour</b>
Game to Enhance Physiotherapy Student's Clinical Reasoning: Petrha+ Serious Game- Goals- Theoretical Framework- and Strategy-Establishing Physiotherapy Diagnosis- Using Sentiment Analytics to Understand Learner Experiences: Enjoyment in Serious Game- Sentiment Analytics- Enjoyment Analytics Framework- Motivating Sustainable Recycling Practices: Gamified Recycling Applications- Technologies of Persuasion and Application of Gamification Processes-Solution Conception and Game Logic	

<b>Unit-4 - Gamification Novel Approaches</b>	<b>9 Hour</b>
Artificial Intelligence and Big Data Techniques to Enhance Gamified Financial Services: The Importance of Gamification- Fintech and Gamification- Gamified Healthcare Services and Devices: The Acceptance of Technology- Healthcare and Gamification- Gamified Healthcare Wearable Technology- Augmented Reality Games: Augmented Reality and Gamification- Serious Games and Gamification- Augmented Reality in the Gaming Industry-Game Transfer Phenomenon	

**Unit-5 - Gamification Mindset****9 Hour**

Problems with Applying Gamified Thinking into a Product: Do You Need to Gamify? - Shallow Gamification- Do You Need to Be a Game Designer to Make a Gamification?- Games Are Cool Gamification Is Not-Dull or Juicy Game Feel- Gamification Problems- Ethical Problems- Do Not Forget Algorithms and Big Data- How Can Real-Time Use of Gamification Drive Performance or Not?- Game Design Principles Usable in Gamification: Game Thinking- Game Design Framework- Game Design Elements- Game Dynamics- Embedded Narrative- Emergent Narrative- Game Theory—And It's Not Gamification- Game Theory as a Tree-Game-Inspired Design- Game Player in a Wider Context

<b>Learning Resources</b>	1. Filipe Portela, Ricardo Queirós, Next-Generation Applications and Implementations of Gamification Systems, IGI Globa, - 2022 2. Ole Goeth, Gamification Mindset, Springer, 2019. 3. Wells, Simon & Kotkanen, Henri & Schlaflie, Michael & Gabrielli, Silvia & Masthoff, Judith & Jylhä, Antti & Forbes, Paula. (2014). Towards an Applied Gamification Model for Tracking, Managing, & Encouraging Sustainable Travel Behaviours. ICST Transactions on Ambient Systems. 1. E2. 10.4108/amsys.1.4. e2.	4. Transforming Society and Organizations Through Gamification: From the Sustainable Development Goals to Inclusive Workplaces. Germany, Springer International Publishing, 2021.
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**Learning Assessment**

Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%
Level 2	Understand	25%	-	20%	-	25%
Level 3	Apply	30%	-	25%	-	30%
Level 4	Analyze	30%	-	25%	-	30%
Level 5	Evaluate	-	-	10%	-	-
Level 6	Create	-	-	5%	-	-
	Total	100 %		100 %		100 %

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr Jai Naresh, South Region Head, Media Entertainment Cell, and council 2. Mr Ajay Kumar, Consultant, Scopik edutech private limited.	1. Dr M Kumaraesan Professor / CSE, Jain University	1. Dr P. Saravanan, SRMIST

<b>Course Code</b>	21CSE445T	<b>Course Name</b>	METAVERSE FUNDAMENTALS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Study the various application of metaverse												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Classify VR and AR possibilities in Metaverse															
<b>CLR-3:</b>	Discover the challenges for implementation															
<b>CLR-4:</b>	Identity the hardware and software for closely real time usage															
<b>CLR-5:</b>	Justify the possibilities of brain computing interface with the applications of VR															
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>															
<b>CO-1:</b>	Study about the Metaverse and Gaming												2	1	-	
<b>CO-2:</b>	summarize the hardware and software possibilities												2	2	-	
<b>CO-3:</b>	Review about the challenges in NFT												2	2	-	
<b>CO-4:</b>	Analyse the future of Metaverse												2	2	2	
<b>CO-5:</b>	Develop investments in metaverse												3	3	3	

<b>Unit-1 - Introduction to Metaverse</b>	9 Hour
Introduction to Metaverse - Rise of Metaverse - Future of Metaverse - Meta - Microsoft - Epic Games - Roblox - Minecraft - Milestones of Metaverse – ramifications- Various applications in Metaverse	
<b>Unit-2 - Virtual Reality and Augmented Reality in Metaverse</b>	9 Hour
VR in Metaverse - Recruitment - Coordination - New Target - Preparation for virtual Reality - AR updates via spark - Ecommerce using Augmented Reality - AR in Military - Ubiquitous Computing - AR and VR in Metaverse	
<b>Unit-3 - NFT's In the Metaverse</b>	
9 Hour	
Introduction to NFT - NFT's effect on Metaverse - NFT's Becoming identity in Metaverse - Avoid Risk and Challenges in Metaverse - Legal Ramifications - Data exchange - AI Regulation- NFT and Metaverse	
<b>Unit-4 - The Future of Metaverse</b>	
9 Hour	
Current states of metaverse market - Shopping and Business - Education - Advertising - Healthcare -, Workplace and Office - Entertainment and Media - Revive History - Social Experience - Enterprise activities- The future of Metaverse	
<b>Unit-5 - Metaverse Investments</b>	
9 Hour	
Relationship with Crypto - Top crypto and metaverse projects - NFT Games - Virtual real estate - NFT impact on Metaverse - Virtual real estate trend, Physical and virtual real estate – Cryptocurrencies- Metaverse in enterprises	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Metaverse for Beginners -A Guide to Help You Learn About Metaverse, Virtual Reality and Investing In NFTs, Andrew Clemens (2022).</li> <li>2. Jesse Glover, Jonathan Linowes – Complete Virtual Reality and Augmented Reality Development with Unity: Leverage the power of Unity and become a pro at creating mixed reality applications. Packt publishing, 17th April 2019. ISBN -13: 978-1838648183</li> <li>3. Jonathan Linowes, Krystian Babilinski – Augmented Reality for Developers: Build practical augmented reality applications with Unity, ARCore, ARKit, and Vuforia. Packt publishing, 9th October 2017. ISBN-13: 978-1787286436), "Retail Analytics: The Secret Weapon", Wiley, ISBN- 978-1-118-09984-1</li> <li>4. Jesse Glover, Jonathan Linowes – Complete Virtual Reality and Augmented Reality Development with Unity: Leverage the power of Unity and become a pro at creating mixed reality applications. Packt publishing, 17th April 2019. ISBN -13: 978-1838648183</li> <li>5. Jonathan Linowes, Krystian Babilinski – Augmented Reality for Developers: Build practical augmented reality applications with Unity, ARCore, ARKit, and Vuforia. Packt publishing, 9th October 2017. ISBN-13: 978-1787286436</li> </ol>
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<b>Learning Assessment</b>						
Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%
Level 2	Understand	25%	-	20%	-	25%
Level 3	Apply	30%	-	25%	-	30%
Level 4	Analyze	30%	-	25%	-	30%
Level 5	Evaluate	-	-	10%	-	-
Level 6	Create	-	-	5%	-	-
	Total	100 %		100 %		100 %

<b>Course Designers</b>		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Ravikumar, CEO at Hackwit Technologies Pvt Ltd, Chennai.	1. Prof. Indrakishor, Department of Computer Science and Engineering, Poornima Institute of Engineering & Technology, Jaipur, Rajasthan.	1. Dr. R. Rajkumar, SRMIST

<b>Course Code</b>	21CSE446T	<b>Course Name</b>	DIGITAL MARKETING AND PUBLISHING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 3	T 0	P 0	C 3
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<b>Pre-requisite Courses</b>	<i>Nil</i>	<b>Co- requisite Courses</b>	<i>Nil</i>	<b>Progressive Courses</b>	<i>Nil</i>
<b>Course Offering Department</b>	<i>School of Computing</i>		<b>Data Book / Codes / Standards</b>	<i>Nil</i>	

Course Outcomes (CO):		At the end of this course, learners will be able to:																	
		Engin	ProbI	Desig	soluti	Cond	compo	Mode	The e	Envir	Sustai	Ethics	Individ	Comm	Projec	Life L	PSO	PSO	PSO
CO-1:	Understand the role of digital marketing in marketing strategy	-	-	-	-	-	-	-	2	-	-	-	3	2	-	-	-	-	-
CO-2:	Identify the key elements of a digital marketing strategy	2	-	3	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-3:	Analyze the role that social marketing plays in the digital marketing	2	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-
CO-4:	Explore the structure, methods, and key issues in games industry	2	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO-5:	Create and publishing of a game	-	-	3	-	-	-	-	2	-	-	-	-	3	-	-	-	-	3

**Unit-1 - Introduction to Digital marketing**

9 Hour

Introduction to Digital Marketing: Introduction - Original and Development of Digital Marketing - Internet Users: Penetration and Kind of Internet Use - Digital Marketing strategy – Digital Advertising Marketing Plan - Ethical and legal of framework of Digital Marketing - Skills Required in Digital Marketing - Digital Advertising: Introduction - Concept of display advertising - Digital Metrics - Types of Digital Ad - Targeting in digital marketing - Challenges faced by display marketing

## **Unit-2 - Marketing Strategies**

9 Hour

Unit-2 - Marketing Strategies | 3 Hour

**Unit-3 - Social Media Marketing Strategies**

9 Hour

Facebook Marketing: Introduction – Organic Marketing – Paid Marketing – Facebook Insights LinkedIn: Introduction - LinkedIn Strategy - Content Strategy - LinkedIn Native Videos - LinkedIn Analytics - Asset Copying, LinkedIn Sales Navigator, Ad campaigns, Emerging Platforms: Instagram, Pinterest

**Unit 4 Publishing and Legal agreement**

0 Hours

**Unit-4 - Publishing and Legal agreement** 9 Hour  
Game publishing-Introduction-overview of Indie PC and console market-types of publishers-, publishing strategies, Game publishing agreement-Publisher's Objectives-Developer's objectives- Key legal issues in game publishing agreement.

### **Unit 5 Case Study**

0 Nov

case study - Business process-promoting games-Case studies-practical and Ethical Concerns in usability testing with children- Usability testing of a Three -Dimensional library Orientation Game

447

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Kevin Hartman <i>Digital Marketing Analytics: In Theory and In Practice</i> Ostmen Bennett Bridge Publishing Services 2nd Edition, 2020</li> <li>2. <i>The Publishing Challenge for Independent Video Game Developers A Practical Guide</i> By Odile Limpach 2020</li> <li>3. Simon Kingsnorth <i>Digital Marketing Strategy: An Integrated Approach to Online Marketing</i> 2nd Edition Kogan Page 2nd Edition, 2019.</li> <li>4. Seema Gupta <i>Digital Marketing</i> McGraw Hill Education 2 nd Edition, 2018</li> <li>5. <i>Games User Research A Case Study Approach</i> 2017, CRC Press</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>			
	<i>Bloom's Level of Thinking</i>	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	15%	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr Jai Naresh, South Region Head, Media Entertainment Cell, and council 2. Mr Ajay Kumar, Consultant, Scopik edutech private limited.	1. Dr.Selvakumar,NIT Trichy	1. Dr.G.Divya, SRMIST

**ACADEMIC CURRICULA**

**UNDERGRADUATE/ INTEGRATED POST  
GRADUATE DEGREE PROGRAMMES**

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(Choice Based Flexible Credit System)

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Volume - 11K

(Syllabi for Computer Science and Engineering w/s in  
Big Data Analytics and Data Science Programme Courses)



**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

# ACADEMIC CURRICULA

Engineering Science Courses

Regulations 2021



**SRM**

INSTITUTE OF SCIENCE & TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

<b>Course Code</b>	21CSS202T	<b>Course Name</b>	FUNDAMENTALS OF DATA SCIENCE	<b>Course Category</b>	S	ENGINEERING SCIENCES	<b>L</b>	T	P	C
							3	2	0	5

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Learn the different data structures and their packages in Python												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Know to create functions to access and manipulate numbers, strings and datetime data															
<b>CLR-3:</b>	Utilize the Numpy library to analyse numbers															
<b>CLR-4:</b>	Learn the Pandas library to analyse data frames															
<b>CLR-5:</b>	Explore the visualization tools for different kinds of input data formats															

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CO-1:</b>	Distinguish the different data structures using the various packages												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CO-2:</b>	Create functions to access and manipulate numbers, strings and datetime data												-	1	1	-
<b>CO-3:</b>	Implement the code for numbers using Numpy												-	1	1	-
<b>CO-4:</b>	Develop code for data frames using Pandas												-	1	1	-
<b>CO-5:</b>	Visualize different kinds of data using matplotlib and seaborn												-	1	1	-

<b>Unit-1 - Introduction to Data Science</b>	<b>15 Hour</b>
Benefits and uses of Data science, Facets of data, The data science process-Introduction to Python Libraries: Numpy, creating array, attributes, Numpy Arrays objects: Creating Arrays, basic operations (Array Join, split, search, sort), Indexing, Slicing and iterating, copying arrays, Arrays shape manipulation, Identity array, eye function, Universal function, Linear algebra with Numpy, eigen values and eigen vectors with NumPy, NumPy Random: Data Distribution, Normal, Exponential, Binomial, Poisson, Uniform and Chi-square distributions.	
T1: Using Numpy implement Array Indexing and slicing, T2: Using Numpy implement Array basic operations, T3: Using Numpy implement Linear algebra and Random package	

<b>Unit-2 - Introduction to Python Debugging</b>	<b>15 Hour</b>
Debug python scripts using PDB and IDE, Classify Errors, Develop Unit Tests , Create project Skeletons, Implement Database using SQLite, Perform CRUD operations, SQLite database, JSON file – Read, Write and Parse JSON file - JSON Conversion – to dictionary, to JSON, to JSON String, JSON schema – Schema Validation, Resolving JSON Reference, Extending Validator Classes - Virtual Environment, Floating point Arithmetic – Issues and Limitations, Implement Regular Expression and its Basic Functions -.findall(),.search(),.split(),.sub(), Use Classes, Objects, and Attributes, Develop applications based on Object Oriented Programming and Methods.	
T4: Implement programs to handle JSON files, T5: Implement programs to work with Regex functions and classes, T6: Implementing Debugging and creating projects in python IDE	

<b>Unit-3 - Introduction to Python</b>	<b>15 Hour</b>
Django Web Framework: Web development basics and Features of Django, Installing Django and MVC model , HTTP webserver concepts - Use HTTP request and response objects, Create Views, Use URLConf - URL Mapping, Introduction to Django Template System, Load Template Files, Render Templates, Create Forms, Process Form Data and Customize Form Field Validation, Introduction to Django Models, Use Model Fields, populate a Database, CRUD, Use QuerySets for data retrieval, Use jQuery and AJAX with Django to create Dynamic websites	
T7: Implement Django framework using python – creating basic Django App, T8: Create a simple View using Django, T9: Implement Django app for real-time applications using MVC model	

<b>Unit-4 - Handling Data</b>	<b>15 Hour</b>
Problem faced when handling large data-General techniques for handling large volume of data- General programming tips for dealing large data sets Introduction to Pandas, Data Structure in pandas – dataframe and series, Accessing and slicing of series and dataframes - Arithmetic and logical operations on dataframe, Accessing and slicing of series, And dataframes - Arithmetic and logical operations on dataframe, Groupby operations on Dataframe, Pivot tables to understand the relationship between variables in the data, with different aggregation-Crosstab to understand the relationship between variables in the data, Handling missing data – Time series – date functionality, Time delta Vectorization concept implementation using pandas – I/O tools of Pandas, Indexing, multi indexing concepts - Application. Data handling – Categorical data, Integer data. Computational tools – Statistical functions, windowing operations, Chart and Table Visualization in Pandas.	
T10: Building programs to access the csv files as a dataframe and analyze the dataframe, T11: Perform different arithmetic, logical, and filtering operations on dataframes	
T12: Perform group by, pivot and crosstab aggregation on the dataframes	
<b>Unit-5 - Visualization</b>	
Advantages and usecases, working with Matplotlib to plot different visuals, Working with Seaborn to plot different visuals, Univariate graphs for numeric and categorical data, Bivariate graphs for numeric and categorical data, Multivariate Graphs, Choosing appropriate graphical techniques, using graph to explore the data insights, Introduction to dashboards.	
T13: Building programs to visualize the dataframe in matplotlib and seaborn, T14: Building programs to visualize the univariate, bivariate and multivariate relation	
T15: Case study with all the appropriate graphs to visualize the relationship in the data	

<b>Learning Resources</b>	1. Grus, J. (2019). <i>Data Science from Scratch</i> , 2nd Edition. O'Reilly Media, Inc. 2. Davy Cielen, Arno Meysman, Mohamed Ali – <i>Introducing Data Science: Big Data, Machine Learning, and, more, using Python tools</i> , Manning Publications,2016 3. McKinney, W. (2018). <i>Python for data analysis: Data wrangling with pandas, NumPy, and IPython</i> . O'Reilly Media, Inc. 4. Vanderplas, J. T. (2017). <i>Python data science handbook: Essential tools for working with data</i> . O'Reilly Media, Inc.	5. Magnus Lie Hetland, "Beginning Python: From Novice to Professional", Apress, Second Edition, 2005. 6. Shai Vaingast, "Beginning Python Visualization Crafting Visual Transformation Scripts", Apress, 2nd edition, 2014. 7. Wes Mc Kinney, "Python for Data Analysis", O'Reilly Media, 2012. 8. Wesley J.Chun,"Core Python Applications Programming,3rd ed,Pearson,2016
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Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	40%	-	20%	-	40%	-		
Level 2	Understand	40%	-	20%	-	40%	-		
Level 3	Apply	10%	-	20%	-	10%	-		
Level 4	Analyze	10%	-	20%	-	10%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	10%	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. A.G.Rangaraj,Deputy Director (Technical),R&D, RDAF and SRRA Division, National Institute of Wind Energy (NIWE)	. Dr.I.Joe Louis Paul, Associate Professor, SSN College of Engineering	Dr.G.Vadivu, SRMIST

<b>Course Code</b>	21CSS301T	<b>Course Name</b>	FULL STACK DEVELOPMENT	<b>Course Category</b>	S	ENGINEERING SCIENCES	<b>L</b>	T	P	C
							1	1	0	2

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>				
<b>CLR-1:</b>	Learn the basics of JavaScript and importance of MERN stack												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>			
<b>CLR-2:</b>	Learn the role of React in designing front-end components																	
<b>CLR-3:</b>	Understand the design issues in the development of backend components using Node.js and Express																	
<b>CLR-4:</b>	Learn the significance of using MongoDB as a database system																	
<b>CLR-5:</b>	Explore the advanced features of full stack development																	
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>																	
<b>CO-1:</b>	Setting up MERN environment for node.js												-	-	-	1	-	-
<b>CO-2:</b>	Apply the knowledge of react based web programming												-	-	-	-	-	1
<b>CO-3:</b>	Deal with Node based programming and Express												-	-	-	2	-	-
<b>CO-4:</b>	Analyze Express based web development												-	-	-	1	-	-
<b>CO-5:</b>	Create a Mongodatabase for DDL commands												-	-	-	-	-	2

**Unit-1 - Basics of MERN Stack** **10 Hour**  
MERN Introduction-MERN Components - React - Node.js - Express - MongoDB - Need for MERN - Server-Less Hello World - Server Setup - nvm - Node.js npm. MongoDB - MongoDB Basics - Documents - Collections - Query Language - Installation - The mongo Shell - Schema Initialization - MongoDB Node.js Driver - Reading from MongoDB - Writing to MongoDB

**Tutorial:**

- Setting up MERN environment
- Simple programs in MERN environment
- Setting up MongoDB and handling data manipulation

**Unit-2 - React** **10 Hour**  
React Introduction - React ES6 - React Render HTML - React JSX - Components -React Classes - Composing Components - Passing Data - Dynamic Composition - React state - setting State - Async State Initialization - Event Handling Communicating from Child to Parent - Stateless Components - Designing components- React Forms - React CSS - React SaaS

**Tutorial:**

- REACT based programming
- Exploring stateless components

**Unit-3 - Node.js and Express** **10 Hour**  
Node.js basics - Local and Export Modules - Node Package Manager - Node.js web server - Node.js File system - Node Inspector - Node.js Event Emitter - Frameworks for Node.js. Express.js Web App - Serving static Resource - Node.js Data Access - Express REST APIs - REST - Resource Based - HTTP Methods as Actions - JSON- Express - Routing - Handler Function - Middleware-Rest API

**Tutorial:**

1. Node based web development Handling of various APIs associated with Node.js
2. Express based web development Handling of various APIs associated with Node.js

**Mini Project (Tentative Title):**

1. E-commerce Website
2. Food Delivery App
3. Social Media App
4. Chat Messaging App
5. Content Management System
6. Blog Site
7. Workout Tracker App
8. Project Management Dashboard

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Pro MERN Stack, Full Stack Web App Development with Mongo, Express, React, and Node, Vasan Subramanian, A Press Publisher, 2019.</li> <li>2. Bradshaw, S., Brazil, E., &amp; Chodorow, K. (2019). MongoDB: the definitive guide: powerful and scalable data storage. O'Reilly Media.</li> <li>3. Mardan, A. (2014). Express.js Guide: The Comprehensive Book on Express.js. Azat Mardan.</li> </ol>
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**Learning Assessment**

Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
	Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	40%	-	20%	-	40%	-	
Level 2	Understand	40%	-	20%	-	40%	-	
Level 3	Apply	10%	-	20%	-	10%	-	
Level 4	Analyze	10%	-	20%	-	10%	-	
Level 5	Evaluate	-	-	10%	-	-	-	
Level 6	Create	-	-	10%	-	-	-	
	Total	100 %		100 %		100 %		

**Course Designers**

<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
		1. Dr.P.Kanmani, SRMIST

# ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021



**SRM**

INSTITUTE OF SCIENCE & TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

<b>Course Code</b>	21CSC206P	<b>Course Name</b>	ADVANCED OBJECT ORIENTED AND PROGRAMMING	<b>Course Category</b>	C	PROFESSIONAL CORE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Explore JAVA compiler and build domain model for real-time programs												<b>PSC-1</b>			
<b>CLR-2:</b>	Apply the OOP concepts in JAVA programs												<b>PSC-2</b>			
<b>CLR-3:</b>	Utilize interfaces and packages in java applications												<b>PSC-3</b>			
<b>CLR-4:</b>	Develop java applications using collection interface and Array list class with exception handling															
<b>CLR-5:</b>	Design applications using Graphical User Interfaces and explore JDBC															
<b>Course Outcomes (CO):</b>		<b>At the end of this course, learners will be able to:</b>														
<b>CO-1:</b>	Infer the concepts of Object-Oriented Programming with JAVA												<b>PSC-1</b>			
<b>CO-2:</b>	Construct programs using Class and Inheritance												<b>PSC-2</b>			
<b>CO-3:</b>	Create interface and package in java programs												<b>PSC-3</b>			
<b>CO-4:</b>	Apply collection interface and Array list class in programs and explore multithreading															
<b>CO-5:</b>	Design and build simple Graphical User Interfaces and execute queries to store and retrieve data in database															

<b>Unit-1 - Introduction to Java</b>														<b>9 Hour</b>
Java programming Environment and Runtime Environment, Development Platforms -Standard, Enterprise. Java Virtual Machine (JVM), Java compiler, Bytecode, Java applet, Java Buzzwords, Java program structure, Comments, Garbage Collection, Lexical Issues. Primitive Data types -Type Conversion and Casting, Variables, Arrays, Strings, Vector class. -Operators -Control Statements-- Selection Statements, Iteration Statements and Jump Statements.														

<b>Tutorial:</b>	1. Simple JAVA program using control structures, arrays, and Vector Class	9 Hour
	2. Sum of series ( $1 + 2 + 3 + \dots + n$ , $1 + 1/2 + 1/3 + \dots + 1/n$ , $1^2 + 2^2 + 3^2 + \dots + n^2$ )	

<b>Unit-2 - Object Oriented Programming in Java</b>														<b>9 Hour</b>
Class Fundamentals, Declaring Objects, Object Reference, Introduction to Methods, Constructors, this Keyword, Method Overloading, Using Objects as Parameters, Returning Objects, Recursion, Access Control, Static Members, Final Variables, Inner Classes, Command Line Arguments, Variable Length Arguments. Inheritance - Super Class, Sub Class, The Keyword super, protected Members, Calling Order of Constructors, Method Overriding, the Object class, Abstract Classes, and Methods, using final with Inheritance.														

<b>Tutorial:</b>	1. Create Bank class with suitable methods to create objects as account holders	9 Hour
	2. Program with static members and final variable	

<b>Unit-3 - Packages and Interfaces</b>	<b>9 Hour</b>
Defining Package, CLASSPATH, Access Protection, Importing Packages, Interfaces. Exception Handling - Checked Exceptions, Unchecked Exceptions, try Block and catch Clause, Multiple catch clauses, Nested try Statements, throw, throws and finally Input/Output - I/O Basics, Reading Console Input, Writing Console Output, Print Writer Class, Object Streams and Serialization, Working with Files.	
<i>Tutorial:</i>	
1. Create and interface and implement it in a class 2. Create a package and import it in multiple classes	
<b>Unit-4 - Java Library</b>	<b>9 Hour</b>
String Handling – String Constructors, String Length, Special String Operations -Character Extraction, String Comparison, Searching Strings, Modifying Strings, using valueOf(), Comparison of StringBuffer and String.Collections framework - Collections overview, Collections Interfaces- Collection Interface, List Interface. Collections Class – ArrayList class. Accessing a Collection via an Iterator. Event handling - Event Handling Mechanisms, Delegation Event Model, Event Classes, Sources of Events, Event Listener Interfaces, Using the Delegation Model. Multithreaded Programming - The Java Thread Model, The Main Thread, Creating Thread, Creating Multiple Threads, Synchronization, Suspending, Resuming and Stopping Threads.	
<i>Tutorial:</i>	
1. Programs using Collection Interface and ArrayList Class 2. Programs to implement event handling and exception handling	
<b>Unit-5 - Swings Fundamentals</b>	<b>9 Hour</b>
Swing Key Features, Model View Controller (MVC), Swing Controls, Components and Containers, Swing Packages, Event Handling in Swings, Swing Layout Managers, Exploring Swings –JFrame, JLabel, The Swing Buttons, and JTextField. Java Data Base Connectivity (JDBC) - JDBC overview, Creating and Executing Queries – create table, delete, insert, select.	
<i>Tutorial:</i>	
1. Form Design with Swing 2. Program with Java Data Base Connectivity (JDBC)	

<b>Learning Resources</b>	1. Herbert Schildt, Java: The Complete Reference, 8/e, Tata McGraw Hill, 2011. 2. Rajib Mall, Fundamentals of Software Engineering, 4th edition, PHI, 2014. 3. Paul Deitel, Harvey Deitel, Java How to Program, Early Objects 11th Edition, Pearson, 2018.	4. Y. Daniel Liang, Introduction to Java Programming, 7/e, Pearson, 2013. 5. Nageswararao R., Core Java: An Integrated Approach, Dreamtech Press, 2008.
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Learning Assessment								
Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
	Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20% weightage)			
	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	-	20%	-	40%	-
Level 2	Understand	40%	-	-	20%	-	40%	-
Level 3	Apply	10%	-	-	20%	-	10%	-
Level 4	Analyze	10%	-	-	20%	-	10%	-
Level 5	Evaluate	-	-	-	10%	-	-	-
Level 6	Create	-	-	-	10%	-	-	-
	Total	100 %		100 %		100%		-

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.Harisekharan, Praya AI Lab		1. Dr.Paul T Sheeba . ,SRMIST 2. Dr.T.Karthick SRMIST

<b>Course Code</b>	21CSC307P	<b>Course Name</b>	MACHINE LEARNING FOR DATA ANALYTICS	<b>Course Category</b>	C	PROFESSIONAL CORE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<i>The purpose of learning this course is to:</i>	Program Outcomes (PO)												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understanding Human learning aspects.													<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Acquaintance with primitives in the learning process by computer.																
<b>CLR-3:</b>	Develop the linear learning models and classification in machine learning																
<b>CLR-4:</b>	Implement the clustering techniques and their utilization in machine learning																
<b>CLR-5:</b>	Implement the tree-based machine learning techniques and to appreciate their capability																
<b>Course Outcomes (CO):</b>		<i>At the end of this course, learners will be able to:</i>	1	2	3	4	5	6	7	8	9	10	11	12			
<b>CO-1:</b>	Demonstrate knowledge of learning algorithms and concept learning through implementation for sustainable solutions of applications.													PSO-1	PSO-2	PSO-3	
<b>CO-2:</b>	Evaluation of different algorithms on well formulated problems along with stating Valid conclusions that the evaluation supports.																
<b>CO-3:</b>	Formulate a given problem within the Bayesian learning framework with focus on Building lifelong learning ability.																
<b>CO-4:</b>	Analyze research-based problems using Machine learning techniques and apply different clustering algorithms used in machine learning to generic datasets and Specific multidisciplinary domains.													1	-	-	
<b>CO-5:</b>	Evaluate decision tree learning algorithms.													2	-	-	

<b>Unit-1 - Introduction and Types of Learning</b>																<b>9 Hour</b>
<i>Introduction: Machine Learning: What &amp; Why? - Examples of Machine Learning applications, Training versus Testing, Positive and Negative Class, Cross-validation. Types of Learning: Supervised, Unsupervised and Semi-Supervised Learning. The Curse of dimensionality-Over fitting and under fitting-Linear regression-Bias and Variance Tradeoff-Regularization-Learning Curve-Classification-Error and noise-Parametric vs. non-parametric models-Linear Algebra for machine learning</i>																
<i>T1: Building programs to work with the data pre-processing in python, T2: Building programs to work with linear regression in python, T3: Building programs to work with cross validation in Python</i>																

<b>Unit-2 - Design and Analysis of Machine Learning Algorithms</b>																<b>9 Hour</b>
<i>Guidelines for machine learning experiments, Cross Validation (CV) and resampling – K-fold CV, bootstrapping, measuring classifier performance, assessing a single classification algorithm, and comparing two classification algorithms – t test, McNemar's test, K-fold CV paired t test Performance metrics-MSE, accuracy, confusion matrix, precision, recall, F1-score-Linear Regression with multiple variables-Logistic Regression-spam filtering with logistic regression</i>																
<i>T4: Building programs to performance metrics in python, T5: Building programs work with linear regression with multiple variables in Python, T6: Building programs work with logistic regression in python</i>																

<b>Unit-3 - Distance Based Models</b>																<b>9 Hour</b>
<i>Ridge Regression-Maximum likelihood estimation (least squares)- Principal component analysis- K nearest neighbour classification –Gaussian Naive Bayes Classification-Multinomial Naïve Bayes classification- Bernoulli Naïve Bayes Classification-Comparison of Gaussian, Multinomial, Bernoulli naive bayes classification -Support vector machine-Support vector machine + kernels-Multi class classification- Application: face recognition with PCA.</i>																
<i>T7: Building python programs to use principal component analysis, T8: Building python programs to use Naïve Bayes classification, T9: Building programs to use Support Vector Machine</i>																

<b>Unit-4 - Clustering Techniques</b>	<b>9 Hour</b>
Measuring (dis)similarity-Evaluating output of clustering methods-Spectral Clustering-Hierarchical Clustering-Agglomerative Clustering-Divisive Clustering-Choosing the number of clusters-Clustering data points and features-Bi-clustering-multi-view clustering-K-Means clustering-K-medoids clustering-Application: image segmentation using K-means clustering	
T10: Building programs to implement Hierarchical clustering , T11: Building programs to implement K-Means clustering, T12: Building programs to perform cluster evaluation	
<b>Unit-5 - Tree Based Models</b>	<b>9 Hour</b>
Decision tree representation-Basic decision tree learning algorithm-Inductive bias in decision tree Decision tree construction-Issues in decision tree-Classification and regression trees (CART)- Random Forest-Random Forest with scikit-learn Minority Class, Impurity Measures – Gini Index and Entropy, BestSplit -Multivariate adaptive regression trees (MART)-Introduction to Artificial Neural Networks-Perceptron learning	
T13: Building programs to implement decision tree algorithm, T14: Building programs to implement random forest algorithm , T15: Building programs to implement Artificial Neural Networks	

<b>Learning Resources</b>	1. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, Fourth Edition, 2020. 2. Stephen Marsland, "Machine Learning: An Algorithmic Perspective, "Second Edition", CRC Press, 2014. 3. Kevin P. Murphy, —Machine learning: A Probabilistic Perspectivell, MIT Press, 2012.	4. Tom Mitchell, "Machine Learning", McGraw-Hill, 1997. Sebastian Raschka, Vahid Mirjalili,   Python Machine Learning and deep learning  , 2nd edition, kindle book, 2018 5. Carol Quadros,   Machine Learning with python, scikit-learn and Tensorflowll, Packet Publishing, 2018. 6. Gavin Hackeling,    Machine Learning with scikit-learn  , Packet publishing, O'Reilly, 2018.
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Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
	Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20% weightage)			
	Theory	Practice	Theory	Practice	Theory	Practice		
Level 1	Remember	15%	-	-	15%	-	15%	
Level 2	Understand	25%	-	-	20%	-	25%	
Level 3	Apply	30%	-	-	25%	-	30%	
Level 4	Analyze	30%	-	-	25%	-	30%	
Level 5	Evaluate	-	-	-	10%	-	-	
Level 6	Create	-	-	-	5%	-	-	
	Total	100 %		100 %		100 %		

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. E Nagarajan, R&D Head, Solvedge Technology	1. Dr. Anandhakumar P Professor, Madras Institute of Technology, Chrompet	1. Dr.M.Lakshmi, SRMIST 2. Dr.Shobanadevi, SRMIST

# ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021



**SRM**  
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**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

**(Deemed to be University u/s 3 of UGC Act, 1956)**

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

<b>Course Code</b>	21CSE222T	<b>Course Name</b>	BIG DATA TOOLS AND TECHNIQUES	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>																	
<b>CLR-1:</b>	Gain knowledge about the various tools and techniques used in big data analytics																														
<b>CLR-2:</b>	Learn the fundamentals of Hadoop and the related technologies																														
<b>CLR-3:</b>	Understand the basics of development of applications using MapReduce, HDFS, YARN																														
<b>CLR-4:</b>	Learn the basics of Pig, Hive and Sqoop																														
<b>CLR-5:</b>	Learn the basics of Apache Spark, Flink and understand the importance of NoSQL databases																														
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>	<b>Program Outcomes (PO)</b>																														
<b>CO-1:</b> Use the various tools and techniques in big data analytics	-	-	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3															
<b>CO-2:</b> Apply Hadoop and related technologies to big data analytics	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-														
<b>CO-3:</b> Apply MapReduce, HDFS and YARN develop big data applications	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-														
<b>CO-4:</b> Develop applications using Pig, Hive and Sqoop	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-														
<b>CO-5:</b> Apply Apache Spark and Flink to applications and understand the importance of NoSQL databases	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-														

<b>Unit-1 - Overview of Big Data Analytics</b>	<b>9 Hour</b>
Introduction to data analytics and big data-Big data mining-Technical elements of the Big Data platform, Analytics Toolkit, Components of the analytics toolkit -Distributed and Parallel Computing for Big Data-Cloud computing and Big Data-In-Memory Computing Technology for Big Data-Fundamentals of Hadoop-Hadoop Ecosystem-The core modules of Hadoop-Introduction to Hadoop MapReduce-Introduction to Hadoop YARN.	

<b>Unit-2 - Big Data Frame Work</b>	<b>9 Hour</b>
MapReduce-Analyzing data with Unix tools and Hadoop-Scaling Out – Data Flow, CombinerFunctions-Hadoop Streaming-HDFS-Hadoop filesystems-Java Interface to Hadoop-YARN-Job Scheduling-Hadoop I/O-Data Integrity-Compression-Serialization-File based Data Structures-Developing a MapReduce Application.	

<b>Unit-3 - Big Data Ecosystem</b>	<b>9 Hour</b>
Setting up a Hadoop Cluster-Cluster specification and setup-Hadoop configuration-YARN configuration-Introduction to Pig-Installing and running pig-Basics Pig Latin -Example Programs-Introduction to Hive-Installing and running Hive-Introduction to HiveQL-Create-Drop-Alter-order by-Group by-Joins-Introduction to Zookeeper-Installing and running Zookeeper-Creating different types of Znodes-Flume Architecture-Introduction to Sqoop.	

<b>Unit-4 - Database in Big Data Framework</b>	<b>9 Hour</b>
Introducing Oozie-Apache Spark-Limitations of Hadoop and overcoming the Limitations-Core components and architecture of Spark-Introduction to Apache Flink-Installing Flink-Batch analytics using Flink-Big Data Mining with NoSQL-Why NoSQL? -NoSQL databases-Introduction to MongoDB,-Basi queries in MongoDB-Introduction to Cassandra.	

<b>Unit-5 - Visualization</b>	<b>9 Hour</b>
Enterprise Data Science Overview-Data Science Solutions in the enterprise-Enterprise data science – Machine Learning and AI-Enterprise Infrastructure Solutions-Visualizing Big Data-Using Python and R for visualization-Big Data Visualization Tools-Data Visualization with Tableau-Case Studies: Hadoop-Case Studies: Spark-Case Studies: NoSQL.	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>Herbert Schildt, 'C++ - T Bjarne Stroustrup, 'The C++ Programming Language', Addison Wesley, 2000.</li> <li>The Complete Reference', Tata McGraw Hill, 1997.</li> <li>Herbert Schildt, -Java The complete reference, 8th Edition, McGraw Hill Education, 2011</li> <li>Kris Jasma, 'Java Programming – A Complete Reference', Galgotia publication, 1994.</li> <li>Cay S. Horstmann, Gary Cornell, -Core Java Volume -I Fundamentals, 9th Edition, Prentice Hall, 2013.</li> </ol>
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	50%	-	50%	-	50%	-		
Level 2	Understand	50%	-	50%	-	50%	-		
Level 3	Apply	-	-	-	-	-	-		
Level 4	Analyze	-	-	-	-	-	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.R. SivaKumar,Sr. Consultant,rsivakumar@gmail.com A2O Integrated services Pvt., Ltd., Chennai	1. Dr.S Muthurajkumar, Asst. Professor, Department of Computer Technology, muthurai@annauniv.edu, MIT Campus, Anna University, Chromepet, Chennai-600044.	1. Mrs.S.Sindhu, SRMIST

<b>Course Code</b>	21CSE224T	<b>Course Name</b>	COMPUTER ARCHITECTURE	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 3	T 0	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the Fundamentals of computers, Memory operations and Addressing Modes												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Know about Functions of Arithmetic and Logic unit															
<b>CLR-3:</b>	Explore the Operations of Control Unit, Execution of Instruction and Pipelining															
<b>CLR-4:</b>	Classify the Need for Parallelism, Multicore and Multiprocessor Systems															
<b>CLR-5:</b>	Understand the Concepts and functions of Memory unit, I/O unit															
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Identify the computer hardware and how software interacts with computer hardware												2	1	1	1
<b>CO-2:</b>	Apply Boolean algebra as related to designing computer logic, through simple combinational and sequential logic circuits												2	2	1	-
<b>CO-3:</b>	Examine the detailed operation of Basic Processing units and the performance of Pipelining												2	3	1	-
<b>CO-4:</b>	Analyze concepts of parallelism and multi-core processors.												2	3	1	-
<b>CO-5:</b>	Classify the memory technologies, input-output systems and evaluate the performance of memory system												2	2	1	-

**Unit-1 - Introduction to Number System and Logic Gates** 9 Hour  
Number Systems- Binary, Decimal, Octal, Hexadecimal; Codes- Grey, BCD, Excess-3, ASCII, Parity; Binary Arithmetic- Addition, Subtraction, Multiplication, Division using Sign Magnitude, 1's compliment, 2's compliment, BCD Arithmetic; Logic Gates-AND, OR, NOT, NAND, NOR, EX-OR, EX-NOR.

**Unit-2 - Basic Structure of Computers** 9 Hour  
Functional Units of a computer, Operational concepts, Bus structures, Memory addresses and operations, assembly language, Instructions, Instruction sequencing, Addressing modes. Case study: 8086. Design of ALU: De Morgan's Theorem, Adders, Multiplier – Unsigned, Signed, Fast, Carry Save Addition of summands; Division–Restoring and Non-Restoring; IEEE 754 Floating point numbers and operations.

**Unit-3 - Control Unit** 9 Hour  
Basic processing unit, ALU operations, Instruction execution, Branch instruction, Multiple bus organization, Hardwired control, Generation of control signals, Micro-programmed control; Pipelining: Basic concepts of pipelining, Performance, Hazards-Data, Instruction and Control, Influence on instruction sets

**Unit-4 - Types of Memories** 9 Hour  
Need for a hierarchical memory system – Cache memories- Memory Mapping – Improving Cache Performance – Virtual Memory – Memory Management Techniques – Accessing I/O devices – Programmed Input/output – Interrupts – Direct Memory Access.

**Unit-5 - Parallelism** 9 Hour  
Need, types, applications & challenges, Architecture of Parallel Systems-Flynn's classification – Optimization techniques for Parallel Structures; ARM Processor: The thumb instruction set, Processor and CPU cores, Instruction Encoding format, Memory load and Store instruction, Basics of I/O operations. Case study: ARM 5 ,ARM 7 and ARM Neon Architecture

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>Carl Hamacher, ZvonkoVranesic, SafwatZaky, Computer Organization,5thed., McGraw-Hill, 2015</li> <li>KaiHwang, FayeA.Briggs, Computer Architecture and Parallel Processing",3rd ed. McGraw Hill, 2016</li> <li>GhoshT.K.,Computer Organization and Architecture,3rded.,TataMcGraw-Hill,2011</li> <li>P.Hayes,Computer Architecture and Organization,3rded.,McGrawHill,2015.</li> <li>William Stallings, Computer Organization and Architecture—Designing for Performance,10thed.,Pearson Education,2015</li> <li>DavidA.Patterson and JohnL. Hennessy Computer Organization and Design-A Hardware software interface,5thed.,Morgan Kaufmann,2014</li> <li>Neon – Arm@<a href="https://www.arm.com">https://www.arm.com</a> &gt; technologies &gt; neon</li> <li>Neon - Arm Developer<a href="https://developer.arm.com">https://developer.arm.com</a> &gt; Architectures &gt; Neon</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>	
<b>Bloom's Level of Thinking</b>	<b>Formative CLA-1 Average of unit test (50%)</b>	<b>Life-Long Learning CLA-2 (10%)</b>					
		<b>Theory</b>	<b>Practice</b>	<b>Theory</b>	<b>Practice</b>	<b>Theory</b>	<b>Practice</b>
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	<b>Total</b>	<b>100 %</b>		<b>100 %</b>		<b>100 %</b>	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
	<ol style="list-style-type: none"> <li>Dr S.Janakiraman, Pondicherry University</li> <li>Dr P.Thiyagarajan, Rajiv Gandhi National Institute of Youth Development</li> </ol>	<ol style="list-style-type: none"> <li>Dr M.Lakshmi, SRMIST</li> <li>Dr G Vadivu, SRMIST</li> </ol>

<b>Course Code</b>	21CSE321T	<b>Course Name</b>	DATA WAREHOUSING AND DATA MINING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		Program Outcomes (PO)												<b>Program Specific outcomes</b>			
1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3			
CLR-1:	The purpose of learning this course is to:																
<b>CLR-2:</b>	Introduce the concepts of Data Warehousing, difference between database and data warehousing.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<b>CLR-3:</b>	Describe OLAP Model and the Star Schema to design a Data Warehouse.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<b>CLR-4:</b>	Introduce data mining principles and techniques.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<b>CLR-5:</b>	Introduce data mining as a cutting-edge business intelligence tool.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<b>CLR-6:</b>	Develop and apply critical thinking, problem solving and decision-making skills.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<b>Course Outcomes (CO):</b>		At the end of this course, learners will be able to:															
<b>CO-1:</b>	Design and implement a quality data warehouse or data mart effectively and administer the data resources in such a way that it will truly meet management's requirements.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
<b>CO-2:</b>	Learn OLAP operations and data warehousing tools.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
<b>CO-3:</b>	Use data mining tools for projects and to be familiar with open-source tool	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
<b>CO-4:</b>	Evaluate standards and new technologies to determine their potential impact.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
<b>CO-5:</b>	Use data mining tools for projects and to build reliable products as per demand.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-

<b>Unit-1 - Data Warehousing</b> <span style="float: right;">9 Hour</span>																
Overview, Definition, Delivery Process, Difference between Database System and Data Warehouse, Multi-Dimensional Data Model, Data Cubes, Stars, Snow Flakes, Fact Constellations, Concept hierarchy, Process Architecture, 3 Tier Architecture, Data Marting.																
Tutorial:																
T1: Create SnowSQL login in open-Source environment																
T2: Creation of Snowflake Objects																
T3: Use Time travel feature in snowflake																
<b>Unit-2 - OLAP</b> <span style="float: right;">9 Hour</span>																
Aggregation, Historical information, Query Facility, OLAP function and Tools. OLAP Servers, ROLAP, MOLAP, HOLAP, Data Mining interface, Security, Backup and Recovery, Tuning Data Warehouse, Testing Data Warehouse.																
Tutorial:																
T4: Implementation of OLAP operations – Roll up, Drill Down																
T5: Implementation of OLAP operations – Slice and dice																
T6: Implementation of OLAP operations – Rotate																

<b>Unit-3 - Overview of Data Mining</b>	<b>9 Hour</b>
Data Mining-Definition & Functionalities, Data Processing, Form of Data Preprocessing, Data Cleaning: Missing Values, Noisy Data, Inconsistent Data, Data Integration and Transformation. Data Reduction: - Data Cube Aggregation, Dimensionality reduction, Data 35 Compression, Numerosity Reduction, Clustering, Discretization and Concept hierarchy generation. Overview of open-source tool - Orange	
Tutorial: T7: Data Cleaning on Data Set using Orange T8: Data Reduction on Data Set using Orange T9: Data Transformation using Orange	
<b>Unit-4 - Concept Description</b>	
Definition, Data Generalization, Analytical Characterization, Analysis of attribute relevance, Mining Class comparisons, Statistical measures in large Databases. Measuring Central Tendency, Measuring Dispersion of Data, Graph Displays of Basic Statistical class Description, Mining Association Rules in Large Databases, Association rule mining- Apriori Algorithm.	
Tutorial: T10: Generate Association Rules using the Apriori Algorithm using orange T11: Demonstrate Statistical Analysis on Dataset using Orange T12: Demonstrate performing Regression on data sets	
<b>Unit-5 - Cluster Analysis</b>	
Cluster Analysis: Data types in cluster analysis, Categories of clustering methods, Partitioning methods. Hierarchical Clustering- CURE and Chameleon, Density Based Methods-DBSCAN, OPTICS, Grid Based Methods- STING, CLIQUE, Model Based Method –Statistical Approach, Outlier Analysis	
Tutorial: T13: Implementation of Outlier Analysis using orange tool T14: Implementation of k-means algorithm for Iris Dataset using orange tool T15: Demonstration of clustering rule process on data-set iris.arff using simple k-means using orange tool.	

<b>Learning Resources</b>	1. H.Dunham,"Data Mining: Introductory and Advanced Topics" Pearson Education. 2. Sam Anahory, Dennis Murray, "Data Warehousing in the Real World: A Practical Guide for Building Decision Support Systems, Pearson Education.	3. Jiawei Han, Micheline Kamber, "Data Mining Concepts & Techniques" Elsevier. 4. Mallach, "Data Warehousing System", McGraw –Hill. 5. <a href="https://orangedatamining.com/">https://orangedatamining.com/</a>
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Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	20%	-	40%
Level 2	Understand	40%	-	20%	-	40%
Level 3	Apply	10%	-	20%	-	10%
Level 4	Analyze	10%	-	20%	-	10%
Level 5	Evaluate	-	-	10%	-	-
Level 6	Create	-	-	10%	-	-
	Total	100 %		100 %		100 %

<b>Course Designers</b>		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts

1. Dr.P.Kanmani, SRMIST

<b>Course Code</b>	21CSE322T	<b>Course Name</b>	MULTIVARIATE TECHNIQUES FOR DATA ANALYTICS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Utilize data characteristics in the form of distribution of the data structures												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Learn the statistical data reduction techniques															
<b>CLR-3:</b>	Understand the usage of multivariate techniques for the problem under the consideration.															
<b>CLR-4:</b>	Draw valid inferences and to plan for future investigations															
<b>CLR-5:</b>	Optimize the different solutions that maximize returns and minimize cost															
<b>Course Outcomes (CO):</b>		<b>At the end of this course, learners will be able to:</b>														
<b>CO-1:</b>	Understand the characteristics of data and its properties												-	1	-	-
<b>CO-2:</b>	Effectively select and use the data reduction techniques												-	-	-	2
<b>CO-3:</b>	Deploy the multivariate techniques to solve the real-world problems												-	-	-	2
<b>CO-4:</b>	Acquire information and inferences from data to predict future output												-	-	-	2
<b>CO-5:</b>	Achieve optimal solutions that maximize returns												-	-	-	1

<b>Unit-1 - Introduction to Multivariate Analysis</b>	<b>9 Hour</b>
Meaning of Multivariate Analysis - Measurements Scales - Metric measurement scales and non-metric measurement scales - Classification of multivariate techniques – Dependence Techniques - Inter-dependence Techniques - Applications of multivariate techniques - Applications of multivariate techniques -Examples - Applications of multivariate techniques – Demo and Examples.	
T1: Exploration of data sets and characteristics in PYTHON	
T2: Implementation of dependent and interdependence techniques in PYTHON	
T3: Explore scope of multivariate analytics in different applications using PYTHON	
<b>Unit-2 - Factor Analysis</b>	<b>9 Hour</b>
Factor Analysis Introduction - Meanings, Objectives – Assumptions - Designing a factor analysis - Designing a factor analysis – Example - Designing a factor analysis – Demo – Deriving factors and assessing overall factors - Interpreting the factors and validation of factor analysis - Interpreting the factors and validation of factor analysis – Demo and Examples.	
T4: Implementation of factor analysis in PYTHON	
T5: Interpreting and Validating factor analysis in PYTHON	
<b>Unit-3 - Cluster Analysis</b>	<b>9 Hour</b>
Cluster Analysis Introduction - Objectives and Assumptions - Research design in cluster analysis - Deriving clusters - Assessing overall fit - Deriving clusters – Demo and examples - Hierarchical methods - Non-Hierarchical Methods – Combinations. T7: Implement Django framework using python – creating basic Django App	
T6: Implementation of cluster analysis in PYTHON	
T7: Interpretation and Validation of cluster analysis in PYTHON and R	

<b>Unit-4 - Discriminant Analysis</b>	<b>9 Hour</b>
Linear Programming problem Introduction - Linear Programming problem Applications - Formulation of LPP - Graphical method - Simplex method - Graphical and simplex methods – Problems, examples and demo - Graphical and Simplex - Integer Programming - Transportation problem - Assignment problem	
T10: Formulating a LPP in PYTHON from a data set	
T11: Solving LPP in PYTHON – Graphical and Simplex	
T12: Implementation of transportation of assignment problem in PYTHON.	
<b>Unit-5 - Visualization</b>	<b>9 Hour</b>
Linear Programming problem Introduction - Linear Programming problem Applications - Formulation of LPP - Graphical method - Simplex method - Graphical and simplex methods – Problems, examples and demo - Graphical and Simplex - Integer Programming - Transportation problem - Assignment problem	
T10: Formulating a LPP in PYTHON from a data set	
T11: Solving LPP in PYTHON – Graphical and Simplex	
T12: Implementation of transportation of assignment problem in PYTHON.	

<b>Learning Resources</b>	1. Joseph F Hair, William C Black etal, "Multivariate Data Analysis" (2016). , "Multivariate Data Analysis". Pearson Education, 7th edition, 2. Anderson, T.W., 2003. "An introduction to statistical multivariate analysis", 3rd Edition", Wiley. 3. Dillon, W.R. and Goldstein, M., 1984. Multivariate analysis: Methods and applications. New York (NY): Wiley.	4. Malhotra, N.K. and Dash, S., 2011. Marketing Research: An Applied Orientation (; Pearson, Ed.). 5. Hamdy A Taha, (2012) "Operations Research", Pearson, 8th Edition. 6. S. R. Yadav, A. K. Malik (2014) "Operations Research", Oxford University Press. 7. <a href="https://python-for-multivariate-analysis.readthedocs.io/">https://python-for-multivariate-analysis.readthedocs.io/</a> "A Little Book of Python for Multivariate Analysis"
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Learning Assessment						
Bloom's Level of Thinking	Continuous Learning Assessment (CLA)					Summative Final Examination (40% weightage)
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	20%	-	40%
Level 2	Understand	40%	-	20%	-	40%
Level 3	Apply	10%	-	20%	-	10%
Level 4	Analyze	10%	-	20%	-	10%
Level 5	Evaluate	-	-	10%	-	-
Level 6	Create	-	-	10%	-	-
	Total	100 %		100 %		100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mrs.Sivasankari.S , Freelance Software consultancy on Big data, analytics	1. Dr.JeyaShree, Professor, Rajalakshmi Institute of Technology	1. Dr.A.Shobanadevi, SRMIST

<b>Course Code</b>	21CSE323T	<b>Course Name</b>	MARKETING ANALYTICS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>								
<b>CLR-1:</b>	The purpose of learning this course is to:												<b>PSC-1</b>	<b>PSC-2</b>	<b>PSC-3</b>							
<b>CLR-1:</b>	Learn to build brand architecture on brand value	1	Problem Analysis	2	Design/development of solutions	3	Conduct investigations of complex problems	4	Modern Tool Usage	5	The engineer and society	6	Environment & Sustainability	7	Ethics	8	Individual & Team Work					
<b>CLR-2:</b>	Know to create functions to access and manipulate numbers, strings and date time data	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	3	-	-	1	-	-
<b>CLR-3:</b>	Know the emphasis on scaling for brands	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	3	-	-	2	-	-
<b>CLR-4:</b>	Utilize the information for strategic marketing alternatives	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	2	-	-
<b>CLR-5:</b>	Explore the experiments for digital marketing efforts	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
<b>Course Outcomes (CO):</b>	At the end of this course, learners will be able to:	9	Communication	10	Project Mgt. & Finance	11	Life Long Learning	12														
<b>CO-1:</b>	analyse user Generated Contents	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	3	-	-	1	-	-
<b>CO-2:</b>	analyse the digital products	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	3	-	-	2	-	-
<b>CO-3:</b>	understand customer Lifetime Value	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
<b>CO-4:</b>	analyse the marketing with ML models	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	2	-	-
<b>CO-5:</b>	communicate with digital analytics	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-

#### **Unit-1 - User Generated Contents** 9 Hour

Marketing Analytics, Data for Marketing Analytics, Business Intelligence, Analytics, and Data Science, Analysis, Exploratory Data Analysis, Descriptive Analysis, Predictive Analytics, Prescriptive Analytics, Benefits of Customer Analytics, Factors Essential for Obtaining Benefits from Customer Analytics, Segmentation Analytics, Cluster Analysis.

T1: Data for Marketing Analytics

T2: Predictive Analysis

T3: Segmentation and cluster analysis

#### **Unit-2 - Product Analysis** 9 Hour

Product Analytics, Perceptual Mapping, White Spaces, Umbrella Brands, Multidimensional Scaling, Analyzing Digital Products, Analyzing Non-Digital Products,

T4: Product analysis

T5: Multimodel scaling

T5: Digital and Non - digital Products

#### **Unit-3 - Customer Lifetime Value** 9 Hour

Customer Lifetime Value (CLV), Calculating CLV, Understanding the CLV Formula, Applying the CLV Formula, Extending the CLV Formula, Using CLV to Make Decisions, A Forward-Looking Measure.

T7: Customer Lifetime Value (CLV)

T5: Applying the CLV Formula,

T6: Using CLV to Make Decisions

#### **Unit-4 - Market Analysis** 9 Hour

Market Mix Modeling, Variables in Market Mix Modeling, Techniques of Market Mix Modeling, Metrics for Tracking Customer Experience, Upgrading Customers: Use Case of Upselling, Logistic Regression Analysis, Use of Logistic Regression as a Classification Technique

T10: Regression Analysis

T11: Multivariable Regressions

T12: Marketing Mix Models

#### **Unit-5 - Digital Analytics**

**9 Hour**

Search Engine Marketing, Search Engine Optimization, Social Media Analytics, App Marketing Metrics, Importance of AI in Marketing, Random Forests, Model Evaluation Using ROC, AUC, and Confusion Matrix, Simple Feed-Forward Network, Deep Neural Network, Recommendation Systems, Necessity of Data Visualization, Visualizations Useful with Common Data Science Techniques

T13: Search Engine Marketing

T14: AI in Marketing

T15: Data Visualization Techniques

<b>Learning Resources</b>	1. Seema Gupta, Avadhoot Jathar, "Marketing Analytics", ISBN: 97893542625 2. Brea Cesar (2014), "Marketing and Sales Analytics: Proven Techniques and Powerful Applications from Industry Leaders", FT Press, ISBN-0133761711 3. Emmett Cox (2012), "Retail Analytics: The Secret Weapon", Wiley, ISBN- 978-1-118-09984-1  4. Fok Dennis (2003), "Advanced Econometric Marketing Models", ERIM, ISBN 90-5892-049-6 5. Mireles Carlos Hernández (2010), "Marketing Modeling for New Products", ERIM, ISBN 978-90-5892-237-3 6. Rackley Jerry (2015), "Marketing Analytics Roadmap: Methods, Metrics, and Tools", Apress, ISBN-1484202597
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Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	40%	-	20%	-	40%	-		
Level 2	Understand	40%	-	20%	-	40%	-		
Level 3	Apply	10%	-	20%	-	10%	-		
Level 4	Analyze	10%	-	20%	-	10%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	10%	-	-	-		
Total		100 %		100 %		100 %			

#### **Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
2. Dr.K.Jafar Ali MBA, Ph.D. Consultant, iSpark Learning Solutions, Chennai.	2. Angeline Gautami Fernando, Associate Professor (Marketing & Analytics) at Great Lakes Institute of Management	2. Dr. R. Rajkumar, SRMIST

<b>Course Code</b>	21CSE325T	<b>Course Name</b>	APPLIED SOCIAL NETWORK ANALYSIS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand mathematical concepts of a network and centrality												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Find the importance of social influence												-	-	-	
<b>CLR-3:</b>	Know about balance networks												-	-	2	
<b>CLR-4:</b>	Learn the concepts and methods of social networks												-	-	-	
<b>CLR-5:</b>	Understand about the algorithms related to web graph searching												-	-	2	
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>												-	-	1	
<b>CO-1:</b>	Find the important node in each graph network												-	-	-	
<b>CO-2:</b>	Implement to find communities in the graph network												-	-	2	
<b>CO-3:</b>	Convert unstable to stable network												-	-	-	
<b>CO-4:</b>	Detecting the communities in the network												-	-	2	
<b>CO-5:</b>	Code page ranking algorithms for web graph												-	-	1	

<b>Unit-1 - Introduction to Social Network</b>	<b>9 Hour</b>
SNA Introduction - Basic Network Concepts, Adjacency Matrices, Graphs, and Notation, Nodes and Links – Centrality Measures - “What is “Centrality” and why do we Study IT, Calculating Nodal Centrality Measures, Directed Networks and Centrality Measures, Location in the Network - Graph Level Measures – Density, Diameter, Centralization, Average Centralities, Network Topology.	
T1: Introduction to networks	
T2: Finding connectedness of a graph	
T3: Implementation of centrality measures	
<b>Unit-2 - SNA Algorithms</b>	<b>9 Hour</b>
SNA Algorithms -Node assortativity coefficients and correlation measures, Directed Acyclic Graphs & Topological Sort, Dinitz's algorithm and its applications, Euler's Algorithm – Graph Generators - Geometric Generator Models, Sudoku, and Graph coloring.	
T4: Calculate the assortativity coefficient	
T5: Implement programs for Directed Acyclic Graphs & Topological Sort	
T6: Implement Maximum flow problem	
<b>Unit-3 - Establishing Stable Networks</b>	<b>9 Hour</b>
Exploring Social Networking Data Sets - Establishing a Social Network, Connectivity of Users in Social Networks, Case Study of Facebook. Signed Networks - unstable network to stable network	
T7: Code to find unstable network	
T8: Find the number of unstable triangles	
T9: Solution to convert unstable into stable network	

<b>Unit-4 - Communities in the Network</b>	<b>9 Hour</b>
Community Detection - Strength of Weak Ties, Triadic Closure, Detecting Communities in a Network, Girvan-Newman Algorithm Modularity, Minimum Cut Trees, Tie Strengths in Mobile Communication Network, Exact Betweenness Centrality	
T10: Detect the communities in the graph	
T11: Code for Triadic Closure	
T12: Explore the strong and weak ties in the network	
<b>Unit-5 - Link Analysis in Web</b>	<b>9 Hour</b>
The Structure of the Web - The World Wide Web, Information Networks, Hypertext, and Associative Memory, The Web as a Directed Graph, The Bow-Tie Structure of the Web, The Emergence of Web - Link Analysis and Web Search - Searching the Web: The Problem of Ranking, Link Analysis Using Hubs and Authorities, PageRank, Applying Link Analysis in Modern Web Search – Power Law.	
T13: Implement points distribution method	
T14: Code for random walk method	
T15: Explore the tools related to SNA	

<b>Learning Resources</b>	1. Ian McCulloh (2013), Social Network Analysis with Applications, Wiley 2. <a href="https://networkx.org/nx-guides/index.html">https://networkx.org/nx-guides/index.html</a> 3. Edited by Mohammad Gouse Galety Chiai Al Atroshi Bunil Kumar Balabantaray and Sachin Nandan Mohanty (2022), Social Network Analysis, Theory and Applications, Wiley	4. Krishna Raj P. M., Ankith Mohan, and K. G. Srinivasa (2018), Practical Social Network Analysis with Python, Springer. 5. David Easley Cornell University Jon Kleinberg Cornell University (2010), Networks, Crowds, and Markets Reasoning about a Highly Connected World Cambridge University Press.
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Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	40%	-	20%	-	40%	-		
Level 2	Understand	40%	-	20%	-	40%	-		
Level 3	Apply	10%	-	20%	-	10%	-		
Level 4	Analyze	10%	-	20%	-	10%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	10%	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mrs.Sivasankari.S , Freelance Software consultancy on Big data, analytics	1. Dr.A.Bhuvaneswari, Professor, VIT, School of Computer Science and Engineering,Chennai	1. Dr.G.Vadivu, SRMIST

<b>Course Code</b>	21CSE326T	<b>Course Name</b>	ARTIFICIAL NEURAL NETWORKS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the biological background and basic concepts of neural networks												<b>PSO-1</b>			
<b>CLR-2:</b>	Gain knowledge about perceptron and back propagation												<b>PSO-2</b>			
<b>CLR-3:</b>	Know about various training rules and error minimization												<b>PSO-3</b>			
<b>CLR-4:</b>	Learn the concepts of unsupervised neural networks															
<b>CLR-5:</b>	Explore the fine-tuning procedures and case studies for designing neural network models															
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Explain the basic concepts of neural networks															<b>1</b>
<b>CO-2:</b>	Describe perceptron and back propagation															<b>2</b>
<b>CO-3:</b>	Apply various training rules in neural networks															<b>2</b>
<b>CO-4:</b>	Explain unsupervised neural networks															<b>1</b>
<b>CO-5:</b>	Fine tune the neural networks															

<b>Unit-1 - Introduction to Neural Networks</b>																
<b>9 Hour</b>																
History of neural network research- Biological inspiration: Neural computation, Models of computation, Elements of computing models- Network of neurons: structure, Information processing at neurons and synapses, Information storage, Neurons as self-organizing systems- Artificial Neural Networks: Network of primitive functions, approximation of functions- Neuron Model: Single and multiple input neurons, Transfer functions- Network architectures: Single layered and multi layered neurons, Recurrent Networks																
Tutorials:																
3. Implement various neural network architectures 4. Implement and study the effect of various activation functions																
<b>Unit-2 - Perceptron</b>																
<b>9 Hour</b>																
Introduction to Perceptron- Perceptron Architecture: Single Neuron Perceptron, Multi Neuron Perceptron- Perceptron learning rule: Constructing Learning rules, Unified Learning rule, Training multi neuron perceptron- Complexity of perceptron learning-Computational Limits of Perception-Linearity separable functions- Learning XOR-Feed forward Networks- Back propagation: Chain of rule Calculus, Back-Propagation Computation in Fully-Connected Multi-layer Perceptron																
Tutorials:																
3. Implement Feed forward networks 4. Implement back propagation																

<b>Unit-3 - Learning and Training</b>	<b>9 Hour</b>
Paradigms of Learning - Using training samples - Gradient Optimization Procedure- Batch Gradient Descent, Stochastic Gradient Descent, Mini-Batch Gradient Descent - Hebbian learning rule – Delta learning rule- Convergence and local minima, representational power of feed forward networks, hypothesis search space and inductive bias, generalization, overfitting and stopping criterion-Error functions, Error minimizing procedures-Hebbian learning	
Tutorials:	
5. Implementation of gradient descent 6. Implementation of delta learning rule	
<b>Unit-4 - Unsupervised Neural Networks</b>	<b>9 Hour</b>
Unsupervised learning in neural networks: Hebbian learning rule, Principle Component Learning, Learning Vector Quantizer-I- Self Organizing Maps: Functionality, Training, Topology Function, Decreasing Learning Rate, Variations of SOMs, Neural gas, Multi-SOM, Multi-neural gas, Growing neural gas- Adaptive Resonance Theory, Orienting subsystems, Learning Laws	
7. Implementation of Principle Component analysis 8. Implementation of Self Organizing Maps	
<b>Unit-5 - Tuning the Neural Networks</b>	<b>9 Hour</b>
Pretraining the model: Data selection, Preprocessing, Selection of network architecture- Training the network: Initializing weights, Choice of training algorithm, stopping criteria, Choice Of performance function, Committees of Networks-Post Training Analysis: Fitting, Pattern Recognition, Clustering- Time delay and Recurrent Neural Networks-Case Studies: Smart Sensor system with function approximation- Myocardial Infarction Recognition using pattern recognition-Forest cover problem using Clustering	
<b>Learning Resources</b>	1. Martin T. Hagan, Neural Network Design, 2nd edition. 2. Tom M. Mitchell, Machine Learning, McGraw-Hill Education (India) Private Limited. 3. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT Press, 2016 4. Andries P., Computational Intelligence: An Introduction, Second Edition, Wiley, 2007 5. David Kriesel, A Brief Introduction to Neural Networks, 2009

<b>Learning Assessment</b>							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice		
Level 1	Remember	20%	-	20%	-	20%	
Level 2	Understand	20%	-	20%	-	20%	
Level 3	Apply	30%	-	30%	-	30%	
Level 4	Analyze	30%	-	30%	-	30%	
Level 5	Evaluate	-	-	-	-	-	
Level 6	Create	-	-	-	-	-	
	Total	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
		2. Dr. Sharanya, SRMIST

<b>Course Code</b>	21CSE327T	<b>Course Name</b>	CLOUD COMPUTING FOR DATA ANALYTICS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Comprehend fundamentals of cloud application development												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Deployment of Cloud Applications using Cloud Native Services															
<b>CLR-3:</b>	Design various Cloud Applications															
<b>CLR-4:</b>	Understand the Cloud Security and Cloud pricing models															
<b>CLR-5:</b>	Learn the purpose of stream processing and its basic components															
<b>Course Outcomes (CO):</b>		<b>At the end of this course, learners will be able to:</b>														
<b>CO-1:</b>	Comprehend Cloud fundamental Concepts												-	<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>
<b>CO-2:</b>	Understand virtualization foundations to cater the needs of elasticity, portability, and resilience by cloud service providers.												-	1	-	-
<b>CO-3:</b>	Compare operation and economic models of various trending cloud platforms prevailing in IT industry												-	2	-	-
<b>CO-4:</b>	Design a cloud framework with appropriate resource management techniques with its security.												-	2	-	-
<b>CO-5:</b>	Understand the concepts of Transfer Learning												-	1	-	-

<b>Unit-1 - Introduction Cloud Computing</b>	<b>9 Hour</b>
Introduction-- Cloud Introduction --NIST Definition: Cloud service Models - IaaS/ PaaS / SaaS, Deployment Models –Public, Private, Hybrid and Community, Cloud Characteristics, Cloud Challenges –user, Service Provider end, Applications of Cloud, Cloud federation, Cloud Enabling Technology, - Challenges and Issues-LAB1: Hosted Hypervisor and Bare Metal Hypervisor- LAB2: Install a Virtual box / VMware Workstation with different flavours of linux or windows.LAB3: Configure Kafka Streaming on cloud.	
<b>Unit-2 - Cloud Resource Virtualization</b>	
Hypervisors – Type 1 Hypervisors – Type 2 Hypervisors –. Basics of Virtualization - Types of Virtualizations - Understanding Hypervisors - Implementation Levels of Virtualization -Virtualization Structures - Tools and Mechanisms – Resource sharing and Resource pooling -Desktop Virtualization – Server Virtualization.LAB3: Implementation of Virtual Machine(S) and create a Virtual Datacenter.LAB4: Kafka simple producer consumer message passing, topics and partitions on cloud.	
<b>Unit-3 - Advances in Cloud Platforms</b>	
Comparing Amazon web services, Google AppEngine, Microsoft Azure from the perspective of architecture (Compute, Storage Communication) services and cost models. Working with EC2 API – Google App Engine API - Facebook API, Twitter API. Overview on Public Cloud Platforms-AWS, Amazon Web Services (AWS), Azuer, Google Cloud Platform (GCP). Docker, Containers, Usage of containers, Terminology, Docker Run Static sites, Docker Images, Docker File, Docker on AWS, Devops.LAB5: Deployment of VMs in AWS. LAB6: Install a docker engine and docker client on windows. LAB7: Creation and removal of container, container images. Lab 8:: Building Kafka Streams application on cloud.	

**Unit-4 – Cloud Security****9 Hour**

Cloud Application Development – Cloud Application Execution, Applications using Containers - Testing the Cloud Application, Case study on Cloud Application – Cloud Security Concepts - Cloud Security Threats, Cloud Security Mechanisms: Encryption , Public Key Infrastructure, Identity and Access Management, Single Sign-On: Kerberos authentication , Mobile Cloud, Green Cloud.LAB9: Find a procedure to transfer the files from one virtual machine to another virtual machine Using VMWare. LAB10: Install Google App Engine. Create a hello world app and other simple web applications using python/java. Lab 11: Docker Containerization Lab 14:: Configure Apache Storm single node cluster on cloud.

**Unit-5 - Stream Processing****9 Hour**

Introduction to Stream Processing - Batch vs Stream Processing, Examples of stream processing - Applications of stream processing - Stateful Stream Processing - Stream Processing Graph - Data Sources, Stream processing pipelines, Sinks - Transformations and Aggregation - Windowing - Stateless and stateful processing - Effect of time in stream processing - Complexity analysis. LAB15: : Build Apache Storm Word Count Topology on cloud.

Learning Resources	1. Rajkumar Buyya, James Broberg, Andrzej, M. Goscinski, <i>Cloud Computing: Principles and Paradigms</i> , Wiley, 1st Edition, 2013.	5. Buyya, Rajkumar, Christian Vecchiola, and S. Thamarai Selvi. <i>Mastering Cloud Computing: Foundations and Applications Programming</i> , Tata Mcgraw Hill, 1 st Edition, 2017.
	2. Sosinsk, Barrie, <i>Cloud Computing Bible</i> , John Wiley & Sons, 1 st Edition, 2011.	6. Ellis B, <i>Real-Time Analytics – Techniques to analyze and visualize streaming data</i> , 1st ed., John Wiley & Sons Inc,2014
	3. Docker: Up & Running: Shipping Reliable Containers in Production”, Sean P. Kane, Karl Matthias, O'Reilly Media Inc, 2015.	7. Mark Wilkins, “Learning Amazon Web Services (AWS): A Hands-On Guide to the Fundamentals of AWS Cloud”, 2019.
	4. Thomas Erl, ZaighamMahmood, RichardoPuttini, "Cloud Computing: Concepts, Technology and Architecture", Fourth Printing, 2014, Prentice Hall/PearsonPTR, ISBN: 9780133387520.	8. <a href="https://cloudacademy.com/course/introduction-to-devops/intro-3/">https://cloudacademy.com/course/introduction-to-devops/intro-3/</a>

**Learning Assessment**

Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1 Remember	40%	-	40%	-	40%	-
Level 2 Understand	40%	-	40%	-	40%	-
Level 3 Apply	10%	-	10%	-	10%	-
Level 4 Analyze	10%	-	10%	-	10%	-
Level 5 Evaluate	-	-	-	-	-	-
Level 6 Create	-	-	-	-	-	-
Total	100 %		100 %		100 %	

**Course Designers****Experts from Industry**

1. Rajarajan Sundaramurthy, Senior Vice President - Devops

**Experts from Higher Technical Institutions****Internal Experts**

1. Dr.N.Manikandan, SRMIST

<b>Course Code</b>	21CSE373T	<b>Course Name</b>	STREAMING ANALYTICS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the basic building blocks of stream processing												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Relate streaming data in real time															
<b>CLR-3:</b>	Explore the data ingestion options into stream processing engines															
<b>CLR-4:</b>	Extend stream processing results to end users															
<b>CLR-5:</b>	Explore NOSQL storage options to store real time data															
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>															
<b>CO-1:</b>	Illustrate the concepts and terminologies in stream processing												2	-	-	
<b>CO-2:</b>	Interpret stream processing applications using Apache Spark Streaming												2	2	-	
<b>CO-3:</b>	Summarize real-time streaming data pipelines and applications that adapt to the data streams using Kafka												2	2	-	
<b>CO-4:</b>	Interpret stream processing applications using Apache Storm Streaming												2	2	-	
<b>CO-5:</b>	Inquire real time data using NoSQL databases & MongoDB												2	2	-	

**Unit-1 - Fundamentals of Stream Processing** 9 Hour  
 Introducing Stream Processing, Stream Processing, Examples of Stream Processing, Scaling Up Data Processing, Distributed Stream Processing, Stream-Processing Model, Sources and Sinks, Immutable Streams Defined from One Another, Transformations and Aggregations, Window Aggregations, Stateless and Stateful Processing, Stateful Streams, An Example: Local Stateful Computation in Scala, Stateless or Stateful Streaming, Streaming Architectures, Components of a Data Platform, Architectural Models, The Use of a Batch-Processing Component in a Streaming Application, Referential Streaming Architectures, Streaming Versus Batch Algorithms

**Unit-2 - Apache Spark & Structured Streaming** 9 Hour  
 Apache Spark as a Stream-Processing Engine, Spark's Distributed Processing Model, Spark's Resilience Model, Introducing Structured Streaming, The Structured Streaming Programming Model

**Unit-3 - Kafka-A Realtime Data and Stream Processing** 9 Hour  
 Getting Started with Kafka, Kafka, Publish Subscribe messaging model, Kafka Architecture, Messages and Batches, Schemas, Topics and Partitions, Producers and consumers, Brokers and Clusters, Multiple Clusters, Data Ecosystem, Kafka Producers: Writing messages to Kafka, Kafka Consumers - Reading data from Kafka, Stream Processing- Stream Processing Design Patterns-Kafka Streams by Examples- Kafka Streams: Architecture Overview

**Unit-4 - Apache Storm** 9 Hour  
 Apache Storm - Introduction, Real-Time Processing and Storm Introduction, Storm Deployment, Topology Development, and Topology Options, Storm Parallelism and Data Partitioning, Integration of Storm, and Kafka

**Unit-5 - NoSQL Databases in Cloud and MongoDB** 9 Hour  
 NoSQL Data Bases, AWS Cloud Dynamo Database: Amazon DynamoDB features, Serverless, Introduction to MongoDB, MongoDB Data Model, MongoDB Architecture - Core Processes, MongoDB Tools, Standalone Deployment, Replication, Sharding, MongoDB Use Cases- Performance Monitoring, and Social Networking.

<b>Learning Resources</b>	7. Garillot F and Mass. G., <i>Stream Processing with Apache Spark</i> , 1st ed., O'Reilly Media, Inc., 2019. 8. Narkhede N, Shapira. G, and Palino T., <i>Kafka: The Definitive Guide - Real-Time Data and Stream Processing at Scale</i> , 1st ed., O'Reilly Media, Inc., 2017 9. Ankit Jain, <i>Mastering Apache Storm</i> , 1st ed., Packt Publishing, 2017	10. <a href="https://docs.mongodb.com/manual/changeStreams/">https://docs.mongodb.com/manual/changeStreams/</a> 11. Shakuntala Gupta Edward Navin Sabharwal, "Practical MongoDB Architecting, Developing, and Administering MongoDB" Apress, 2016 12. <a href="https://aws.amazon.com/dynamodb/features/?pg=dynamodb&amp;sec=hs">https://aws.amazon.com/dynamodb/features/?pg=dynamodb&amp;sec=hs</a>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>			
	<i>Bloom's Level of Thinking</i>	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	25%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. Gangeyan Ranganathan, Project Delivery Specialist II , Deloitte Consulting Llp, Sacramento, California	1. Dr Surendiran B, Associate Professor, National Institute of Technology, Puducherry	1. Dr. B Yamini, SRMIST
2. Mr. Shri Raghu Raaman, Solidity Developer, Pixelvault Inc., Toronto, Canada	2. Dr. Selvakumar K, B.E., M.E., Ph. D, Assistant Professor Grade-II, Department of Computer Applications, National Institute of Technology Trichy, Tiruchirappalli-620015, Tamil Nadu, India	2. Dr. G Suseela, SRMIST

<b>Course Code</b>	21CSE421T	<b>Course Name</b>	BUSINESS INTELLIGENCE AND ANALYTICS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Familiarize with Business Intelligence, Analytics and Decision Support												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Understand the technologies for Decision making												-	-	-	
<b>CLR-3:</b>	Familiarize with predictive modeling techniques												-	-	-	
<b>CLR-4:</b>	Familiarize with sentiment analysis techniques												-	-	-	
<b>CLR-5:</b>	Understand about Decision-making systems												-	-	-	
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Gain knowledge on Business Intelligence, Analytics and Decision Support															
<b>CO-2:</b>	Understand the technologies for Decision making															
<b>CO-3:</b>	Apply predictive modeling techniques															
<b>CO-4:</b>	Apply sentiment analysis techniques															
<b>CO-5:</b>	Gain knowledge on Decision-making systems															

#### **Unit-1 - Introduction: Business Intelligence, Analytics and Decision Support** 9 Hour

Information Systems Support for Decision Making - An Early Framework for Computerized Decision Support - The Concept of Decision Support Systems - A Framework for Business Intelligence - Business Analytics Overview - Brief Introduction to Big Data Analytics - Clickstream Analysis – Metrics - Clickstream Analysis - Practical Solutions - Competitive Intelligence Analysis

T1: Introduction to Power BI and SSMS

T2: Installing Power BI and SSMS

T3: Prepare data in Power BI Desktop

#### **Unit-2 - Decision Making** 9 Hour

Decision Making - Introduction and Definitions - Phases of the Decision - Making Process - The Intelligence Phase - Design Phase - Choice Phase - Implementation Phase - Decision Support Systems Capabilities - Decision Support Systems Classification - Decision Support Systems Components

T4: Load data in Power BI Desktop

T5: Model data in Power BI Desktop part-1

T6: Model data in Power BI Desktop part-2

#### **Unit-3 - Predictive modeling and Sentiment Analysis** 9 Hour

Basic Concepts of Neural Networks - Developing Neural Network - Based Systems - Illuminating the Black Box of ANN with Sensitivity - Support Vector Machines - A Process Based Approach to the Use of SVM - Nearest Neighbor Method for Prediction -Sentiment Analysis Overview - Sentiment Analysis Applications - Sentiment Analysis Process - Sentiment Analysis - Speech Analytics

T7: Implement data model using SQL in Power BI

T8: Create DAX calculations in Power BI Desktop part-1

T9: Create DAX calculations in Power BI Desktop part-2

<b>Unit-4 - Multi-Criteria Decision-Making Systems</b>	<b>9 Hour</b>
Decision Support Systems modeling - Structure of mathematical models for decision support - Decision making under certainty - Uncertainty and Risk - Decision modeling with spreadsheets - Mathematical programming optimization - Decision analysis introduction - Decision tables - Decision Trees - Multi-criteria decision making - Pairwise comparisons	
T10: Design a report in Power BI Desktop part-1	
T11: Design a report in Power BI Desktop part-2	
T12: Create a Power BI dashboard	
<b>Unit-5 - Automated Decision Systems</b>	<b>9 Hour</b>
Automated Decision Systems - The Artificial Intelligence field - Basic concepts of Expert Systems - Applications of Expert Systems - Structure of Expert Systems - Knowledge Engineering - Development of Expert Systems - Location based Analytics - Cloud Computing - Business Intelligence	
T13: Create a Power BI paginated report	
T14: Perform data analysis in Power BI Desktop	
T15: Enforce Row-level security	

<b>Learning Resources</b>	7. Ramesh Sharda, Dursun Delen, Efraim Turban, J.E. Aronson, Ting-Peng Liang, David King, "Business Intelligence and Analytics: System for Decision Support", 10 <sup>th</sup> Edition, Pearson Global Edition, 2013. 8. Brett Powell, "Mastering Microsoft Power BI: Expert techniques for effective data analytics and business intelligence", 2018	9. Alberto Ferrari Marco Russo, "Definitive Guide to DAX, The: Business intelligence for Microsoft Power BI, SQL Server Analysis Services, and Excel", Second Edition, By Pearson, 2020
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Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers	Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1. Mr.V.Selvakumar,Hexaware Technologies, selvakumars@hexaware.com	1. Dr. T. Veerakumar, Professor, NIT Goa	1. Dr. T. Karthick, SRMIST

<b>Course Code</b>	21CSE422T	<b>Course Name</b>	CONVOLUTIONAL NEURAL NETWORKS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		Program Outcomes (PO)												<b>Program Specific outcomes</b>									
CLR-1:	Learn the evolution of neural networks											1	2	3	4	5	6	7	8	9	10	11	12
CLR-2:	Utilize the knowledge for model development											-	-	-	-	-	-	-	-	-	-	-	-
CLR-3:	Fine tune the performance with optimization techniques											-	-	-	-	-	-	-	-	-	-	-	-
CLR-4:	Utilize class and build domain model for real-time programs											-	-	-	-	-	-	-	-	-	-	-	-
CLR-5:	Construct CNN model for image-based applications											-	-	-	-	-	-	-	-	-	-	-	-
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Engineering Knowledge															Program Specific outcomes						
CO-1:	Understand fundamentals of Neural Networks															PSO-1							
CO-2:	Understand fundamentals of CNN Architecture															PSO-2							
CO-3:	apply performance optimization															PSO-3							
CO-4:	compare different CNN Architectures																						
CO-5:	apply CNN in image classification																						

#### **Unit-1 - Introduction to AI & ML** 9 Hour

Types of ML-Old versus new ML-Artificial neural networks-Activation functions The XOR problem-Training neural networks-Backpropagation and the chain rule-Batches Loss functions-The optimizer and its hyperparameters- Underfitting versus overfitting Feature Scaling-Fully connected layers

T1: Implement Simple Programs like vector addition in TensorFlow.

T2: Implement a simple problem like regression model in Keras.

T3: Implement a perceptron in TensorFlow/Keras Environment.

#### **Unit-2 - Fundamental CNN Architecture** 9 Hour

Convolution Input Padding-Calculating the number of parameters (weights)- Calculating the number of operations-Converting convolution layers into fully connected layers-The pooling layer-1x1 Convolution-Calculating the receptive field-Building a CNN model in TensorFlow.

T1: Implement a CNN based classifier of handwritten digits: The Convolution Layer

T2: Implement a CNN based classifier of handwritten digits: The Max Pooling Layer

T3: Implement a CNN based classifier of handwritten digits: The Fully Connected Layer

#### **Unit-3 - Performance Optimization** 9 Hour

Number of hidden layers -Number of neurons per hidden layer -Batch normalization -Advanced regularization and avoiding overfitting -Applying dropout operations with TensorFlow -Which optimizer to use? -Memory tuning - Appropriate layer placement -Building the second CNN by putting everything together - Dataset description and preprocessing -Creating the CNN model -Training and evaluating the network.

T1: Implement a CNN with Adam optimizer

T2: Implement a CNN and apply dropout operations with TensorFlow

T3 Implement a CNN with a validation technique

<b>Unit-4 - Popular CNN Model Architectures</b>	<b>9 Hour</b>
Introduction to ImageNet -LeNet -AlexNet architecture -VGGNet architecture -VGG16 image classification code example -GoogLeNet architecture -Architecture insights -Inception module -ResNet architecture.	
T1: Implement Image Net model for a Dataset	
T2: Traffic sign classifiers using AlexNet	
T3: Implement VGGNet model for a Dataset	
<b>Unit-5 - Image Classification</b>	<b>9 Hour</b>
CNN model architecture-Cross-entropy loss (log loss)-multi-class cross entropy loss-The train/test dataset split-Datasets-ImageNet-CIFAR- Loading CIFAR- Building the CNN graph-Learning rate scheduling-Introduction to the tf.data API-Main training loop-Model Initialization-Do not initialize all weights with zeros-Initializing with a mean zero distribution-Xavier-Bengio and the Initializer-Improving generalization by regularizing-L2 and L1 regularization.	
T1: Implement Image classification with TensorFlow	
T2: Build TensorFlow input pipelines for image	
T3: Implement a CNN for Image processing L2 regularization	

<b>Learning Resources</b>	1. Iffat Zafar, Giounona Tzanidou, Richard Burton, Nimesh Patel, Leonardo Araujo, "Hands-On Convolutional Neural Networks with TensorFlow", Packt Publishing,2018. 2. Mohit Sewak, Pradeep Pujari, Md. Rezaul Karim,"Practical Convolutional Neural Networks: Implement Advanced Deep Learning Models Using Python, ",Packt Publishing ,2018	3. Charu C. Aggarwal. <i>Neural Networks and Deep Learning: A Textbook</i> . Springer. 2019. 4. Stanford University Course <a href="http://cs231n.stanford.edu/2018/syllabus.html">http://cs231n.stanford.edu/2018/syllabus.html</a>
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Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
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Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. Gowtham Kumar Jyayachandiran Assistant Vice President Nomura		1. Dr.K.Arthi, SRMIST

Course Code	21CSE423T	Course Name	BIG DATA VISUALIZATION	Course Category	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3																								
Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil																													
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil																															
<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>																																		
<p><b>CLR-1:</b> Learn the basics of EDA analysis and exploring PyViz, HoloViz for data visualization</p> <p><b>CLR-2:</b> Know to perform D3 for data visualization</p> <p><b>CLR-3:</b> Utilize the Matplotlib library to visualize data</p> <p><b>CLR-4:</b> Explore the Tableau to visualize data</p> <p><b>CLR-5:</b> Explore the Apache Superset to visualize data</p>																																		
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>																																		
<p><b>CO-1:</b> Use EDA techniques to identify insights of data and data visualization using PyViz and HoloViz</p> <p><b>CO-2:</b> Create effective visualization using D3 templates</p> <p><b>CO-3:</b> Implement the code to visualize data using Matplotlib</p> <p><b>CO-4:</b> Visualize different kinds of dataset using Tableau</p> <p><b>CO-5:</b> Visualize different kinds of dataset using Apache Superset</p>																																		
Program Outcomes (PO)																																		
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th> </tr> </thead> <tbody> <tr> <td>Engineering Knowledge</td><td>Problem Analysis</td><td>Design/development of solutions</td><td>Conduct investigations of complex problems</td><td>Modern Tool Usage</td><td>The engineer and society</td><td>Environment &amp; Sustainability</td><td>Ethics</td><td>Individual &amp; Team Work</td><td>Communication</td><td>Project Mgt. &amp; Finance</td><td>Life Long Learning</td> </tr> </tbody> </table>											1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
1	2	3	4	5	6	7	8	9	10	11	12																							
Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning																							
PSO-1      PSO-2      PSO-3																																		

#### **Unit-1 - Introduction to Eda, PyViz and HoloViz**

**9 Hour**

Fundamentals of EDA-EDA with Personal Email-Descriptive Statistics-EDA on Wine Quality Data Analysis-Exploratory data analysis using seaborn-Using PyViz / HoloViz (Geoviews, Datashader, HvPlot)-creating several types of Leaflet maps using folium.

T1: A data-centric approach to visualization using plot, T2: Building interactivity in plots, T3: Building dashboards using Panel

#### **Unit-2 - Data Driven Documents-D3**

**9 Hour**

Introduction to D3-Getting started with D3-D3 visualization sample templates-Displaying Results Using D3-Create a summary file for visualization-Visualization using HTML document-Data visualization showing the stacked view-Bar chart-Multiple Donuts-Stacked Area-Pie chart

T4: Identifying appropriate template for the available dataset, T5: Displaying results using D3, T6: Creating visualization showing bar chart, donuts, pies using D3

#### **Unit-3 - Visualization with Matplotlib**

**9 Hour**

Simple Line Plots-Simple Scatter Plots-Visualizing Errors-Density and Contour Plots-Histograms, Binnings, and Density-Customizing Plot Legends-Customizing Colorbars-Multiple Subplots-Text and Annotation-Customizing Ticks-Customizing Matplotlib: Configurations and Stylesheets-Three-Dimensional Plotting in Matplotlib-Geographic Data with Basemap-Visualization with Seaborn

T7: Implement simple plotting using Matplotlib, T8: Customizing colorbars, multiple subplots, text and annotation using Matplotlib, T9: Implement geographic data visualization using Seaborn

#### **Unit-4 - Tableau Your Data**

**9 Hour**

Creating Visual Analytics with Tableau Desktop: shortcomings of traditional information analysis, Workspace-Connecting to Your Data :Connection, Generated values, Data Extract, Joining, Blending, Data Quality-Building Your First Visualization-creating calculations to enhance Your Data: Showme, Trendline, sorting, filters, sets, groups-Creating Calculations to Enhance Your Data: Aggregation, calculated values, Formulas, function reference-Bringing It All Together with Dashboards: understanding, right way, best practices

T10: Exploring the workspaces of Tableau, T11: Building simple visualization using Tableau, T12 Building dashboards using Tableau

**9 Hour**

**Unit-5 - Apache Superset**

Getting Started with Data Exploration: Installing, sharing, configuring, add database, uploading, customization -Configuring Superset and Using SQL Lab: setting wen server, creation, migration, securing, caching, mapbox-User Authentication and Permissions: security, google sign in, list users page, views/ menus, list permission, user statistics page-Visualizing Data in a Column-Comparing Feature Values-Drawing Connections between Entity Columns-Mapping Data That Has Location Information-Building Dashboards

T13: Exploring the workspaces of Superset, T14: Building simple visualization using Superset, T15 Building dashboards using Superset

<b>Learning Resources</b>	9. Jake VanderPlas (2017). Python Data Science Handbook: Essential Tools for Working with Data. First Edition O'Reilly Media, Inc. ISBN-10: 1491912057, ISBN-13:978-1491912058.	13. Big Data Visualization, James D. Miller, Copyright © 2017 Packt Publishing Ltd.
	10. Suresh Kumar Mukhiya, Usman Ahmed (2020). Hands-On Exploratory Data Analysis with Python: Perform EDA techniques to understand, summarize, and investigate your data, Copyright © Packt Publishing Ltd.	14. Tableau Your Data:Fast and Easy Visual Analysis with Tableau Software- Daniel G.Murray, with the InterWorks team, John Wiley & Sons, Inc. ISBN: 978-1-118-61204-0
	11. Shashank Shekhar (2018). Apache Superset Quick Start Guide-Develop interactive visualizations by creating user-friendly dashboards, -Copyright © Packt Publishing Ltd.	15. Shai Vaingast, "Beginning Python Visualization Crafting Visual Transformation Scripts", Apress, 2nd edition, 2014.
	12. Mike Dewar (2012). Getting Started with D3. O'Reilly Media, Inc., ISBN:9781449328795	16. Wes Mc Kinney, "Python for Data Analysis", O'Reilly Media, 2012.
		17. Wesley J.Chun,"Core Python Applications Programming,3rd ed,Pearson,2016
		18. <a href="https://pyviz.org/">https://pyviz.org/</a>
		19. <a href="https://holoviz.org/">https://holoviz.org/</a>

Learning Assessment						
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)		
		Theory	Practice	Theory	Practice	Theory
Level 1	Remember	40%	-	20%	-	40%
Level 2	Understand	40%	-	20%	-	40%
Level 3	Apply	10%	-	20%	-	10%
Level 4	Analyze	10%	-	20%	-	10%
Level 5	Evaluate	-	-	10%	-	-
Level 6	Create	-	-	10%	-	-
	Total	100 %		100 %		100 %

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Vishwa Prasath T S Technology Analyst Accenture Pvt Ltd	1. Mr.C.M.T.Karthikeyan, Asst. Professor, Government College of Engineering - Bargur	1. Dr. P.Rajasekar, SRMIST

<b>Course Code</b>	21CSE424T	<b>Course Name</b>	DEEP LEARNING FOR DATA ANALYTICS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the theoretical foundations, algorithms, and methodologies of convolutional neural networks												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Identify and apply appropriate recurrent neural networks for analyzing the data for variety of problems.															
<b>CLR-3:</b>	Understand the principles and applications of computer vision															
<b>CLR-4:</b>	Construct Generative Adversarial Networks to solve real - world problems.															
<b>CLR-5:</b>	Understand different methodologies to create application using deep nets.															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12			
<b>CO-1:</b>	Recognize the characteristics of convolutional neural networks and the use of optimizers.	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
<b>CO-2:</b>	Analyze various recurrent neural networks models.	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
<b>CO-3:</b>	Apply the Deep Learning models for Computer Vision.	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
<b>CO-4:</b>	Solve various real - world problems using Generative Adversarial Networks.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
<b>CO-5:</b>	Build a Deep Reinforcement Learning models for solving various problems.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1

<b>Unit-1 - Convolutional Neural Networks</b>	<b>9 Hour</b>
Introduction to Convolutional neural networks – Autoencoders: types, denoising, Convolutional autoencoder example, Uses and limitations – Variational autoencoders: Parameters to define a normal distribution, VAE loss function, Kullback-Leibler divergence, Training the VAE, The reparameterization trick – Applications of autoencoders – Optimizers: Gradient Descent, RMSProp, Adam	
Tutorial: T1. To build a convolutional autoencoder model for the MNIST dataset. T2. To build a convolutional variational autoencoders for the MNIST dataset	
Experiment with different learning rates and objective functions for gradient descent	

<b>Unit-2 - Recurrent Neural Networks</b>	<b>9 Hour</b>
Recurrent Neural Networks: Overview, Neural Networks with and without Hidden States, RNN-based Character-Level Language Models - Implementation: RNN Model, RNN-based Language Model, Gradient Clipping, Training, Decoding - Long Short-Term Memory (LSTM), Gated Recurrent Units (GRU)	
Tutorial: T3. To implement the RNN model using the H. G. Wells' The Time Machine data set. T4. To implement the LSTM model using the H. G. Wells' The Time Machine data set.	
To implement the GRU model using the H. G. Wells' The Time Machine data set.	

<b>Unit-3 - Deep Learning for Computer Vision</b>	<b>9 Hour</b>
Image Augmentation - Object Detection and Bounding Boxes - Anchor Boxes - Multiscale Object Detection - Region-based CNNs: R-CNNs, Fast R-CNN, Faster R-CNN, Mask R-CNN	
Tutorial: T5. To demonstrate object detection model banana detection dataset. T6. To implement the classification model for CIFAR-10 dataset.	
To implement the classification model for Dog Breed Identification dataset	

<b>Unit-4 - Generative Adversarial Networks</b>	<b>9 Hour</b>
Generative Adversarial Networks: Generator, Discriminator, Loss function, Generator loss, Discriminator loss, Training - Deep Convolutional Generative Adversarial Networks: Wasserstein GAN, BEGAN, CycleGAN - Conditional GANs: Pix2Pix.	
<i>Tutorial:</i>	
T7. To build a model using GAN to resemble MNIST digits., T8. To implement a Deep Convolutional GAN to generate complex color images.	
To implement a Deep Convolutional GAN on Fashion-MNIST data set using ReLU as activation function for generator, leaky ReLU as activation function for discriminator.	
<b>Unit-5 - Deep Reinforcement Learning</b>	<b>9 Hour</b>
Stateless Algorithms: Naïve Algorithm, $\varepsilon$ -Greedy Algorithm, Upper Bounding Methods - The Basic Framework of Reinforcement Learning: Challenges, Simple Reinforcement Learning for Tic-Tac-Toe, Role of Deep Learning, and a Straw-Man Algorithm	
<i>Tutorial:</i>	
T9. Self-Learning Robots - Case Study, T10. Building Conversational Systems: Deep Learning for Chatbots - Case Study	
Self-Driving Cars - Case Study	

<b>Learning Resources</b>	1. Iffat Zafar, Giounona Tzanidou, Richard Burton, Nimesh Patel, Leonardo Araujo, <i>Hands-On Convolutional Neural Networks with TensorFlow</i> , Packt Publishing, 2018. (Unit I) 2. Aston Zhang, Zack C. Lipton, Mu Li, Alex J. Smola, <i>Dive into Deep Learning</i> , arXiv preprint, 2021 ( <a href="http://d2l.ai/index.html">http://d2l.ai/index.html</a> ) (Unit II, III & IV) 3. Charu C. Aggarwal, <i>Neural Networks and Deep Learning - A Text Book</i> , Springer Nature, 2018. (Unit V)	4. Ian Goodfellow, Yoshua Bengio and Aaron Courville, <i>Deep Learning</i> , the MIT Press, 2017. 5. Umberto Michelucci, <i>Applied Deep Learning – A Case-Based Approach to Understanding Deep Neural Networks</i> , Apress, 2018. 6. François Chollet, <i>Deep Learning with Python</i> , Manning Publications, 2018.
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Learning Assessment						
Bloom's Level of Thinking	Continuous Learning Assessment (CLA)					Summative Final Examination (40% weightage)
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
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Level 4	Analyze	30%	-	25%	-	30%
Level 5	Evaluate	-	-	10%	-	-
Level 6	Create	-	-	5%	-	-
	Total	100 %		100 %		100 %

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
		1. Dr. M. Prakash, SRMIST 2. Dr.G.Vadivu, SRMIST

Course Code	21CSE425T	Course Name	ADVANCED MACHINE LEARNING	Course Category	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards			Nil

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes
		1	2	3	4	5	6	7	8	9	10	11	12	
CLR-1:	Understand the definition of a range of neural network models.													
CLR-2:	Understand neural implementations of attention mechanisms and sequence embedding models and how these modular components can be combined to build state of the art NLP systems.													
CLR-3:	Understand the mathematics necessary for constructing novel machine learning solutions.													
CLR-4:	Focusing on recent advances in deep learning with neural networks, such as recurrent and Bayesian neural networks.													
CLR-5:	Introduce the mathematical definitions of the relevant machine learning models and derive their associated optimization algorithms													

Course Outcomes (CO):	At the end of this course, learners will be able to:	Engineering Knowledge	Problem Analysis	Design/development of Solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	derive and implement optimization algorithms for these models.	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
CO-2:	implement and evaluate common neural network models for language.	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-3:	choose a model to describe a particular type of data	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO-4:	design and implement various machine learning algorithms in a range of real world applications.	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-5:	Covers a range of applications of neural networks in natural language processing, including analyzing latent dimensions in text, translating between languages, and answering questions.	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-

#### **Unit-1 - Reinforcement Learning 9 Hour**

Introduction to Reinforcement Learning, Basic concepts in RL, value iteration, policy iteration, Model-Based Reinforcement Learning (Dynamic Programming), value function approximator Model-Free Reinforcement Learning (SARSA, Monte Carlo, Q-Learning), Approximate and Deep Reinforcement Learning (Deep Q-Learning), Policy Gradient Reinforcement Learning, Advanced Topics on Exploration and Planning

T1: Implementation of reinforcement learning using public dataset – chatbot, T2: Implementation of Deep Reinforcement learning, T3: Implementation of Policy Gradient reinforcement learning

#### **Unit-2 - Machine Learning with Graphs 9 Hour**

Introduction; Machine Learning for Graphs, Traditional Methods for ML on Graphs, Node Embeddings, Link Analysis: PageRank, Label Propagation for Node Classification, Graph Neural Networks 1: GNN Model, Graph Neural Networks 2: Design Space, Applications of Graph Neural Networks, Knowledge Graph Embeddings, Reasoning over Knowledge Graphs, Frequent Subgraph Mining with GNNs

T4: Building Graph Neural Networks using PYTHON, T5: Implementation of Knowledge Graphs, T6: Implementation of Frequent Subgraph Mining with GNNs

#### **Unit-3 - Ensemble Learning Models 9 Hour**

Markov models - Hidden Markov models - Ensemble learning methods - Regularizations-pros and cons-Voting, Boosting, AdaBoost - Gradient Boosting - Bagging with its impact on bias and variance - Random Forest - Fine Tuning Ensemble - Cascading - Application Face recognition - using Ensemble techniques - Examples - Learning - Conditional random fields (CRFs) - Structural SVMs

T7: Implementation of Ada boosting and Gradient Boosting using public dataset, T8: Implementation of Bagging Classifiers using public dataset,

T9: Implementation of Face recognition system using Ensemble Techniques.

<b>Unit-4 - Association Rule Mining</b>	<b>9 Hour</b>
The applications of Association Rule Mining: Market Basket, Recommendation Engines, etc. A mathematical model for association analysis; Large item sets; Association Rules, Apriori: Constructs large item sets with mini sup by iterations; Interestingness of discovered association rules; Application examples: Association analysis vs. classification of FP-trees T10: Implementation of Association Rule Mining in Real-time applications., T11: Implementation of Apriori Algorithm, T12: Building Frequent Pattern Tree for Classification	
<b>Unit-5 - Neural Networks</b>	<b>9 Hour</b>
Neural Networks representations - McCulloch-Pitts units - Thresholding logic - Perceptron - Feed forward networks - multi-layer perceptron - Back propagation algorithms – Convergence and Hidden layer representation in back propagation - Optimization Algorithms - Gradient Decent - Stochastic gradient - Adam, Adagrad - RMSProp - Drop out - Batch Normalization – Application Face recognition using - Neural Networks T13: Implementation of optimization algorithm, T14: Implementation of Back-Propagation Algorithm, T15: Building Face recognition system using Neural Networks	

<b>Learning Resources</b>	1. Kevin P. Murphy. <i>Machine Learning: A Probabilistic Perspective</i> . MIT Press 2012 2. Ian Goodfellow, Yoshua Bengio and Aaron Courville. <i>Deep Learning</i> . MIT Press 2016 3. Ian Goodfellow, YoshuaBengio and Aaron Courville. <i>Deep Learning</i> . MIT Press 2016	4. William L. Hamilton, <i>Graph Representation Learning</i> , McGill University, 2020 5. <a href="http://cs229.stanford.edu/">http://cs229.stanford.edu/</a> 6. JasonBrownlee, <i>DeepLearningwithPython</i> , ebook, 2016. 7. Sebastian Raschka, VahidMirjilili, <i>Python Machine Learning and deep learning</i> , 2nd edition, kindle book, 2018
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. E Nagarajan, R&D Head, Solvedge Technology	1. Dr. Anandhakumar P Professor, Madras Institute of Technology, Chrompet	1. Dr.M.Lakshmi, SRMIST 2. Dr.A.Shobanadevi, SRMIST

<b>Course Code</b>	21CSE426T	<b>Course Name</b>	FINANCIAL MACHINE LEARNING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Learn the machine learning for the finance domain												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Know to the regression based supervised learning															
<b>CLR-3:</b>	Explore the classification based supervised learning															
<b>CLR-4:</b>	Explore the clustering based unsupervised learning															
<b>CLR-5:</b>	Understand the NLP concepts to study various case studies															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CO-1:</b>	Understand the machine learning approach to address finance domain												-	1	-	-
<b>CO-2:</b>	Implement regression based supervised learning in finance												-	-	-	2
<b>CO-3:</b>	Implement classification based supervised learning in finance												-	-	-	-
<b>CO-4:</b>	Implement clustering based unsupervised learning in finance												-	-	-	2
<b>CO-5:</b>	Understand various case studies with NLP concepts												-	-	-	2

<b>Unit-1 - Machine Learning in Finance</b>	<b>9 Hour</b>
Machine Learning in Finance: Introduction to Machine Learning- Types of Machine Learning, NLP, Python packages for Machine Learning, Introduction and Installation, ANN models in Python-Keras-GPU and cloud services	
T1: Identifying Python packages for Machine Learning	
T2: Implementing ANN models in python	
T3: Using Keras to build Machine Learning models	

<b>Unit-2 - Supervised Learning: Regression</b>	<b>9 Hour</b>
Supervised Learning- Model Performance-Model Selection-Regression: Time series models, Case Studies-Stock price prediction-Derivative Pricing-Investor Risk Tolerance and Robo-Advisors-Yield Curve Prediction	
T4: Using regression model to predict stock price	
T5: Using regression model for derivative pricing	
T6: Using regression model for yield curve prediction	

<b>Unit-3 - Supervised Learning: Classification</b>	<b>9 Hour</b>
Supervised Learning: Classification-Case Studies- Fraud Detection-Loan Default Probability-Bitcoin Trading Strategy	
T7: Using classification model for fraud detection	
T8: Using classification model to identify loan default probability	
T9: Using classification model for bitcoin trading strategy	

<b>Unit-4 - Unsupervised Learning: Clustering</b>	<b>9 Hour</b>
Unsupervised Learning: Clustering – Clustering Techniques-Case Studies-Clustering for Pairs Trading-Portfolio Management: Clustering Investors-Hierarchical Risk Parity	
T10: Using clustering model for Pairs trading	
T11: Using clustering model for portfolio management	
T12 Using clustering model for hierarchical risk parity	
<b>Unit-5 - Natural Language Processing</b>	<b>9 Hour</b>
Natural Language Processing packages -Theory and concepts-Case Studies-NLP and Sentiment Analysis-Based Trading Strategies-Chatbot Digital Assistant- Document Summarization	
T13: Implement sentiment analysis-based trading strategies using NLP	
T14: Building simple chatbot digital assistant	
T15 Building document summarization using NLP	

<b>Learning Resources</b>	1. Hariom Tatsat, Sahil Puri & Brad Lookabaugh (2021). <i>Machine Learning &amp; Data Science Blueprints for Finance-From Building Trading Strategies to Robo-Advisors Using Python</i> , O'Reilly Media, ISBN: 9781492073055	4. Bob Mather (2018). <i>Machine Learning in Finance: Use Machine Learning Techniques for Day Trading and Value Trading in the Stock Market</i> . Abiprod Pty Limited.
	2. Jannes Klaas (2019). <i>Machine Learning for Finance</i> . Publisher: Packt Publishing-ISBN: 9781789136364	5. German G. Creamer, Gary Kazantsev, and Tomaso Aste (2021). <i>Machine Laerning and AI in Finance</i> . Routledge, an imprint of the Taylor & Francis Group.
	3. Matthew F. Dixon, Igor Halperin and Paul Bllokon (2020). <i>Machine Learning in Finance: From Theory to Practice</i> . Springer Publication-ISBN: 9783030410674	6. Wesley J.Chun,"Core Python Applications Programming,3rd ed,Pearson,2016

Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice		
Level 1	Remember	40%	-	20%	-	40%	
Level 2	Understand	40%	-	20%	-	40%	
Level 3	Apply	10%	-	20%	-	10%	
Level 4	Analyze	10%	-	20%	-	10%	
Level 5	Evaluate	-	-	10%	-	-	
Level 6	Create	-	-	10%	-	-	
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Vishwa Prasath T S Technology Analyst Accenture Pvt Ltd	1. Mr.C.M.T.Karthikeyan, Asst. Professor, Government College of Engineering - Bargur	1. Dr. P.Rajasekar, SRMIST

<b>Course Code</b>	21CSE427T	<b>Course Name</b>	AUGMENTED AND VIRTUAL REALITY	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	Data Science and Business Systems	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>			
<b>CLR-1:</b>	Learning various functions of Virtual Reality and Augmented Reality for 3D applications												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>		
<b>CLR-2:</b>	Exploring the hardware and softwares for VR and AR for many applications																
<b>CLR-3:</b>	Knowing about the challenges for implementation especially in VR and AR																
<b>CLR-4:</b>	Utilities of hardware and software for closely real time usage for AR and VR																
<b>CLR-5:</b>	Explore the possibilities of brain computing interface with the applications of VR																
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	<b>Program Specific outcomes</b>			
<b>CO-1:</b>	Understand AR and VR applications in real time												-	PSO-1	PSO-2	PSO-3	
<b>CO-2:</b>	Learn the requirements of Hardwares and softwares												-	-	-	2	-
<b>CO-3:</b>	Analyse the Challenges in AR and VR												-	-	-	2	-
<b>CO-4:</b>	Create applications close to reality												-	-	-	2	-
<b>CO-5:</b>	Create Brain Computer Interface with VR												-	-	-	1	-

<b>Unit-1 - Applications of VR and AR</b>	<b>9 Hour</b>
Virtual reality in industry, Augmented reality and industrial applications, VR-AR for industrial renewal, augmented reality, Computer-assisted surgery, Virtual reality and simulation for learning, Augmented reality and intervention planning, Augmented reality in surgery, Current conditions and future prospects, Sustainable cities, Mobility aids in an urban environment, Building and architecture, Cities and urbanism, Towards sustainable urban systems, Innovative, integrative and adaptive societies, Education, Arts and cultural heritages.	

T1: VR and AR for Industrial applications , T2: Augmented Reality for building and architecture , T3: Sustainable solutions using AR and VR

<b>Unit-2 - Hardwares and Softwares</b>	<b>9 Hour</b>
Positioning and orientation devices, Restitution devices, Technological challenges and perspectives, software, developing 3D applications, Managing peripheral devices, Dedicated VR-AR software solutions, sensory-motor actions for interaction, multisensory feedback, users and perception, Visual perception.	

T4: Sensors for AR and VR, T5: Hardwares for AR and VR, T6: Softwares for AR and VR

<b>Unit-3 - Challenges</b>	<b>9 Hour</b>
Physical model and detecting collisions, Populating 3D environments: single virtual human to a surging crowd, the difficulty of making 3D interaction natural, the difficulty of synthesizing haptic feedback, the real-virtual relationship in augmented reality, Acquisition and restitution equipment, Pose computation, Realistic rendering, Complexity and scientific challenges of 3D interaction, Complexity and challenges surrounding the 3D interaction loop.	

T7: Collisions in digital reality, T8: Synthesizing in digital reality , T9: Complexity in digital reality

<b>Unit-4 – Close to Real World</b>	<b>9 Hour</b>
Choosing a display device, Spatial localization, Topics in AR, Hybridization through a screen or HMD, Spatial augmented reality, Hybridization of the real world and the virtual world, Current evolutions, Presence in augmented reality, Mixed reality, From mixed reality to mixed presence, Augmented reality, 3D interaction on tactile surfaces T10: Head Mounted Display, T11: Hybridization of real world, T12: Tactile Stimulation	
<b>Unit-5 – Immersive Medium with Brain</b>	
Polymorphic immersive medium, promised experiences, Brain-computer interfaces, Working principle of BCIs, Current applications of BCIs, The future of BCIs, Alternative perceptions in virtual reality, Pseudo-sensory feedback, Alternative perception of movement, Sensorimotor incoherences, Mitigation of the impact on visuo-vestibular incoherence T13: Brain Computer Interface, T14: Alternative Perceptions, T15: Sensorimotor Incoherences	

<b>Learning Resources</b>	1. Bruno Arnaldi, Pascal Guitton, Guillaume Moreau, "Virtual Reality and Augmented Reality: Myths and Realities", ISBN: 978-1-786-30105-5 May 2018 Wiley-ISTE	4. Jesse Glover, Jonathan Linowes – Complete Virtual Reality and Augmented Reality Development with Unity: Leverage the power of Unity and become a pro at creating mixed reality applications. Packt publishing, 17 <sup>th</sup> April 2019. ISBN -13: 978-1838648183
	2. Jesse Glover, Jonathan Linowes – Complete Virtual Reality and Augmented Reality Development with Unity: Leverage the power of Unity and become a pro at creating mixed reality applications. Packt publishing, 17 <sup>th</sup> April 2019. ISBN -13: 978-1838648183	5. Jonathan Linowes, Krystian Babilinski – Augmented Reality for Developers: Build practical augmented reality applications with Unity, ARCore, ARKit, and Vuforia. Packt publishing, 9 <sup>th</sup> October 2017. ISBN-13: 978-1787286436), "Retail Analytics: The Secret Weapon", Wiley, ISBN- 978-1-118-09984-1
	3. Jonathan Linowes, Krystian Babilinski – Augmented Reality for Developers: Build practical augmented reality applications with Unity, ARCore, ARKit, and Vuforia. Packt publishing, 9 <sup>th</sup> October 2017. ISBN-13: 978-1787286436), "Retail Analytics: The Secret Weapon", Wiley, ISBN- 978-1-118-09984-1	

Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	40%	-	20%	-	40%	-		
Level 2	Understand	40%	-	20%	-	40%	-		
Level 3	Apply	10%	-	20%	-	10%	-		
Level 4	Analyze	10%	-	20%	-	10%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	10%	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Ravikumar, CEO at Hackwit Technologies Pvt Ltd, Chennai.	1. Prof. Indra kishor, Department of Computer Science and Engineering, Poornima Institute of Engineering & Technology, Jaipur, Rajasthan.	1. Dr. R. Rajkumar, SRMIST

<b>Course Code</b>	21CSE428T	<b>Course Name</b>	HEALTHCARE ANALYTICS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Familiarize with Healthcare Data Analytics, EHR												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Understand the technologies for analyzing Biomedical Image															
<b>CLR-3:</b>	Familiarize with predictive modeling techniques for Clinical Data															
<b>CLR-4:</b>	Familiarize with predictive analysis techniques for genomic data															
<b>CLR-5:</b>	Understand about NLP and Data mining for clinical text															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12			
<b>CO-1:</b>	Gain knowledge on Healthcare Data Analytics, EHR												-	-	-	-
<b>CO-2:</b>	Understand the technologies for analyzing Biomedical Image												-	-	-	2
<b>CO-3:</b>	Apply predictive modeling techniques for Clinical Data												-	-	-	1
<b>CO-4:</b>	Apply predictive analysis techniques for genomic data												-	-	-	2
<b>CO-5:</b>	Gain knowledge on NLP and Data mining for clinical text												-	-	-	1

**Unit-1 - An Introduction to Healthcare Data Analytics** 9 Hour  
 Healthcare Data Sources and Basic Analytics- Advanced Data Analytics for Healthcare- Applications and Practical Systems for Healthcare- Resources for Healthcare Data Analytics- Electronic Health Records- Components of HER- Coding Systems- Benefits of HER- Barriers to Adopting HER- Challenges of Using EHR Data  
 T1: Understanding HER, T2: Preprocessing of HER – Standardization, Data Cleaning, T3: Preprocessing of HER – Redundant data removal, Missing data

**Unit-2 - Biomedical Image Analysis** 9 Hour  
 Biomedical Imaging Modalities- Object Detection- Image Segmentation- Image Registration- Feature Extraction- Mining of Sensor Data in Healthcare- Mining Sensor Data in Medical Informatics- Challenges in Healthcare Data Analysis- Sensor Data Mining Applications  
 T4: Biomedical Image Processing – enhancement, restoration, segmentation, Compression, T5: Biomedical Image Analysis Techniques – SIFT, RANSAC, CNN, T6: Biomedical Image - Visualization

**Unit-3 - Predictive Models for Integrating Clinical and Genomic Data** 9 Hour  
 Introduction- Issues and Challenges- Different Types of Integration- Different Goals of Integrative Studies- Validation- Information Retrieval for Healthcare- Knowledge-Based Information in Healthcare and Biomedicine- Content of Knowledge-Based Information Resources- Indexing- Retrieval- Evaluation- Research Directions  
 T7: Patient prediction for Improved staffing, T8: Using healthcare data for Informed Strategic Planning - Part 1, T9: Using healthcare data for Informed Strategic Planning – Part 2

**Unit-4 - Natural Language Processing and Data Mining for Clinical Text** 9 Hour  
 Natural Language Processing- Mining Information from Clinical Text- Challenges of Processing Clinical Reports- Clinical Applications- Social Media Analytics for Healthcare- Social Media Analysis for Detection and Tracking of Infectious Disease Outbreaks- Social Media Analysis for Public Health Research- Analysis of Social Media Use in Healthcare  
 T10: Classification and Clustering of Clinical Text Data, T11: Information Extraction and Entity Recognition of Clinical Text Data, T12: Ranking and word disambiguation of Clinical Text Data

<b>Unit-5 - Advanced Data Analytics for Healthcare</b>		<b>9 Hour</b>
Automated Decision Systems - The Artificial Intelligence field - Basic concepts of Expert Systems - Applications of Expert Systems - Structure of Expert Systems - Knowledge Engineering - Development of Expert Systems – Location-based Analytics - Cloud Computing - Business Intelligence		
T13: Dimensionality reduction for exploratory data analysis in daily medical research, T14: Analyzing the complexity of behavioral factors influencing WEIGHTS IN ADULTS – Part 1		
T15: Analyzing the complexity of behavioral factors influencing WEIGHTS IN ADULTS – Part 2		

<b>Learning Resources</b>	1. <i>Analytics in Healthcare-A Practical Introduction</i> , Christo El Morr, Hossam Ali-Hassan, 2019 2. <i>Healthcare Data Analytics</i> , Charu C. Aggarwal
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Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. S. Santhosh, Manager of Team, Product Owner	1. Dr. M. Manikandan, Professor, MIT Campus, Anna University	1. Dr. T. Karthick, SRMIST

<b>Course Code</b>	21CSE429T	<b>Course Name</b>	DATA SCIENCE FOR INTERNET OF THINGS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Learn the basics of IoT analytics and the challenges involved in design of IoT												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Understand the devices, protocols and standards involved in IoT systems															
<b>CLR-3:</b>	Learn various real-world systems involving IoT sensor															
<b>CLR-4:</b>	Explore the smart applications development using IoT sensors and systems															
<b>CLR-5:</b>	Identify the possible applications in healthcare using IoT sensors and the IoT data analytics in this domain															
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Identify the challenges involved in the design of IoT Analytics systems															
<b>CO-2:</b>	Understand the internals of IoT devices and the sensor networks															
<b>CO-3:</b>	Design IoT Sensor networks for various real-world applications															
<b>CO-4:</b>	Develop smart applications using IoT sensors and analyse the data received from them															
<b>CO-5:</b>	Implement IoT healthcare systems and IoT Healthcare data analytical systems															

<b>Unit-1 - Defining IoT Analytics and Challenges</b>	<b>9 Hour</b>
The situation - Defining IoT analytics - Defining the Internet of Things - The concept of constrained - IoT analytics challenges - The data volume - Problems with time - Problems with space - Data quality - Analytics challenges - Business value concerns	

<b>Unit-2 - IoT Devices, Networking Protocols and Standards for Internet of Things</b>	<b>9 Hour</b>
IoT Devices-Healthcare-Manufacturing-Transportation and logistics-Retail-Oil and gas - Home automation or monitoring - Wearables - Sensor types-IoT Data Link Protocols-Network Layer Routing Protocols - Network Layer-Encapsulation Protocols -Session Layer Protocols-IoT Management Protocols-Security in IoT Protocols-IoT Challenges	

<b>Unit-3 - IoT Sensing, Mobile and Cognitive Systems</b>	<b>9 Hour</b>
Sensing Technologies for Internet of Things - IoT Interactions with GPS, Clouds and Smart Machines - Radio Frequency Identification (RFID) - Sensors, Wireless Sensor Networks and GPS Systems - Cognitive Computing Technologies and Prototype Systems – Problems	

<b>Unit-4 - Smart Applications IoT with Data Analytics</b>	<b>9 Hour</b>
Defragmenting Intelligent Transportation: A Practical Case Study -Connected and Autonomous Vehicles-Transit Hub: A Smart Decision Support System for Public Transit Operations – Smart Home Services Using the Internet of Things	

<b>Unit-5 - Case Studies in IoT Healthcare</b>	<b>9 Hour</b>
Big Data Analytics for Healthcare and Cognitive Learning - Machine Learning for Big Data in Healthcare Applications - Healthcare Problems and Machine Learning Tools - IoT-based Healthcare Systems and Applications, Emotional Insights via Wearables- Structural Health Monitoring-Home Healthcare and Remote Patient Monitoring	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>Analytics for the Internet of Things (IoT) by Andrew Minteer, Released July 2017, Publisher(s): Packt Publishing, ISBN: 9781787120730.</li> <li>Big-Data Analytics for Cloud, IoT and Cognitive Computing, Kai Hwang, Min Chen, ISBN: 978-1-119-24729-6 March 2017.</li> <li>Internet of Things and Data Analytics Handbook, Hwaiyu Geng (Editor) - ISBN: 978-1-119-17364-9 January 2017</li> <li>David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017</li> <li>Arshdeep Bahga, Vijay Madisetti, Internet of Things – A hands-on approach, Universities Press, 2015</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>			
	<i>Bloom's Level of Thinking</i>	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	40%	-	20%	-	40%	-		
Level 2	Understand	40%	-	20%	-	40%	-		
Level 3	Apply	10%	-	20%	-	10%	-		
Level 4	Analyze	10%	-	20%	-	10%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	10%	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
	1. Dr.I.Joe Louis Paul, Associate Professor, SSN College of Engineering	1. Dr K.Shantha Kumari, SRMIST

<b>Course Code</b>	21CSE430T	<b>Course Name</b>	AUTOMATIC SPEECH RECOGNITION	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Utilize Language models with regular expressions												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Understand the lexical analysis and neural networks in text processing															
<b>CLR-3:</b>	Understand the machine translation process and deep learning architecture for speech recognition															
<b>CLR-4:</b>	Utilize information extraction and relation extraction applications															
<b>CLR-5:</b>	Construct Automatic speech recognitions applications using Chatbots															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12			
<b>CO-1:</b>	Understand efficient text classification process															
<b>CO-2:</b>	Implement programs using the lexical analysis and neural networks in text processing													2	-	-
<b>CO-3:</b>	recognize the speech recognition models using deep learning architecture													2	-	-
<b>CO-4:</b>	model using information extraction													2	-	-
<b>CO-5:</b>	Implement ASR Applications with chatbots													2	-	-

<b>Unit-1 - Introduction to Speech and Language Processing</b>	<b>9 Hour</b>
Knowledge in speech and language processing-ambiguity-models and algorithms: Regular expression-words, corpora-Text normalization-N Grams-Sampling sentences-smoothing techniques- Vector Semantics and Embeddings, Lexical Semantics, Vector Semantics, Words and Vectors, TF-IDF: Weighing terms in the vector, word to vec, Visualizing Embeddings	
T1. Regular expressions	
T2. Text preprocessing methods using TF-IDF	
T3. Implement Kneser-Ney Smoothing technique	
<b>Unit-2 - Introduction to Neural Predictive Networks</b>	<b>9 Hour</b>
Fundamentals of Neural networks- Linked Predictive Neural Networks - Extensions - Weaknesses of Predictive Networks - Frame Level Training- word level training- and Neural Language Models- Advantages of NN-HMM hybrids	
T4 speech recognition experiment using LPNN	
T5. Design and train a perceptron training for OR gate.	
<b>Unit-3 - RNN in Speech Recognition</b>	<b>9 Hour</b>
Part-of-Speech Tagging, HMM Part-of-Speech Tagging, Rule based POS Tagging- RNN for Sequence Processing, Managing Context in RNNs: LSTMs and GRUs, Self-Attention Networks: Transformers ,Machine Translation and Encoder-Decoder Models, Language Divergences and Typology, The Encoder-Decoder Model	
T6. POS exercise	
T7. Exercise for RNN scenario for HMM	

**Unit-4 - Computational Semantics and Semantic Parsing -Phonetics****9 Hour**

Information Extraction, Relation Extraction, Relation Extraction Algorithms, Word Senses and WordNet, Word Senses, Relations Between Senses, Semantic Roles- Diathesis Alternations- FrameNet-Phonetics-Articulatory Phonetics- Phonological Categories and Pronunciation Variation- Acoustic Phonetics and Signals

T8. Relation extraction process

T9. Frame net generation

T10. Simulation of original Lesk word overlap disambiguation algorithm

**Unit-5 - Text to Speech Conversion****9 Hour**

Automatic Speech Recognition and Text-to-Speech, The Automatic Speech Recognition Task, Feature Extraction for ASR: Log Mel Spectrum, Speech Recognition Architecture, CTC, and ASR Evaluation: Word Error Rate, TTS.

T11. Text to speech conversion

T12. Log mel spectrum techniques

T13. Chatbot creation

Learning Resources	1. Daniel Jurafsky and James H. Martin, "Speech and Language Processing", 3rd edition draft, 2019 [JM-2019]	4. Dong Yu, Li Deng, Signals, and Communications, "Automatic speech recognition" A Deep Learning approach, ISBN 978-1-4471-5779-3 (eBook)
	2. Mark Gales and Steve Young, The application of hidden Markov models in speech recognition, Foundations and Trends in Signal Processing, 1(3):195-304, 2008.	5. Speech Recognition using Neural Networks, Joe Tebelskis, "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition", Feb 2008
	3. Geoffrey Hinton, Li Deng, Dong Yu, George E. Dahl, Abdel-rahman Mohamed, Navdeep Jaitly, Andrew Senior, Vincent Vanhoucke, Patrick Nguyen, Tara N. Sainath, and Brian Kingsbury, Deep Neural Networks for Acoustic Modeling in Speech Recognition, IEEE Signal Processing Magazine, 29(6):82-97, 2012	

**Learning Assessment**

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice		
Level 1	Remember	40%	-	20%	-	40%	
Level 2	Understand	40%	-	20%	-	40%	
Level 3	Apply	10%	-	20%	-	10%	
Level 4	Analyze	10%	-	20%	-	10%	
Level 5	Evaluate	-	-	10%	-	-	
Level 6	Create	-	-	10%	-	-	
	Total	100 %		100 %		100 %	

**Course Designers**

Experts from Industry

Experts from Higher Technical Institutions

Internal Experts

1. Dr D Hemavathi SRMIST

<b>Course Code</b>	21CSE447T	<b>Course Name</b>	ROBOTICS: COMPUTATIONAL MOTION PLANNING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Acquire knowledge of Bug algorithms and configuration Space												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Acquire knowledge of Potential functions and Navigations															
<b>CLR-3:</b>	Acquire knowledge of Sampling Algorithms															
<b>CLR-4:</b>	Gain knowledge of filtering techniques															
<b>CLR-5:</b>	Gain knowledge about Trajectory and Motion Planning and Design motion plan for Robot in the path specified															
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>															
<b>CO-1:</b>	Apply knowledge of Bug algorithms and configuration Space															2
<b>CO-2:</b>	Apply knowledge of Potential functions and Navigations															2
<b>CO-3:</b>	Apply knowledge of Sampling Algorithms															1
<b>CO-4:</b>	Gain knowledge of filtering techniques															1
<b>CO-5:</b>	Gain knowledge about Trajectory and Motion Planning															2

<b>Unit-1 - Introduction to Motion Planning and Bug Algorithms</b>																
<b>9 Hour</b>																
Overview of Motion Planning - Bug1 And Bug 2, Tangent Bug, Implementation: The Tangent Line, Distance On Gradient, Continuation Method, Robot Configuration Specification, Circular Mobile Robot, Two joint planer arm, Dimension Of The Configuration Space, Topology of configuration space: Homeomorphisms and Diffeomorphisms, Differentiable Manifolds, Examples.																
T1: Using Bug Algorithms implement Tangent Line, Distance and Gradient, Continuation Methods.																
T2: Implementation of Configuration space																
T3: Implementation of Matrix Representations of Rigid-Body Configuration																
<b>Unit-2 - Potential Functions and Roadmaps</b>																
<b>9 Hour</b>																
Potential Function: Addictive Attractive/Repulsive Potential, Gradient Descent, Computing Distance From Implementation In The Plane, Local Minima Problem, Wave-Front Planner, Navigation Potential Function: Sphere- Space Star-Space, Potential Functions for Rigid-Body Robots, Path Planning for Articulated Bodies, Visibility Graph, Deformation Retracts : Generalized Voronoi Diagram, Retract-Like Structure: Generalized Voronoi Graph, Piecewise Retracts: The Rod Hierarchical Generalized Voronoi Graph Silhouette Methods.																
T1: Using Potential Functions implementation of Mobile Robot																
T2: Using GVD for deformation retracts																
T3: Implementation using Silhouette Methods																

<b>Unit-3 - Sampling Based Algorithms</b>	<b>9 Hour</b>
Probabilistic Road Maps: Basic PRM, Implementation of basic PRM, PRM sampling Strategies, PRM connection Strategies, Single-Query Sampling Based Planners: Expensive Spaces Trees, Rapidly Exploring Random Trees, Connection Strategies and SBL Planner, Integration of Planners Sampling Based Roadmap, Analysis Of PRM, Control based Planning, Multiple Robots, Manipulation Planning, Assembly Planning.	
T1: Implementation of basic Probabilistic Road Maps	
T2: Analysis of Probabilistic Road Maps	
T3: Implementation of beyond Basic Path Planning	
<b>Unit-4 - Filtering</b>	<b>9 Hour</b>
Linear Kalman Filtering - Kalman Filter: Example - Bayesian Methods: Localization - Basic Idea Probabilistic Localization - Probabilistic Localization As Recursive Bayesian Filtering - Derivation Of Probabilistic Localization - Representation Of Posterior - Sensor Model - Mapping:: Mapping with known Locations - Bayesian Simultaneous Localization and Mapping	
T1: Implementation of Linear Kalman Filtering for Dead Reckoning	
T2: Implementation of Sensor Models	
T3: Study of Bayesian Simultaneous Localization and Mapping	
<b>Unit-5 - Trajectory Planning</b>	<b>9 Hour</b>
Trajectory Planning: Preliminaries - Decoupled Trajectory Planning - Direct Trajectory Planning: Optimal Control - Nonlinear Optimization - Grid-Based Search - Nonholonomic And Underactuated Systems: preliminaries - Control Systems – Controllability - Motion Planning: Optimal Control - Steering Chained-Form Systems Using Sinusoids - Nonlinear Optimization	
T1: Using Trajectory Planning Implement Grid Based Search algorithm	
T2: Using Nonholonomic and Underactuated Systems Implement Simple Mechanical Control Systems	
T3: Implementation of Motion Planning for Cars and Cars Pulling Trailers	

<b>Learning Resources</b>	1. HowieM.Choset, Seth Hutchinson, Kevin M.Lynch, George Kantor, Wolf ram Burgard, LydiaE. Kavraki, Sebastian Thrun, "Principles of Robot Motion: Theory, Algorithms, and Implementation". 2. Jean-Claude Latombe,"Robot Motion Planning", Springer Science & Business Media, 2012	3. <a href="http://robotics.stanford.edu/~latombe/cs326/2009/schedule.htm">http://robotics.stanford.edu/~latombe/cs326/2009/schedule.htm</a>
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<b>Bloom's Level of Thinking</b>		<b>Continuous Learning Assessment (CLA)</b>				<b>Summative Final Examination (40% weightage)</b>	
		<b>Formative CLA-1 Average of unit test (50%)</b>		<b>Life-Long Learning CLA-2 (10%)</b>			
		<b>Theory</b>	<b>Practice</b>	<b>Theory</b>	<b>Practice</b>	<b>Theory</b>	<b>Practice</b>
Level 1	Remember	40%	-	20%	-	40%	-
Level 2	Understand	40%	-	20%	-	40%	-
Level 3	Apply	10%	-	20%	-	10%	-
Level 4	Analyze	10%	-	20%	-	10%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	10%	-	-	-
	Total	100 %		100 %		100 %	

<b>Course Designers</b>		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts 1. Dr.A.Shanthini, SRMIST

<b>Course Code</b>	21CSE448T	<b>Course Name</b>	BIO-INSPIRED COMPUTING AND FUZZY LOGIC	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		Program Outcomes (PO)												<b>Program Specific outcomes</b>			
1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3			
Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning						
<b>CLR-1:</b> Learn the fundamentals of evolutionary theory	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
<b>CLR-2:</b> Learn nature-inspired algorithms and the neural network systems	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
<b>CLR-3:</b> Learn optimization algorithms for feature selection	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
<b>CLR-4:</b> Learn the Genetic algorithm concepts	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
<b>CLR-5:</b> Become familiar with fuzzy logic techniques	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Program Outcomes (PO)												<b>Program Specific outcomes</b>			
1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3			
Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning						
<b>CO-1:</b> understand basic concepts of evolutionary algorithm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
<b>CO-2:</b> implement nature-inspired algorithms and the basics of neural network concepts	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
<b>CO-3:</b> implement the biological background of optimization algorithms	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
<b>CO-4:</b> code for genetic algorithms concepts	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
<b>CO-5:</b> apply fuzzification and defuzzification concepts	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-

<b>Unit-1 - Introduction to Evolutionary Algorithms</b>	<b>9 Hour</b>
Introduction- Learning from Biology- Nature's Way for Optimizing: Algorithm Meets Evolution, The Flavors of Evolutionary Algorithms - Dissecting an Evolutionary Algorithm: The Fitness Function, Initialization, Selection, Recombination, Mutation, Replacement - Fields of Application of Evolutionary Algorithms	
T1: Study of basic concepts of python programming	
T2: Implementation of population concept	
T3: Implementation of selection concept	

<b>Unit-2 - Nature-Inspired Algorithms</b>	<b>9 Hour</b>
Simulated Annealing, Genetic Algorithms, Differential evolution, Ant and Bee Algorithms, Firefly algorithms, Cuckoo algorithms, Bat algorithm, Harmony search, Flower algorithms, Overview of Neural Networks Models: Single and Multi-Layer Perceptron	
T4: Implementation of Firefly Algorithm	
T5: Implementation of Bat algorithm	
T6: Implementation of single and multi-layer perceptron	

<b>Unit-3 - Optimization algorithms</b>	<b>9 Hour</b>
Optimization- Classical Optimization- Taxonomy of optimization problem- continuous optimization - Algorithms for continuous optimization: Unconstrained optimization - constrained optimization. Ant colony optimization: Ant algorithms, ant system, Max min, Ant system. Particle Swarm Optimization- Properties of PSO, Discrete version, application.	
T7: Implementation of Classical optimization	
T8: Implementation of Ant colony optimization	
T9: Implementation of particle swarm optimization	

<b>Unit-4 - Genetic algorithms</b>	<b>9 Hour</b>
History of Genetic Algorithm, Basic concepts- Creation of offspring, working principles, encoding, fitness function, reproduction, Genetic modeling- Inheritance operator, crossover, inversion & deletion, mutation operator, Bitwise operator, Generational Cycle, Convergence of GA, Applications & advances in GA, Differences & similarities between GA & another traditional method, Hybrid systems, evolutionary computing, Genetic Algorithm based on Backpropagation networks- Implementation and comparison on the performance of traditional algorithms with Genetic Algorithm	
T10: Implementation of the fitness function	
T11: Implementation of mutation and cross over	
T12: Implementation of complete genetic algorithm	
<b>Unit-5 - Fuzzy Logic</b>	<b>9 Hour</b>
Introduction to Fuzzy Logic-Fuzzy sets and membership functions-Operations on Fuzzy sets-Fuzzy relations, rules, propositions, implications, and inferences-Defuzzification techniques-Fuzzy logic controller design-Some applications of Fuzzy logic.	
T13: Implementation of fuzzy set operations	
T14: Implementation of fuzzy logic functions (fuzzification and defuzzification)	
T15: Implementation of fuzzy inference	

<b>Learning Resources</b>	1. Stephan Olariu, Albert Y. Zomaya (2006), <i>Handbook of Bioinspired Algorithms and Applications</i> , Taylor & Francis Group, LLC. 2. Wahde, M. (2008). <i>Biologically Inspired Optimization Methods: An Introduction</i> . United Kingdom: WIT Press.	3. George J. Klir (2015), <i>Fuzzy Sets and Fuzzy Logic: Theory and Applications</i> , Prentice Hall. 4. Dennis Mou Ling Wong, Pan Zheng, Tao Song, Xun Wang (2019) <i>Bio-inspired Computing Models and Algorithms</i> . Japan: World Scientific Publishing Company.
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Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	40%	-	20%	-	40%	-		
Level 2	Understand	40%	-	20%	-	40%	-		
Level 3	Apply	10%	-	20%	-	10%	-		
Level 4	Analyze	10%	-	20%	-	10%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	10%	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr.A Alkaff Ahamed, Software Developer Associate, Ceridian	1. Dr.L.Jayakumar, NIT Tripura	1. Dr.A.Shanthini, SRMIST

<b>Course Code</b>	21CSE449T	<b>Course Name</b>	RISK ANALYTICS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co-requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		Program Outcomes (PO)												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Learn risk assessment, management, and analytics	1	2	3	4	5	6	7	8	9	10	11	12			
<b>CLR-2:</b>	Comprehend the functioning of Banking and apply analytic techniques to mitigate risks	-	-	-	-	-	-	-	-	-	-	-	-			
<b>CLR-3:</b>	Explore the operations of Insurance sector	-	-	-	-	-	-	-	-	-	-	-	-			
<b>CLR-4:</b>	Analyze the processes involved in healthcare industry and use data analysis to improve patient care and optimize cost	-	-	-	-	-	-	-	-	-	-	-	-			
<b>CLR-5:</b>	Utilize human relationship management techniques for effective management of people	-	-	-	-	-	-	-	-	-	-	-	-			

  

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Program Outcomes (PO)												<b>Program Specific outcomes</b>		
<b>CO-1:</b>	Understand risk assessment, management, and analytics	1	2	3	4	5	6	7	8	9	10	11	12			
<b>CO-2:</b>	Understand the functioning of banking sector for risk mitigation	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
<b>CO-3:</b>	Identify the operations of insurance sector and the associated risks	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
<b>CO-4:</b>	Appreciate the processes used in healthcare for optimal services	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
<b>CO-5:</b>	Effectively manage people using relationship management techniques	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2

<b>Unit-1 - Risk Introduction and Impacts</b>	<b>9 Hour</b>
Risk Definition and Examples, Components and Factors, Understanding Risk Assessment, Risk Mitigation, Risk Management, Risk Analytics Introduction, Risk Analytics Definition and Objectives	
T1: Discussion with case studies on impacts with risks	
T2: Risk mitigation and management plan document	
T3: Explore Risk Analytics	

<b>Unit-2 - Introduction to Banking Sector</b>	<b>9 Hour</b>
Introduction to Banking Sector, National and International laws, Credit Risk Analytics, Internal capital Adequacy Assessment Process, Internal capital Adequacy Assessment Process Related Risk Analytics, Limit Management, Risk-Adjusted Performance Management, Fraud Risk	
T4: Compare national and international banking laws with case studies and papers	
T5: Internal capital Adequacy Assessment Process Related Risk Analytics	
T6: Risk-Adjusted Performance Management	

<b>Unit-3 - Introduction to Insurance Sector</b>	<b>9 Hour</b>
Property & Causality Insurance Companies, Life Insurance Companies, Using Analytics for Customer Acquisition and Retention, Detecting Fraud, Preventing Fraud, Managing Fraud, Detecting, Preventing and Managing Fraud using Analytics	
T7: A comprehensive study on Insurance sector App	
T8: Implementation of parsing RSS and HTML, pickling	
T9: Fraud Handling using analytics	

<b>Unit-4 - Introduction to Healthcare Sector</b>	<b>9 Hour</b>
HIPAA, Four Enterprise Disciplines of Health Analytics, Health Outcome Analysis, Customer Insights, Health Value and Cost, Actuary Services, Framework for Customer Analytics,	
T10: A survey on healthcare standards – national and international	
T11: Health Value, Cost and Outcome analysis	
T12: Explore available frameworks for customer analytics	
<b>Unit-5 - Introduction to HR Analytics</b>	<b>9 Hour</b>
Workforce Environment and Psychology, Talent Management, understanding retention, Predicting Retention, Boosting Employee Engagement, Sources of Hire, Quality of Hire, Profiling High Performers	
T13: Analyze workforce Psychology and Talent Management	
T14: Retention and employee engagement analytics	
T15: Analyze hiring processes and profiling performers	

<b>Learning Resources</b>	1. Naeem Siddiqi, "Credit Risk Scorecards: Developing and Implementing Intelligent Credit Scoring", ISBN 978-0-471-75451	4. Jason Burke, "Health Analytics: Gaining the Insights to Transform Health Care", John Wiley Sons Inc., 2013, ISBN: 978-1-118-38304-9
	2. Patrical L. Saporito, "Applied Insurance Analytics", FT Press, 2015, ISBN-10:0-13-3760-36-7.	5. Jac Fitz-Enz, John R. Mattox II, "Predictive Analytics for Human Resources", ISBN-13: 978-8126552153.
	3. Laura B. Madsen, "Data-Driven Healthcare: How Analytics and BI are Transforming the Industry", M.S. ISBN 978-1-118-77221-8	6. James C. Sesil, "Applying Advanced Analytics to HR Management Decisions: Methods for Selection, Developing Incentives, and Improving Collaboration", ISBN-13: 978- 0133064605

Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	40%	-	20%	-	40%	-		
Level 2	Understand	40%	-	20%	-	40%	-		
Level 3	Apply	10%	-	20%	-	10%	-		
Level 4	Analyze	10%	-	20%	-	10%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	10%	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
		1. Dr.D.Rajeswari , SRMIST

**ACADEMIC CURRICULA**

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Regulations 2021

Volume - 11L

(Syllabi for M.Tech (Integrated) Computer Science and  
Engineering w/s in Cognitive Computing Programme  
Courses)



**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

# ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021



**SRM**

INSTITUTE OF SCIENCE & TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

<b>Course Code</b>	21CSC505T	<b>Course Name</b>	COMPUTER GRAPHICS AND VISION	<b>Course Category</b>	C	PROFESSIONAL CORE	L 3	T 1	P 0	C 4
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Introduce algorithms for line, circle, and ellipse												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	Enumerate Two dimensional geometric transformations and clipping operations																								
<b>CLR-3:</b>	Illustrate Three-dimensional object representations, transformation and viewing																								
<b>CLR-4:</b>	Articulate Object recognition and feature detection																								
<b>CLR-5:</b>	Discuss the applications of motion estimation																								
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Write algorithms for drawing line, circle, and ellipses.												3	3	-			-	-	-	-	-	-	1	
<b>CO-2:</b>	Perform two dimensional geometric transformations												3	2	-			-	-	-	-	-	-	1	
<b>CO-3:</b>	Practice three dimensional geometric transformations												3	2	-			-	-	-	-	-	-	2	
<b>CO-4:</b>	Determine the models for object recognition and feature detection												3	2	-			-	-	-	-	-	-	2	
<b>CO-5:</b>	Interpret the models for motion estimation												2	2	-			-	-	-	-	-	-	3	

<b>Unit-1 - Introduction</b>	<b>12 Hour</b>
Output primitives – points and lines, line drawing algorithms, loading the frame buffer, line function; circle and ellipse generating algorithms; Pixel addressing and object geometry, filled area primitives. Attributes of output primitives – Line attributes, curve attributes, Color and gray scale levels, Area fill attributes, Character attributes, and Bundled attributes, Inquiry functions, Antialiasing.	
Tutorials: T1: Find out the algorithm for circle generation or curve generation. T2: How does anti-aliasing help to improve graphics?, T3: Identify the different animation functions based on the types of output primitives.	

<b>Unit-2 - Two Dimensional Geometric Transformations</b>	<b>12 Hour</b>
Matrix representations and homogeneous coordinates, composite transformations; Two-dimensional viewing – viewing pipeline, viewing coordinate reference frame; window-to-viewport coordinate transformation, Two dimensional viewing functions; clipping operations – point, line, and polygon clipping algorithms.	
Tutorials: T1: Write a code to get one image as input and apply all 2d transformations on the given image. T2: What are the different types of polygons and various polygon clipping algorithms? T3: Write a program to make puzzle game.	

<b>Unit-3 - Three Dimensional Concepts</b>	<b>12 Hour</b>
Three-dimensional object representations – Polygon surfaces- Polygon tables- Plane equations – Polygon meshes; Curved Lines and surfaces, Quadratic surfaces; Blobby objects; Spline representations – Bezier curves and surfaces -B-Spline curves and surfaces. TRANSFORMATION AND VIEWING: Three dimensional geometric and modeling transformations – Translation, Rotation, Scaling, composite transformations; Three-dimensional viewing – viewing pipeline, viewing coordinates, Projections, Clipping; Visible surface detection methods.	
Tutorials: T1: Apply different 3d transformations on the given input image and show the result. T2: Given a bezier curve with 4 control points-B0 [1 0], B1 [3 3], B2 [6 3], B3 [8 1], Determine any 5 points lying on the curve. Also, draw a rough sketch of the curve. T3: Write a code to implement projections in an image.	

<b>Unit-4 - Introduction to Computer Vision</b>	<b>12 Hour</b>
Recognition - Instance Recognition – Image Classification – Object detection – Semantic segmentation - Feature detection and matching – Points and Patches – Edges and contour – Contour tracking – Lines and Vanishing points. Case study - Pose estimation and Hand written recognition	
Tutorials: T1: Write the different applications of computer vision. T2: Name the different feature detection and keypoints that can be used in person identification application. T3: How active contours are used in different real time applications.	
<b>Unit-5 - Motion Estimation</b>	<b>12 Hour</b>
Translational alignment – Parametric motion – Video stabilization – Spline based motion - medical image registration – Optical flow – Deep learning approaches – Rolling shutter wobble removal - Multi frame motion estimation – Video denoising – Layered motion – Frame interpolation – Transparent layers and reflections – Video object segmentation – Video object tracking. Case study - Road Traffic Analysis and Autonomous Vehicle.	
Tutorials: T1: State the suitable deep learning approach in motion estimation algorithm. T2: Explore the different available AI video denoising softwares, T3: Identify the suitable CV algorithm used in autonomous vehicle applications and list out its challenges.	

<b>Learning Resources</b>	1. Donald Hearn and M. Pauline Baker, "Computer Graphics C Version", second edition,	2. Richard Szeliski,"Computer Vision: Algorithms and Applications",Springer,2010
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>	
<i>Bloom's Level of Thinking</i>	Formative CLA-1 Average of unit test (50%)	Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice		
Level 1	Remember	20%	-	10%	-	20%	
Level 2	Understand	20%	-	10%	-	20%	
Level 3	Apply	30%	-	40%	-	30%	
Level 4	Analyze	30%	-	40%	-	30%	
Level 5	Evaluate	-	-	-	-	-	
Level 6	Create	-	-	-	-	-	
	Total	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. shenbagavalli.pillai@axa.com.sg	1. Dr. Y.V.Lokeshwari - Associate Professor, SSN College of Engineering, Kalavakkam	1. Ms A L Amutha, SRMIST
2. shankarkpillai@qudact.com	2. Gopinath.cse@sairam.edu.in	

<b>Course Code</b>	21CSC506J	<b>Course Name</b>	COMPUTATION AND COGNITION: THE PROBABILISTIC APPROACH	<b>Course Category</b>	C	PROFESSIONAL CORE	<b>L</b>	T	P	C
							3	0	2	4

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the philosophical and psychological cognitive and generative approaches to modelling.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Analyze the basics of causal, conditional, and statistical dependence															
<b>CLR-3:</b>	Acquire the computational and Bayesian models for cognition															
<b>CLR-4:</b>	Implement the working pattern of cognitive architectures															
<b>CLR-5:</b>	Demonstrate the different cognitive architectures and cognitive robots															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12			
<b>CO-1:</b>	Acquire the knowledge philosophical, and psychological approaches in cognitive models and generative models															
<b>CO-2:</b>	Illustrate causal, conditional, and statistical dependence															
<b>CO-3:</b>	Demonstrate cognitive and Bayesian models															
<b>CO-4:</b>	Apply knowledge on computational psycholinguistics															
<b>CO-5:</b>	Design the cognitive robots and cognitive architectures															

<b>Unit-1 - Philosophical and Psychological</b>	<b>15 Hour</b>
Introduction; Philosophical- Psychological - Cognitive approaches to modeling the mind, - Neuroscientific foundations - The Brain I - The Brain II - The Brain III - Brain Recording Techniques- Animal Cognition - The relevance of computation; types of computation – Building Generative Models - Prediction, Simulation and Probabilities	
<b>Unit-2 - Casual, Conditional and Statistical Dependence</b>	<b>15 Hour</b>
Causal and statistical dependence - Detecting Dependence Through Intervention - Graphical Notations for Dependence - Priori Dependence to Conditional Dependence - Non-monotonic Reasoning	
<b>Unit-3 - Cognitive and Bayesian Models</b>	<b>15 Hour</b>
Symbolic representations and models of cognition - Debates about thinking, AI, and representation- Cognitive models and Bayesian inferencing - Bayesian models of cognition - Computational models of attention - Visual Attention; Audio and Multimodal Attention	
<b>Unit-4 - Cognitive Science</b>	<b>15 Hour</b>
Computational psycholinguistics-. Language and Cognitive Science - Language and Cognition - Word Processing - Cognitive architectures- cognitive system organization - Social Cognition – Communication and Language	
<b>Unit-5 - Cognitive Robotics and Applications</b>	<b>15 Hour</b>
Cognitive architectures; Cognitive robotics and embodied cognition - Applications: Audio quality assessment - compression & indexing - Applications: Image quality assessment, compression, Haptic interfaces- Memorability of images; Haptic/tactile displays - Audio Engineering: Quality Assessment; Audio Engineering: Spatial Audio; Audio Engineering: Perceptual.	

<b>Lab Experiments</b>						
Lab 1: Study the Retina Process	Lab 8: Implement the Morphology Technique					
Lab 2: Implement the Retina Computation Process	Lab 9: Demonstrate the Part-of-Speech tagging					
Lab 3: Demonstrate the Scene Statistics and Perception	Lab 10: Implement the Parsing Technique.					
Lab 4: Simulate the Intuitive Physics using Generative Model	Lab 11: Demonstrate the Stochastic Parsing					
Lab 5: Analyse the process of texture synthesis to artistic style transfer	Lab 12: Demonstrate the Audio Synthesis					
Lab 6: Demonstrate the Image Compression method	Lab 13: Implement the Audio Processing					
Lab 7: Implement and analyse the Tokenization/Lexicons/n-grams						
<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Jay Friedenberg and Gordon Silverman. <i>Cognitive Science: An Introduction to the Study of Mind</i>. SAGE Publications, 2006.</li> <li>2. E. Bruce Goldstein. <i>Sensation and Perception</i>. Wadsworth, 8th Edition, 2010.</li> <li>3. José Luis Bermúdez. <i>Cognitive Science: An Introduction to the Science of the Mind</i>. Cambridge, 4th Edition, 2022.</li> <li>4. Matthew J. Traxler. <i>Introduction to Psycholinguistics: Understanding Language Science</i>. Wiley- Blackwell, 2011.</li> <li>5. N. D. Goodman, J. B. Tenenbaum, and the ProbMods Contributors (2016). <i>Probabilistic Models of Cognition</i> (2nd ed.). Retrieved 2022-8-16 from <a href="https://probmods.org/">https://probmods.org/</a></li> <li>6. N. D. Goodman and A. Stuhlmüller (electronic). <i>The Design and Implementation of Probabilistic Programming Languages</i>. Retrieved 2022-8-16 from <a href="http://dippl.org">http://dippl.org</a>.</li> <li>7. Searle, John R. <i>Minds, Brains, and Programs</i>. Behavioral and Brain Sciences 3: 417–424 (1980) [doi: 10.1017/S0140525X00005756] [pdf].</li> <li>8. Pinker, Steven. <i>How the Mind Works</i>. Penguin, 1999.</li> <li>9. Fodor, Jerry. <i>The Mind Doesn't Work That Way: The Scope and Limits of Computational Psychology</i>. MIT, 2000.</li> <li>10. Thomas L. Griffiths, Charles Kemp, and Joshua B. Tenenbaum. <i>Bayesian models of cognition</i>. In Ron Sun (ed.), <i>The Cambridge handbook of computational cognitive modeling</i> (2008) [pdf]</li> </ol>					
<b>Learning Assessment</b>						
Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1 Remember	25%	-	-	10%	25%	-
Level 2 Understand	25%	-	-	20%	25%	-
Level 3 Apply	20%	-	-	30%	20%	-
Level 4 Analyze	20%	-	-	30%	20%	-
Level 5 Evaluate	10%	-	-	10%	10%	-
Level 6 Create	-	-	-	-	-	-
Total	100 %		100 %		100 %	
<b>Course Designers</b>						
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>				
1. Dr Vijay Daniel, Software Engineering Manager, MasterCard, Dublin, Ireland	1. Dr D Sumathi, Professor, VIT-AP, Amaravathi	1. Dr S Prithi, SRMIST				

# ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021



**SRM**  
INSTITUTE OF SCIENCE & TECHNOLOGY  
(Deemed to be University u/s 3 of UGC Act, 1956)

**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

**(Deemed to be University u/s 3 of UGC Act, 1956)**

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

<b>Course Code</b>	21CSE541T	<b>Course Name</b>	PROBABILISTIC GRAPHICAL MODELS: PRINCIPLES AND TECHNIQUES	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>	<i>The purpose of learning this course is to:</i>	<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>			
		1	2	3	4	5	6	7	8	9	10	11	12				
<b>CLR-1:</b>	Outline the ideas of probabilistic model used in probability theory, statistics, and machine learning																
<b>CLR-2:</b>	Illustrate directed and undirected graphical models																
<b>CLR-3:</b>	Gain knowledge on Inference in exact, approximate inferences with algorithms																
<b>CLR-4:</b>	Relate inference in MAP and temporal inference algorithms																
<b>CLR-5:</b>	Learn about different learning algorithms																
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>																
<b>CO-1:</b>	Understand the fundamentals of probability theory	1	-	-												PSO-1	
<b>CO-2:</b>	Learn the directed and undirected graphical models with example algorithms	2	-	-	-	-	-	-	-	-	-	-	-			PSO-2	
<b>CO-3:</b>	Understand the Inference in exact, approximate Inference with algorithms	-	-	-	2	-	-	-	-	-	-	-	-			PSO-3	
<b>CO-4:</b>	Analyze the Inference in MAP and Temporal Inference with algorithms	-	-	-	2	-	-	-	-	-	-	-	-				
<b>CO-5:</b>	Design different learning algorithms in graphical models	-	-	-	3	-	-	-	-	-	-	-	-				3

**Unit-1 - Fundamentals** 9 Hour  
Fundamentals of Probability Theory - Views of Probability, Random Variables and Joint Distributions, Conditional Probability, Conditional Independence, Expectation and Variance, Probability Distributions - Conjugate Priors, Introduction to Exponential Family; Fundamentals of Graph Theory - Paths, Cliques, Subgraphs, Cycles and Loops.

**Unit-2 - Graphical Models** 9 Hour  
Introduction - Directed Models -Bayesian Network, Undirected Models -Markov Random Fields, Dynamic Models -Hidden Markov Model & Kalman Filters and Factor Graph; Conditional Independence -Bayes Ball Theorem and D-separation, Markov Blanket, Factorization-Hammersley-Clifford Theorem, Equivalence: I-Maps & Perfect Maps; Factor Graphs - Representation, Relation to Bayesian Network and Markov Random Field.

**Unit-3 - Inference in Graphical Models** 9 Hour  
Exact Inference - Variable Elimination, Elimination Orderings, Relation to Dynamic Programming, Dealing with Evidence, Forward-Backward Algorithm, Viterbi Algorithm; Clique Tree Algorithm; Belief Propagation (Sum Product); Approximate Inference - Variation Methods-Kikuchi & Bethe Approximation, Expectation Propagation, Gaussian Belief Propagation;

**Unit-4 - Inference in MAP and Temporal** 9 Hour  
Max-Product, Graph Cuts, Linear Programming Relaxations to MAP: Tree-Reweighted Belief Propagation, MPLP; Sampling - Markov Chain Monte Carlo, Metropolis Hastings, Gibbs - Collapsing & Blocking, Case study: Particle filtering applications.

**Unit-5 - Learning in Graphical Models** 9 Hour  
Parameter Estimation - Expectation Maximization, Maximum Likelihood Estimation, Maximum Entropy, Pseudo likelihood, Bayesian Estimation, Conditional Likelihood, Structured Prediction; Learning with Approximate Inference; Learning with Latent Variables; Structure Learning, Case Study-Structure Search.

<b>Learning Resources</b>	1. Koller, D. and Friedman, N. (2009). <i>Probabilistic Graphical Models: Principles and Techniques</i> . MIT Press. 2. Jensen, F. V. and Nielsen, T. D. (2002). <i>Bayesian Networks and Decision Graphs</i> . Information Science and Statistics. Springer, 2nd edition. 3. Kevin P. Murphy (2013) <i>Machine Learning: A Probabilistic Perspective</i> . 4th Printing. MIT Press. 4. Barber, D. (2011). <i>Bayesian Reasoning and Machine Learning</i> . Cambridge University Press, 1st edition. 5. Wainwright, M. and Jordan, M. (2008). <i>Graphical Models, Exponential Families, and Variational Inference</i> . Foundations and Trends in Machine Learning, 1:1–305. 6. David Bellot (2016) <i>Learning Probabilistic Graphical Models in R</i> 7. Kiran R Karkera, (2014) <i>Building Probabilistic Graphical Models with Python</i>
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Learning Assessment		Continuous Learning Assessment (CLA)						Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)							
		Theory	Practice	Theory	Practice						
Level 1	Remember	40%	-	40%	-	40%	-				
Level 2	Understand	40%	-	40%	-	30%	-				
Level 3	Apply	20%	-	20%	-	20%	-				
Level 4	Analyze	-	-	-	-	10%	-				
Level 5	Evaluate	-	-	-	-	-	-				
Level 6	Create	-	-	-	-	-	-				
	Total	100 %		100 %		100 %					

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mrs.Savitha Boomiperumal, Technical Lead, Accenture Technology Solutions, Portugal, Europe	1. Dr.Anusha K, Associate Professor, School of Computing, VIT Chennai.	1. Dr.Sumathy G, SRMIST

<b>Course Code</b>	21CSE542T	<b>Course Name</b>	DEEP GENERATIVE MODELS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 3	T 0	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Understand the basics of generative models and deep learning architectures												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	Understand the significance of autoregressive and flow-based models												-	-	-										
<b>CLR-3:</b>	Apply latent variable models for non-linear variables and to improve the performance												-	-	-										
<b>CLR-4:</b>	understand various basic generative adversarial networks for different applications												-	-	-										
<b>CLR-5:</b>	Explore deep GAN models for various multimedia applications												-	-	-										
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	gain the knowledge on basic units of generative models and their types												-	-	-	-	-	-	-	-	-	-	-		
<b>CO-2:</b>	implement autoregressive models and flow-based models with continuous and discrete random variables												-	-	-	-	-	-	-	-	-	-	-		
<b>CO-3:</b>	Learn the latent variable models and variational encoders												-	-	-	-	-	-	-	-	-	-	2		
<b>CO-4:</b>	develop the hybrid model and energy-based models for different applications												-	-	-	-	-	-	-	-	-	-	2		
<b>CO-5:</b>	Apply various case studies that adapt deep GAN models												-	-	-	-	-	-	-	-	-	-	3		

<b>Unit-1 - Generative Modeling</b>	<b>9 Hour</b>
Introduction - Generative Versus Discriminative Modeling - Advances in Machine Learning - The Rise of Generative Modeling - The Generative Modeling Framework – Probabilistic Generative Models - The Challenges of Generative Modeling - Representation Learning -Setting Up Your Environment – Deep Learning – Structural and unstructural data – Deep Neural Network – Example – Improving model.	
<b>Unit-2 - Deep generative modelling</b>	
Types – Autoregressive models - Autoregressive Models Parameterized by Neural Networks - Deep Generative Autoregressive Model: an example Flow based models - Flows for Continuous Random Variables - Change of Variables for Deep Generative Modeling - Building Blocks of RealNVP – example - Flows for Discrete Random Variables - Flows in R or Maybe Rather in Z - Integer Discrete Flows. Case study using Deep generative modeling	
<b>Unit-3 - Latent Variable Models</b>	
probabilistic principal component analysis - Variational Auto-Encoders: Variational Inference for Non-linear Latent Variable Models - Improving Variational Auto-Encoders - Hierarchical Latent Variable Models.	
<b>Unit-4 - Hybrid Modeling and GAN</b>	
Naive approach – shared parameterization approach – example – Energy based models – model formation – training – example – restricted Boltzmann machines Generative adversarial networks – GAN architecture – GAN challenges – Wasserstein GAN – WGAN – GP. Case study using Hybrid approach with GAN	
<b>Unit-5 - Future of Generative Modelling</b>	
the transformer – advances in image generation – applications of generative modelling	
<b>Case studies</b> – BERT – GPT-2- MuseNet – ProGAN – SAGAN – BigGAN – StyleGAN – AI Art – AI Music	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>David Foster, <i>Generative Deep Learning, Teaching Machines to Paint, Write, Compose, and Play</i>, O'Reilly Media, Inc., 2019, ISBN: 9781492041948</li> <li>Jakub M. Tomczak, <i>Deep Generative Modeling</i>, Springer nature, Edition 1, 2022, ISBN - 978-3-030-93157-5</li> <li>Kailash Ahirwar, <i>Generative Adversarial Networks Projects, build next-generation generative models using TensorFlow and Keras</i>, pakt publisher, 2019. ISBN: 978-1789136678</li> <li>Roozbeh Razavi-Far, Ariel Ruiz-Garcia, Vasile Palade, Juergen Schmidhuber, <i>Generative Adversarial Learning: Architectures and Applications</i>, (2022), Springer Cham</li> <li>Jakub M. Tomczak, <i>Deep Generative Modeling</i>, Springer, 2022, 978-3-030-93158-2</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>	
<b>Bloom's Level of Thinking</b>	<b>Formative CLA-1 Average of unit test (50%)</b>	<b>Life-Long Learning CLA-2 (10%)</b>					
		<b>Theory</b>	<b>Practice</b>	<b>Theory</b>	<b>Practice</b>	<b>Theory</b>	<b>Practice</b>
Level 1	Remember	30%	-	30%	-	30%	-
Level 2	Understand	30%	-	30%	-	30%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	10%	-	10%	-	10%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100%		100%		100%	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Kavita Ganeshan Artificial Intelligence Principal - AI Products and Solutions, Accenture, Mumbai, India	1. Dr. S. Chandrakala, Professor, School of Computing, Sastra Deemed to be University, Thanjavur	1. Dr. A. Robert Singh, SRMIST

<b>Course Code</b>	21CSE543T	<b>Course Name</b>	BRAIN MACHINE INTERFACE: SCIENCE, TECHNOLOGY AND APPLICATION	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the basic concepts of brain computer/machine interface												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Study the various signal acquisition methods of Brain Machine/Computer Interface															
<b>CLR-3:</b>	Interpret signal processing methods used in Brain Machine/Computer Interface															
<b>CLR-4:</b>	Understand the various machine learning methods of Brain Machine/Computer Interface															
<b>CLR-5:</b>	Learn the various applications of Brain Machine/Computer Interface															
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Summarize the Brain Machine /Computer Interface												2	1	Problem Analysis	
<b>CO-2:</b>	Assess concept of BCI												2	1	Design/development of solutions	
<b>CO-3:</b>	Assign functions appropriately to the human and to the machine												3	1	Conduct investigations of complex problems	
<b>CO-4:</b>	Choose appropriate feature extraction methods												2	1	Modern Tool Usage	
<b>CO-5:</b>	Apply machine learning algorithms for translation												3	2	The engineer and society	
															Environment & Sustainability	
															Ethics	
															Individual & Team Work	
															Communication	
															Project Mgt & Finance	
															Life Long Learning	

#### **Unit-1 - Introduction to BCI** 9 Hour

Introduction - Brain structure and function, Brain Computer Interface Types - Synchronous and Asynchronous -Invasive BCI -Partially Invasive BCI - Non Invasive BCI, Structure of BCI System- BCI Monitoring Hardware, EEG, ECoG, MEG, fMRI-10-20 electrode positions.

#### **Unit-2 - Brain Activation** 9 Hour

Brain activation patterns - Spikes, Oscillatory potential and ERD, Slow cortical potentials, Movement related potentials-Mu rhythms, motor imagery, Stimulus related potentials - Visual Evoked Potentials – P300 and Auditory Evoked Potentials, Potentials related to cognitive tasks.

#### **Unit-3 - Feature Extraction Methods** 9 Hour

Data Processing – Spike sorting, Frequency domain analysis, Wavelet analysis, Time domain analysis, Spatial filtering -Principal Component Analysis (PCA), Independent Component Analysis (ICA), Artefacts reduction, Feature Extraction - Phase synchronization and coherence. Case study : Application of Feature extraction methods

#### **Unit-4 - Machine Learning Methods for BCI** 9 Hour

Classification techniques –Binary classification, Ensemble classification, Multiclass Classification, Evaluation of classification performance, Regression - Linear, Polynomial, RBF's, Perceptron's, Multilayer neural networks, Support vector machine, Graph theoretical functional connectivity analysis. Case study: Machine learning methods in BCI applications.

#### **Unit-5 - Applications of BCI** 9 Hour

Invasive BCIs: decoding and tracking arm (hand) position, controlling prosthetic devices such as orthotic hands, Cursor and robotic control using multi electrode array implant, Cortical control of muscles via functional electrical stimulation. Non-invasive BCIs: P300 Mind Speller, Visual cognitive BCI, Emotion detection. Ethics of Brain Computer Interfacing.

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Rajesh.P.N.Rao, "Brain-Computer Interfacing: An Introduction", Cambridge University Press, First edition, 2019.</li> <li>2. Jonathan Wolpaw, Elizabeth Winter Wolpaw, "Brain Computer Interfaces: Principles and practice", Oxford University Press, USA, Edition 1, January 2012.</li> <li>3. Ella Hassianien, A &amp;Azar.A.T (Editors), "Brain-Computer Interfaces Current Trends and Applications", Springer, 2015.</li> <li>4. Bernhard Graimann, Brendan Allison, GertPfurtscheller, "Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction", Springer, 2010</li> <li>5. Ali Bashashati, MehrdadFatourechi, Rabab K Ward, Gary E Birch," A survey of signal Processing algorithms in brain-computer interfaces based on electrical brain signals" Journal of Neural Engineering, Vol.4, 2007, PP.32-57.</li> <li>6. Arnon Kohen, "Biomedical Signal Processing", Vol I and II, CRC Press Inc, Boca Rato, Florida.Bishop C.M., "Neural networks for Pattern Recognition", Oxford, Clarendon Press, 1995.</li> <li>7. Andrew Webb, "Statistical Pattern Recognition", Wiley International, Second Edition, 2002.</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>			
	<i>Bloom's Level of Thinking</i>	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	30%	-	20%	-	20%	-		
Level 2	Understand	40%	-	40%	-	40%	-		
Level 3	Apply	30%	-	40%	-	40%	-		
Level 4	Analyze	-	-	-	-	-	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr.M.Prakash Team Lead(Associate Consultant) ,Virtusa ,Chennai	1. Dr.V Haribaabu Associate Faculty in Entrepreneurship Development Institute of India Gandhi Nagar, Gujarat.	1. Dr.M.UMA, SRMIST

<b>Course Code</b>	21CSE544T	<b>Course Name</b>	DATA ANALYSIS AND VISUALIZATION	<b>Course Category</b>	C	PROFESSIONAL ELECTIVE	L 3	T 0	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the basics of data analytics and essential tools												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Apply the preprocessing methods to prepare the data for data analytics															
<b>CLR-3:</b>	Utilize various data visualization tools for understanding the insights of data															
<b>CLR-4:</b>	Analyze time-series data and its structure for making prediction															
<b>CLR-5:</b>	Apply advanced data analytic tools for real time applications															
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>															
<b>CO-1:</b>	Use data analysis tools in the panda's library												1	-		
<b>CO-2:</b>	Load, clean, transform, merge, and reshape data.												-	-	3	
<b>CO-3:</b>	Handle various data visualization tools.												-	-	1	
<b>CO-4:</b>	Analyze and manipulate time series data.												-	-	2	
<b>CO-5:</b>	Solve real world data analysis problems.												-	-	3	

<b>Unit-1 - Introduction</b>	<b>9 Hour</b>
Introduction to Data Science, Exploratory Data Analysis and Data Science Process. Motivation for using Python for Data Analysis, Introduction of Python shell iPython and Jupyter Notebook.	
<b>Unit-2 - Started with Pandas</b>	<b>9 Hour</b>
Arrays and vectorized computation, Introduction to pandas Data Structures, Essential Functionality, Summarizing and Computing Descriptive Statistics. Data Loading, Storage and File Formats. Reading and writing Data in Text Format, Web Scraping, Binary Data Formats, Interacting with Web APIs, Interacting with Databases Data Cleaning and Preparation. Handling Missing Data, Data Transformation, String Manipulation Case study: Understanding the data thoroughly using APIs	
<b>Unit-3 - Data Wrangling</b>	
Hierarchical Indexing, Combining and Merging Data Sets Reshaping and Pivoting. Data Visualization matplotlib: Basics of matplotlib, plotting with pandas and seaborn, other python visualization tools - Plotnine, geoplotlib	
<b>Unit-4 - Data Aggregation and Group operations</b>	
Group by Mechanics, Data aggregation, General split-apply-combine, Pivot tables and cross tabulation Time Series Data Analysis: Date and Time Data Types and Tools, Time series Basics, date Ranges, Frequencies and Shifting, Time Zone Handling, Periods and Periods Arithmetic, Resampling and Frequency conversion, Moving Window Functions.	
<b>Unit-5 - Advanced Pandas:</b>	
Categorical Data, Advanced GroupBy Use, Techniques for Method Chaining, Case studies: mining text data, analyze image dataset, analyze social network data set	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. McKinney, W. (2017). <i>Python for Data Analysis: Data Wrangling with Pandas, NumPy and IPython</i>. 2nd edition. O'Reilly Media</li> <li>2. O'Neil, C., &amp; Schutt, R. (2013). <i>Doing Data Science: Straight Talk from the Frontline</i> O'Reilly Media</li> <li>3. Anil Maheshwari, <i>Data Analytics</i>, 1st Edition (2017), TataMcGraw Hill</li> <li>4. Dr. Ossama Embarak, <i>Data Analysis and Visualization Using Python</i>, Springer (2018).</li> <li>5. Avinash Navlani, Armando Fandango, Ivan Idris, <i>Python Data Analysis</i>, Packt publisher, 2021, 9781789955248</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>	
<i>Bloom's Level of Thinking</i>	<i>Formative CLA-1 Average of unit test (50%)</i>	<i>Life-Long Learning CLA-2 (10%)</i>					
		<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>
Level 1	<i>Remember</i>	30%	-	30%	-	30%	-
Level 2	<i>Understand</i>	30%	-	30%	-	30%	-
Level 3	<i>Apply</i>	20%	-	20%	-	20%	-
Level 4	<i>Analyze</i>	20%	-	20%	-	20%	-
Level 5	<i>Evaluate</i>	-	-	-	-	-	-
Level 6	<i>Create</i>	-	-	-	-	-	-
	Total	100%		100%		100%	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. R. Praveen Kumar, Technical lead, Allianz Technology, Thiruvananthapuram, Kerala.	1. Dr. N. Sudha, Professor, School of Computing, Sastra Deemed to be University, Thanjavur	1. Dr. A. Robert Singh, SRMIST

<b>Course Code</b>	21CSE545T	<b>Course Name</b>	COMPUTATIONAL PERCEPTION AND COGNITION	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 3	T 0	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>	<i>The purpose of learning this course is to:</i>	<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>
		1	2	3	4	5	6	7	8	9	10	11	12	
<b>CLR-1:</b>	Introduce the computational models, and perception of cognition	-	-	-	-	-	-	-	-	-	-	-	-	PSO-1
<b>CLR-2:</b>	Illustrate the basic parameter estimation techniques	-	-	-	-	-	-	-	-	-	-	-	-	PSO-2
<b>CLR-3:</b>	Introduce the bayesian parameter estimation techniques and Hierarchical modeling	-	-	-	-	-	-	-	-	-	-	-	-	PSO-3
<b>CLR-4:</b>	Relate the different computational models	-	-	-	-	-	-	-	-	-	-	-	-	
<b>CLR-5:</b>	Analyze the models in psychology	-	-	-	-	-	-	-	-	-	-	-	-	
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>													
<b>CO-1:</b>	Understand the computational models, and Cognition	-	-	-	2	-	-	-	-	-	-	-	-	-
<b>CO-2:</b>	Apply the basic parameter estimation techniques	-	-	3	2	-	-	-	-	-	-	-	-	-
<b>CO-3:</b>	Interpret the bayesian parameter estimation techniques and Hierarchical modeling	-	-	-	3	-	-	-	-	-	-	-	-	-
<b>CO-4:</b>	Compare the different computational models	-	-	3	3	-	-	-	-	-	-	-	-	3
<b>CO-5:</b>	Analyze the models in psychology	-	-	-	3	-	-	-	-	-	-	-	-	-

<b>Unit-1 - Introduction to Modeling</b>	<b>9 Hour</b>
Introduction to Modeling: Models and Theories in Science - Quantitative Modeling in Cognition - Potential Problems: Scope and Falsifiability from Words to Models: Response Times in Speeded-Choice Tasks - Building a Simulation - The Basic Toolkit	
<b>Unit-2 - Basics Parameter Estimation</b>	
Basic Parameter Estimation Techniques- Discrepancy Function- Fitting Models to Data: Parameter Estimation Techniques- Least-Squares Estimation in a Familiar Context- Inside the Box: Parameter Estimation Techniques Variability in Parameter Estimates - Maximum Likelihood Parameter Estimation- Basics of Probabilities- Defining a Probability Distribution- Finding the Maximum Likelihood Combining Information from Multiple Participants	
<b>Unit-3 - Parameter Estimation</b>	
Bayesian Parameter Estimation- Bayesian Inference- Analytic Methods for Obtaining Posteriors- Determining the Prior Distributions of Parameters- Markov Chain Monte Carlo Methods- Problems Associated with MCMC Sampling- Gibbs Sampling - Multilevel or Hierarchical Modeling- Conceptualizing Hierarchical Modeling- Bayesian Hierarchical Modeling- Hierarchical Maximum Likelihood Modeling.	
<b>Unit-4 - Model Comparison</b>	
Psychological Data and the Very Bad Good Fit- Model Comparison- The Likelihood Ratio Test- Akaike's Information Criterion- Other Methods for Calculating Complexity and Comparing Models- Parameter Identifiability and Model Testability Bayesian Model Comparison using Bayes Factors: Marginal Likelihoods and Bayes Factors- Methods for Obtaining the Marginal Likelihood- Bayes Factors for Hierarchical Models- The Importance of Priors. Case study on Model comparison.	

**Unit-5 - Models in Psychology****9 Hour**

*Models in Psychology: Broad Overview of the Steps in Modeling- Drawing Conclusions from Models- Good Practices to Enhance Understanding and Reproducibility Neural Network Models- Hebbian Models- Backpropagation Models in Neuroscience- Methods for Relating Neural and Behavioral Data- Reinforcement Learning Models- Neural Correlates of Decision-Making. Case study: Applications of Cognition towards model building.*

<b>Learning Resources</b>	1. Computational Modeling of Cognition and Behavior, Simon Farrell and Stephan Lewandowsky, Cambridge University Press, 2018	4. Emmanuel M. Pothos, Andy J. Wills, Formal Approaches in Categorization, Cambridge University Press, 2011
	2. Jerome R. Busemeyer, Zheng Wang, James T. Townsend, Ami Eidels (ed.), The Oxford Handbook of Computational and Mathematical Psychology, Oxford University Press, 2015	5. Ron Sun (ed.), The Cambridge Handbook of Computational Psychology, Cambridge University Press, 2008
	3. Jerome R. Busemeyer, Peter D. Bruza, Quantum Models of Cognition and Decision, Cambridge University Press, 2014	6. Nils J. Nilsson, The Quest for Artificial Intelligence, Cambridge University Press, 2009
		7. Bernard J. Bears, Nicole M. Gage, Cognition, Brain and Consciousness: Introduction to Cognitive Neuroscience (2010), Academic Press, 2010

Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	30%	-	20%	-	20%	-		
Level 2	Understand	40%	-	40%	-	40%	-		
Level 3	Apply	30%	-	40%	-	40%	-		
Level 4	Analyze	-	-	-	-	-	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Guruprasad Lakshmanan, Chief Technology Officer, Twice Group & Blocksrus, Chennai	1. Dr. B.Sathish Babu, Professor, Department of AI & ML, RV College of Engineering, Bengaluru, Karnataka	1. Dr. M. Uma, SRMIST

<b>Course Code</b>	21CSE546T	<b>Course Name</b>	MEDICAL SIGNAL PROCESSING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 3	T 0	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the basic concepts of signals and frequency-based transforms												<b>PSC-1</b>	<b>PSC-2</b>	<b>PSC-3</b>	
<b>CLR-2:</b>	understand the basics of digital filters												-	-	-	
<b>CLR-3:</b>	Investigate the events in the signal and interpret the basic architecture of the processor												-	-	-	
<b>CLR-4:</b>	Study of spectral and cross-spectral features of electrocardiographic signals												-	-	-	
<b>CLR-5:</b>	Interpret the basic architecture of the DSP processor and its applications												-	-	-	
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Comprehend and analyse the signals in different statistical methods															1
<b>CO-2:</b>	Gain the transforms enactments on bio-signal															-
<b>CO-3:</b>	Comprehend the implementations of filters in biosignals															-
<b>CO-4:</b>	ECG signal analysis and modelling															-
<b>CO-5:</b>	Familiarize the digital signal processors and its application in medical fields															3

<b>Unit-1 - Introduction to Signal Processing</b>	<b>9 Hour</b>
Z transform introduction, definition, convergence. Inverse Z transforms, Analysis of discrete-time systems using Z transforms. Solutions of differential equations. Transfer functions and stability.	
<b>Unit-2 - Time-Frequency Domain Analysis</b>	<b>9 Hour</b>
Fourier transforms for continuous signals. Energy spectrum, Properties (without proof), Gibbs phenomena, Auto and cross-correlation. Discrete Fourier transforms. Properties (without proof), Inverse DFT, introduction to FFT.	
<b>Unit-3 - Digital Filters</b>	<b>9 Hour</b>
Types of artefacts and noise - Time domain filters, frequency domain filters, notch and comb filters, optimal filtering, adaptive filters - Signal decomposition-based filtering.	
<b>Unit-4 - Event Detection and Feature Extraction Techniques</b>	<b>9 Hour</b>
Signal segmentation - Envelop extraction and analysis, temporal, spectral, statistical, information theoretic and cross spectral features - Waveform complexity. <b>Case Studies:</b> Estimating fractal connectivity with an application to neurophysiological signals, Cross spectral analysis of electrocardiographic signals.	
<b>Unit-5 - Digital Signal Processors</b>	<b>9 Hour</b>
Introduction, General purpose DSP processors, architecture, hardware configuration, software development tools - Implementation considerations. TMS 320 Family of DSP Processors-Architecture - Functional units - Pipelining-Registers - Linear and Circular addressing - Types of instructions - Sample Programs - Real Time Implementation on DSP processors. Case Studies: - Linear Discrimination-Detection of motor activity from EMG, Harmonic analysis - Estimation of heart rate in ECG - Auto-regressive model - Estimation of spectrum of thoughts in EEG	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Digital signal processing, Proakis (PHI)</li> <li>2. Rangaraj M. Rangayyan, "Biomedical Signal Analysis", 2015, 2nd Edition, Wiley/IEEE Press, New</li> <li>3. Signal Analysis by R. P. Singh, Second edition Tata McGraw – Hill</li> <li>4. Engineering Electronics by Mauro R Prentice – Hall</li> <li>5. Malmivuo, J. and Plonsey, R. Bioelectromagnetism: Principles and Applications of Bioelectric and Biomagnetic Fields, Oxford University Press, New York, 1995.</li> <li>6. D C Reddy, McGraw Hill, Biomedical Signal Processing.</li> <li>7. Ralph Chassaing, "Digital Signal Processing and Applications with the C6713 and C6416 DSK", 2012, 1st Edition, Wiley, New York.</li> <li>8. Nasser Kehtarnavaz, "Real Time Signal Processing Based on TMS320C6000", 2011, 2nd Edition, Elsevier, Netherlands.</li> </ol>
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	40%	-	40%	-	40%	-		
Level 2	Understand	40%	-	40%	-	40%	-		
Level 3	Apply	20%	-	20%	-	20%	-		
Level 4	Analyze	-	-	-	-	-	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. K. Selvaraj, Caterpillar, Bangalore	1. Dr. S.Shoba, VIT, Chennai 2. Dr.R.Rajavel,ECE,SSN College of Engineering, Chennai	1. Dr.R.Athilakshmi, SRMIST

<b>Course Code</b>	21CSE547T	<b>Course Name</b>	DEEP MULTITASK AND META LEARNING	<b>Course Category</b>	C	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>			
<b>CLR-1:</b>	Acquire knowledge in Multitask learning and Meta learning												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>		
<b>CLR-2:</b>	Gain knowledge in Optimization algorithms and dimensionality reduction												-	-	-		
<b>CLR-3:</b>	Acquire knowledge in neural network approach to pattern recognition												-	-	-		
<b>CLR-4:</b>	Acquire knowledge in Transfer learning and Sequential Models												-	-	-		
<b>CLR-5:</b>	Understand the principles of unconstrained optimization												-	-	-		
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12				
<b>CO-1:</b>	Explore Multitask learning and Meta learning	3	3	-	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>
<b>CO-2:</b>	Compare the optimization algorithms and high dimensional data using reduction techniques	3	2	-	-	-	-	-	-	-	-	-	-	-	1	-	2
<b>CO-3:</b>	Explore various approaches to identify the patterns.	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2
<b>CO-4:</b>	Apply RNN and transfer learning to real world scenarios	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	3
<b>CO-5:</b>	Acquire the principles of unconstrained optimization	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	1

**Unit-1 - 1 Introduction and Start of multi-task learning** 9 Hour  
Multi-task learning- Single task learning, Multi task classification, Image Net classification with deep convolution neural networks, Task conditioning, Alternative view on Multi task Architecture- concatenation based conditioning, Additive conditioning, Multi head architecture, Multiplicative Conditioning, Multi label learning T1: Multi – Task learning, T2: Multi -Transfer learning, T3: Fine tuning.

**Unit-2 - Meta-Learning Structure** 9 Hour  
Meta learning Advantages, Bayesian meta-learning approaches: black-box approaches, optimization-based meta-learning, metric learning), Non-Parametric Few-Shot Learning: Siamese networks, matching networks, prototypical networks Embed, nearest neighbours. T4: Properties of Meta-Learning Algorithms, T5: Meta-features for meta-learning, T6: Federated and Meta learning over Non-Wireless and Wireless Networks

**Unit-3 - Advanced Meta-Learning Topics** 9 Hour  
Stacking Generalization, Meta learning approaches and its applications, meta-overfitting, unsupervised meta-learning, Bayesian models, Multi-task RL, goal-conditioned RL, Meta-reinforcement learning, hierarchical RL. T7: Example of Meta-Learning Applications - Imitation learning, T8: Example of Meta-Learning Applications-Drug discovery, motion prediction, T9: Example of Meta-Learning Applications- language generation.

**Unit-4 - Optimization-Based Meta-Learning** 9 Hour  
Unconstrained Optimization and Neural Networks, Single-Neuron Training, Backpropagation Algorithm, Genetic Algorithms, Chromosomes and Representation Schemes, Selection and Evolution. T10: Hessian in Meta Learning, T11: The Rank One Correction Formula, T12: Analysis of Genetic Algorithms

**Unit-5 - Dynamic Meta Learning** 9 Hour  
Prototypical clustering Networks for Dermatological Image Classification, selecting models for forecasting stationary time series. T13: Real-Number Genetic Algorithms, T14: Dynamic meta-learning for failure prediction in large-scale systems, T15:Dynamic Alignment via Meta-filter for Few-shot Learning

<b>Learning Resources</b>	1. Eugene Charniak, <i>Introduction to Deep Learning</i> , MIT Press, 2018. 2. Robert J. Schalkoff, <i>Pattern Recognition: Statistical, Structural and Neural Approaches</i> , John Wiley & Sons Inc., New York, Reprint 2014. 3. Fukunaga, <i>Introduction to Statistical Pattern Recognition</i> , second edition, Academic press, 2013. 4. Edwin K.P. Chong, Stanislaw H. Zak, <i>An Introduction to Optimization</i> , Wiley-Interscience, Second edition 5. Dimitri P. Bertsekas, <i>Nonlinear Programming</i> , MIT, Second Edition 6. <a href="https://cs330.stanford.edu/lecture_slides/cs330_nonparametric_2022.pdf">https://cs330.stanford.edu/lecture_slides/cs330_nonparametric_2022.pdf</a> .					
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<b>Learning Assessment</b>		<b>Continuous Learning Assessment (CLA)</b>				<b>Summative Final Examination (40% weightage)</b>			
	<i>Bloom's Level of Thinking</i>	<i>Formative CLA-1 Average of unit test (50%)</i>		<i>Life-Long Learning CLA-2 (10%)</i>					
		<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>				
Level 1	<i>Remember</i>	40%	-	30%	-	30%	-		
Level 2	<i>Understand</i>	40%	-	40%	-	30%	-		
Level 3	<i>Apply</i>	20%	-	30%	-	40%	-		
Level 4	<i>Analyze</i>	-	-	-	-	-	-		
Level 5	<i>Evaluate</i>	-	-	-	-	-	-		
Level 6	<i>Create</i>	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr.M.Vivekanandan,Nokia	1. Karthikeyan.C.M.T, Govt College of Engg,Bangur	1. Dr.N.Meenakshi, SRMIST
2. Mr.SanthoshKumar,CTS	2. Syedthouheed,Reva University, Bangalore	

<b>Course Code</b>	21CSE548T	<b>Course Name</b>	SPATIAL AND TEMPORAL COMPUTING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 3	T 0	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Outline the ideas of traditional relational data and spatial data.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	Illustrate the basics of spatial databases.												-	-	-	-									
<b>CLR-3:</b>	Gain knowledge on spatial data models.												-	-	-	-									
<b>CLR-4:</b>	Gain knowledge on Spatio-Temporal computing Techniques.												-	-	-	-									
<b>CLR-5:</b>	Learn about different Application programming Interfaces.												-	-	-	-									
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Illustrate the concepts of traditional relational data and spatial data.												-	-	-	-	-	-	-	-	-	-	-		
<b>CO-2:</b>	Learn the spatial databases.												-	-	-	-	-	-	-	-	-	-	1		
<b>CO-3:</b>	Understand the spatial data models.												-	-	-	-	-	-	-	-	-	-	1		
<b>CO-4:</b>	Analyze Spatio-Temporal computing Techniques.												-	-	2	-	2	-	-	-	-	-	2		
<b>CO-5:</b>	Analyze various Application programming Interfaces.												-	2	-	-	2	-	-	-	-	-	-	2	

#### **Unit-1 - Introduction to Spatio Temporal Data** 9 Hour

Representation of Spatio temporal data, Visualization of Spatio-Temporal Data – Spatial plots – Time series plots - Hovmoller plot – Interactive plots, Visualizing large spatial temporal datasets –Visualizing Uncertainty- Exploratory Analysis of Spatio-Temporal Data - Empirical Spatial Means and Covariances - Spatio-Temporal Covariograms and Semivariograms - Empirical Orthogonal Functions (EOFs) - Spatio-Temporal Canonical Correlation Analysis

#### **Unit-2 - Introduction to Spatial Databases** 9 Hour

Requirements, Principles, and Concepts for Spatial Database Management Systems (SDBMS) – Spatial Databases and Geographic Information Systems SDBMS and GIS Applications. Spatial networks: conceptual, logical and physical level design issues, Spatial networks Query: shortest path from a start-point to a destination, shortest route to deliver packages to a set of homes, Query processing in spatial network databases.

#### **Unit-3 - Models for Spatial Data: Geographic Space Modelling** 9 Hour

Representation Models – Geometry of Collection of Objects – Vector Data – Raster Data. Modelling Spatial Data. Spatial Access Methods (SAM): Issues in SAM Design – Space Driven Structures versus Data Driven Structures – The Grid File – Quadtree and Variants – R-Tree and Variants – k-d-B Tree. Case study- SAM Cost Models

#### **Unit-4 - Spatio-Temporal Computing** 9 Hour

Techniques of spatial and temporal analysis, point patterns, spatio - temporal database applications. geostatistics, spectral analysis, wavelet analysis, interpolation, and mapping. Spatial information services: virtual globes, location-based services, Case study-Enterprise consulting service.

#### **Unit-5 - Application Programming Interfaces** 9 Hour

HTML5 Geolocation API, Google Maps API, Bing Maps API, Maps SDK, Flickr location API, Twitter location API, OSHDB: a framework for spatio-temporal analysis of OpenStreetMap history data.

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>1. Christopher K. Wikle, Andrew Zammit-Mangion, Noel Cressie, Spatio Temporal Statistics with R, CRC Press, 2019.</li> <li>2. Philippe Rigaux, Michel Scholl, Agnes Voisard, "Spatial Databases with Applications to GIS", Morgan Kaufman, 2002.</li> <li>3. Shashi Shekhar, Pamela Vold, Spatial Computing, The MIT Press, 2020.</li> <li>4. Noel Cressie, Christopher K. Wikle, Statistics for Spatio-Temporal data, Wiley, 2015.</li> <li>5. Narayan Panigrahi , Computing in Geographic Information Systems, CRC press, 2014.</li> <li>6. Shashi Shekhar and Sanjay Chawla "Spatial Databases: A Tour "Pearson.</li> <li>7. Evangelos Petroutsos, Google Maps: Power Tools for maximizing the API, McGraw-Hill, 2014.</li> </ol>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>			
	<i>Bloom's Level of Thinking</i>	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	40%	-	40%	-	40%	-		
Level 2	Understand	40%	-	40%	-	30%	-		
Level 3	Apply	20%	-	20%	-	20%	-		
Level 4	Analyze	-	-	-	-	10%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
Total		100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mrs.Savitha Boomiperumal, Technical Lead, Accenture Technology Solutions, Portugal, Europe	1. Dr.Anusha K, Associate Professor, School of Computing, VIT Chennai.	1. Dr.Sumathy G, SRMIST

<b>Course Code</b>	21CSE549T	<b>Course Name</b>	DECISION MAKING UNDER UNCERTAINTY	<b>Course Category</b>	C	PROFESSIONAL ELECTIVE	L 3	T 0	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>	<i>The purpose of learning this course is to:</i>	<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>
		1	2	3	4	5	6	7	8	9	10	11	12	
<b>CLR-1:</b>	learn and identify the opportunities for creating value using these models													
<b>CLR-2:</b>	Develop models that can be used to improve decision making under uncertainty within an organization													
<b>CLR-3:</b>	Sharpen their ability to structure problems and to perform logical analyses													
<b>CLR-4:</b>	Know how to assess the significance of model outputs for managerial insights and action													
<b>CLR-5:</b>	Develop the skills to identify, define, scope, model, and analyze complex decision problems													
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>													
<b>CO-1:</b>	Gain a broad fundamental understanding of the mathematical models and solution methods for decision making	-	3	1	-	-	-	-	-	-	-	-	-	PSO-1
<b>CO-2:</b>	Implement and extend key algorithms for learning and decision making	-	3	2	-	-	-	-	-	-	-	-	-	PSO-2
<b>CO-3:</b>	Identify an application of the theory and formulate it mathematically	-	3	-	2	-	-	-	-	-	-	-	-	PSO-3
<b>CO-4:</b>	Gain a deep understanding of an area of particular interest and apply it to a problem	-	3	-	2	-	-	-	-	-	-	-	-	
<b>CO-5:</b>	Make inferences about a management problem based on the solution of a model	-	3	-	2	-	-	-	-	-	-	-	-	

**Unit-1 - Probabilistic Reasoning** 9 Hour  
 Introduction-Degrees of Belief and Probability-Probability Distributions-Bayesian Networks-Inference in Bayesian Networks- Inference in naïve Bayes Models-Direct Sampling-Gibbs Sampling-Inference in Gaussian Models-Bayesian Parameter Learning-Nonparametric Learning-Learning with Missing Data-Bayesian Network Scoring-Directed Graph Search-Markov Equivalence Classes-Partially Directed Graph Search-Simple Decisions-Constraints on Rational Preferences-Utility Functions-Utility Elicitation-Maximum Expected Utility Principle-Decision Networks.

**Unit-2 - Sequential Problems** 9 Hour  
 Markov Decision Processes-Policy Evaluation-Value Function Policies-Policy Iteration-Value Iteration-Asynchronous Value Iteration-Linear Program Formulation-Linear Systems with Quadratic Reward-Parametric Representations-Nearest Neighbor-Kernel Smoothing-Linear Interpolation-Simplex Interpolation-Linear Regression-Neural Network regression-Forward Search-Branch and Bound-Sparse Sampling-Monte Carlo Tree Search-Heuristic Search-Labeled Heuristic Search-Open-Loop Planning-Local Search-Genetic Algorithms-Cross Entropy Method-Evolution Strategies.

**Unit-3 - Model Uncertainty** 9 Hour  
 Bandit Problems-Bayesian Model Estimation-Undirected Exploration Strategies-Directed Exploration Strategies –Optimal Exploration Strategies-Maximum Likelihood Models-Bayesian Methods-Bayes-Adaptive Markov decision Processes-Incremental Estimation of the Mean- Q-Learning- Sarsa-Eligibility Trace-Action Value Function Approximation-Behavioural Cloning-Data Set Aggregation-Stochastic Mixing Iterative Learning-Maximum Margin Inverse Reinforcement Learning-Maximum Entropy Inverse Reinforcement Learning.

<b>Unit-4 - State Uncertainty</b>	<b>9 Hour</b>
Belief Initialization-Discrete State Filter-Kalman Filter-Extended Kalman Filter-Unscented Kalman Filter-Belief-State Markov Decision Processes-Conditional Plans-Alpha Vectors-Pruning-Value Iteration-Linear Policies-Fully Observable Value Approximation-Fast Informed Bound-Fast Lower Bounds-Point-Based Value Iteration-Randomized Point-Based Value Iteration-Sawtooth Heuristic Search-Triangulated Value Functions-Online Belief State Planning- Forward Search-Branch and Bound-Sparse Sampling-Monte Carlo Tree Search-Determinized Sparse Tree Search	
<b>Unit-5 - Multiagent Systems</b>	<b>9 Hour</b>
Multiagent Reasoning-Simple Games-response Models-Dominant Strategy Equilibrium-Nash Equilibrium-Correlated Equilibrium-Hierarchical Softmax-Sequential Problems- Markov Games-Response Models- Nash Equilibrium-Fictitious Play-Gradient Ascent-Nash Q-Learning-State Uncertainty-Partially Observable Markov Games-Policy Evaluation-Nash Equilibrium-Dynamic Programming-Decentralized Partially Observable Markov Decision Processes-Subclasses-Dynamic Programming-Iterative Best Response-Heuristic Search-Nonlinear Programming.	

<b>Learning Resources</b>	1. Mykel J. Kochenderfer, Tim A. Wheeler, Kyle H. Wray Algorithms for Decision Making, MIT Press, 2022 2. <a href="https://github.com/JuliaAcademy/Decision-Making-Under-Uncertainty">https://github.com/JuliaAcademy/Decision-Making-Under-Uncertainty</a> 3. Laura Graesser, Wah Loon Keng, Foundations of Deep Reinforcement Learning: Theory and Practice in Python. Pearson Education, 2020.	4. Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction, 2nd Ed. MIT Press, 2018. Dimitri P. Bertsekas, Dynamic Programming and Optimal Control, Athena Scientific, 2012 (4th Ed.). 5. D.V.Lindley, Making Decisions, 2 <sup>nd</sup> Edition, John Wiley & Sons.
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<b>Learning Assessment</b>							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice		
Level 1	Remember	40%	-	40%	-	40%	
Level 2	Understand	40%	-	40%	-	40%	
Level 3	Apply	20%	-	20%	-	20%	
Level 4	Analyze	-	-	-	-	-	
Level 5	Evaluate	-	-	-	-	-	
Level 6	Create	-	-	-	-	-	
	Total	100 %		100 %		100 %	

<b>Course Designers</b>		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. S Sai Marjunath Software engineer – I Cisco Systems	1. Dr. P Vetrivelan Professor, VIT-Chennai	1. Dr. Kanipriya M, SRMIST

<b>Course Code</b>	21CSE553T	<b>Course Name</b>	NEURAL NETWORK MODELS OF COGNITION	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Describe the various neural processes												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Illustrate computational neuroscience (Neural Network Models)															
<b>CLR-3:</b>	Analyze simulating cognitive, perceptual, emotional, and motivational processes using neural network models,															
<b>CLR-4:</b>	Formalize behavioral and biological levels of analysis															
<b>CLR-5:</b>	Observe a range of phenomena within this framework, including attention, memory, language, higher-level cognition, motivation, emotion, and personality.															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12			
<b>CO-1:</b>	Acquire the knowledge on the various neural processes															
<b>CO-2:</b>	Implementation computational neuroscience (Neural Network Models)															
<b>CO-3:</b>	Simulating cognitive, perceptual, emotional, and motivational processes using neural network models,															
<b>CO-4:</b>	Analysis behavioral and biological levels															
<b>CO-5:</b>	Examine a range of phenomena within this framework, including attention, memory, language, higher-level cognition, motivation, emotion, and personality.															

**Unit-1 - Introduction to Neural Networks** 9 Hour  
The Necessity of Neural Networks- Toward A Natural-Science Account of Human Behavior -Interpreting Complex behavior Using Neural Networks - Network Architecture -A Statistical Framework -Evolving Artificial Neural Networks -A Computational Approach -Ontogeny -Phylogeny - The Baldwin Effect - Simulations -Genetic Algorithms - Network Architectures -Evolution Simulations - Effects on Learning.

**Unit-2 - Neurotransmission** 9 Hour  
Principles Of Neurotransmission-Neurotransmitter and Neuropeptide Systems-Synaptic Structure and Sites of Neurotransmitter Action- Neurotransmitters and Gene Regulation in The Nervous System-Cellular Mechanisms-Mechanisms Of LTP-Phases Of LTP-Late Phase of LTP (L-LTP)-Protein Synthesis and LTI-Temporal Information Processing: -Spatial and Temporal Information -Time-Dependent Neuronal Properties-A Model of Temporal Information Processing-Simulations of Temporal Processing-Plasticity

**Unit-3 - Neocortical Processing** 9 Hour  
Perceiving-Development and Plasticity-Of Neocortical Processing Architectures-Two Strategies, Two Classes of Connections-Strategies for Response Selection -assembly-Forming Connections-Plasticity, Orientation, and Size-Columnar Organization in TE-Organization of Afferents to TE-Optical Imaging of The Columnar Organization-Changeability of Selectivity in The Adult-Functions of the Columns:- Case Studies: Sparse Coding of Faces in A Neuronal Model, Face Recognition and Categorization

**Unit-4 - Object Perception** 9 Hour  
Structure And Binding in Object Perception- Constancy and Structure in Object Perception-A Neural-Network Approach- -A Bottom-Up Model of Redundancy Compression in Entorhinal Cortex-Evaluating the Entorhinal Model. -Incorporating Models of Sept Hippocampal Cholinergic Modulation-Behaving-Motor Cortex; Network Modelling of Motor-Cortical Directional Operations-Selectionist Constraints on Neural Networks.

**Unit-5 - Reinforcement Learning****9 Hour**

Reinforcement Learning of Complex Behavior-Adaptive Dopaminergic Neurons Report-Adaptive Properties of Dopaminergic Neurons-Relations to Associative Learning Theories-Neuronal-Network Simulation of the Selection of Behavior-Simulation of the Selection of Stimulus Configurations-Implications for Complex Behavior-Reinforcement Learning in Artificial Intelligence- -Value Functions-The Optimality Equation Case Studies: Models Using Dopamine-Through Reinforcement Learning-The Credit-Assignment Problem-The Reinforcement-Learning Problem

<b>Learning Resources</b>	1. J.W. Donahoe, V.P. Dorsel, "Neural-Network Models of Cognition Biobehavioral Foundations" (Volume 121) (Advances in Psychology, Volume 121) 1st Edition. 2. Michael I. Jordan and Terrence J. Sejnowski. "Graphical Models: Foundations of Neural Computation" 2011	3. Hagan, Martin T., Howard B. Demuth, and Mark Beale. "Neural network design" PWS Publishing Co., 1997.
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**Learning Assessment**

Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1 <i>Remember</i>	40%	-	40%	-	40%	-
Level 2 <i>Understand</i>	40%	-	40%	-	40%	-
Level 3 <i>Apply</i>	20%	-	20%	-	20%	-
Level 4 <i>Analyze</i>	-	-	-	-	-	-
Level 5 <i>Evaluate</i>	-	-	-	-	-	-
Level 6 <i>Create</i>	-	-	-	-	-	-
Total	100 %		100 %		100 %	

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. P S Saravanan, Associate Consultant, CTS, USA	1. Dr.A Balaji , Senior Assistant Professor at VIT Bhopal University, 2. Prof.K Somasundram, Department of Computer Science and Engineering, Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences,	1. Dr. K Suresh 2. Dr. B.Hariharan

<b>Course Code</b>	21CSE552T	<b>Course Name</b>	COMPUTATIONAL LINGUISTICS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 3	T 0	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Introduce the Basic Concepts of Computational Linguistics in NLP.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Illustrate the knowledge on language Interpretation															
<b>CLR-3:</b>	Analyze the classification of computer in accomplishing linguistics tasks.															
<b>CLR-4:</b>	Illustrate the uniqueness of text meaning with linguistics multistage transformation.															
<b>CLR-5:</b>	Illustrate the various modelling techniques based on linguistics															
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Summarize the concepts in Computational Linguistics.												3	2	-	
<b>CO-2:</b>	Construct the various applications of computers in linguistics and language studies.												3	2	-	
<b>CO-3:</b>	Design the various Tools for Linguistic analysis												3	-	-	
<b>CO-4:</b>	Apply the text transformation of linguistic and strengthen NLP systems												3	-	-	
<b>CO-5:</b>	Apply the different model techniques based on linguistics												3	2	-	

**Unit-1 - Introduction** **9 Hour**  
The Role of Natural Language Processing – Linguistics and Its Structure - What We Mean by Computational Linguistics - The Important Role of The Fundamental Science - Current State of Applied Research on Spanish.

**Unit-2 - Overview of Grammar** **9 Hour**  
A Historical Outline - The Structural list Approach - Initial Contribution of Chomsky - A Simple Context-Free Grammar - Transformational Grammars - The Linguistic Research After Chomsky: Valencies and Interpretation – free grammar allows for a lot of different types of ungrammatical sentences. - Linguistic Research After Chomsky: Constraints - Head-Driven Phrase Structure Grammar - The Idea of Unification - Multistage Transformer and Government Patterns - Dependency Trees - Semantic Links

**Unit-3 - Products of Computational Linguistics** **9 Hour**  
Present And Prospective - Classification of Applied Linguistic Systems - Automatic Hyphenation - Spell Checking - Grammar Checking - Style Checking - References To Words And Word Combinations - Information Retrieval - Topical Summarization - Automatic Translation - Natural Language Interface - Extraction Of Factual Data From Texts - Text Generation - Systems Of Language Understanding - Related Systems.

**Unit-4 - Language as A Meaning** **9 Hour**  
Text Transformer - Possible Points Of View On Natural Language - Language As A Bi-Directional Transformer Text – Two Ways To Represent Meaning - Decomposition And Atomization Of Meaning - Not-Uniqueness Of Meaning –Text Mapping: Synonymy - Not-Uniqueness Of Text - Meaning Mapping: Homonymy - More On Homonymy - Multistage Character Of The Meaning - Text Transformer - Translation As A Multistage Transformation - Two Sides Of A Sign - Linguistic Sign - Linguistic Sign In The MMT - Linguistic Sign In HPSG - Generative, MTT, And Constraint Ideas In Comparison - Case Study writing simple parsers in groups for regional languages.

**Unit-5 - Linguistic Models****9 Hour**

What Is Modeling In General - Neurolinguistic Models - Psycholinguistic Models - Functional Models Of Language - Research Linguistic Models - Common Features Of Modern Models Of Language - Specific Features Of The Meaning - Text Model - Reduced Models - Analogy In Natural Languages - Empirical Versus Rationalist Approaches - Limited Scope of The Modern Linguistic Theories – Case Study applications involving language models, Demonstration of simple application specific modules using tools.

<b>Learning Resources</b>	1. Igor Bolshakov & Alexander Gelbukh, "Computational Linguistics Models, Resources and applications ", Ciencia De La Computación. 2004. 1. Alexander Clark, Chris Fox, & Shalom Lappin, "The Handbook of Computational Linguistics and Natural Language Processing", A John Wiley & Sons. 2010	2. Ralph Fasold & Jeff Connor-Linton, "An Introduction to Language and Linguistics", Cambridge University Press. 2018 3. Roland Haussler, "Man-Machine Communication in natural language ". 4. Stabler, "Notes on computational linguistics", UCLA, Winter 2003
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**Learning Assessment**

Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%
Level 2	Understand	25%	-	25%	-	25%
Level 3	Apply	30%	-	30%	-	30%
Level 4	Analyze	30%	-	30%	-	30%
Level 5	Evaluate	-	-	-	-	-
Level 6	Create	-	-	-	-	-
	Total	100 %		100 %		100 %

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.A.Mohanraj, Data Scientist, Standard chartered 2. Mr.N. Nagendran, Senior Software Engineer, Cognizant	1. Dr.P.Visu, Professor, Velammal College of Engineering 2. Dr.K.Sathishkumar, ,Associate Professor, KLEF- AP.	1. Dr.P.G. Om Prakash, SRMIST 2. Dr.R.Siva, SRMIST

<b>Course Code</b>	21AIE536T	<b>Course Name</b>	ARTIFICIAL INTELLIGENCE ENGINES	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Learn the fundamentals of Artificial Neural Networks and Linear Associative Networks												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Gain Knowledge on Hopfield Network, Boltzmann Machines.															
<b>CLR-3:</b>	Gain Knowledge on Hopfield Network, Boltzmann Machines.															
<b>CLR-4:</b>	Illustrate the Variational Auto encoders and Deep Back propagation Networks.															
<b>CLR-5:</b>	Learn Reinforcement Learning function.															
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>															
<b>CO-1:</b>	Describe the features of Artificial Neural network and Linear Associative Networks.												3	1	1	1
<b>CO-2:</b>	Understand the Perceptrons and Back propagation algorithms.												3	2	2	-
<b>CO-3:</b>	Apply AI techniques in Hopfield Networks and Boltzmann Machines.												3	1	1	-
<b>CO-4:</b>	Articulate AI systems that are used in Convolutional Neural Networks and Autoencoder networks.												3	1	2	-
<b>CO-5:</b>	Understand the Reinforcement Learning function and Applications.												3	2	1	-

<b>Unit-1 - Introduction</b>	<b>9 Hour</b>
Artificial Neural Networks- Origins of Neural Networks, From Backprop to Deep Learning, Linear Associative Networks- Setting One Connection Weight, Learning One Association, Gradient Descent, Learning Two Associations, Learning Many Associations, Learning Photographs	
<b>Unit-2 - Perceptrons and Backpropagation</b>	
Perceptron Learning Algorithm- Exclusive OR Problem, Exclusive OR Matters, Backpropagation Algorithm- Sigmoidal Hidden Units, Generalisation and Overfitting, Vanishing Gradients, Speeding Up Backprop, Local and Global Minima, Temporal Backprop, Early Backprop Achievements	
<b>Unit-3 - Hopfield Nets and Boltzmann Machines</b>	
Hopfield Network- Content Addressable Memory, Tolerance to Damage, Energy Function, Boltzmann Machines- Generative Models, Energy Function, Simulated Annealing, Learning by Sculpting Distributions, learning in Boltzmann Machines, Learning by Maximising Likelihood, Restricted Boltzmann Machines, Autoencoder and Deep Autoencoder Networks, Deep RBMs - Restricted Boltzmann Machines, Training Restricted Boltzmann Machines, Deep Autoencoder Networks	
<b>Unit-4 - Variational Autoencoder and Deep Backprop Networks</b>	
Variational Autoencoders- Overview of Variational Autoencoders, Latent Variables and Manifolds, Key Quantities, VA Work, Evidence Lower Bound, Alternative Derivation, Maximising the Lower Bound, Conditional Variational Autoencoders Applications, Convolutional Neural Networks- LeNet1, LeNet5, AlexNet, GoogLeNet and ResNet, Ladder Autoencoder Networks- Denoising Autoencoders- Fooling Neural Networks- Generative Adversarial Networks- Temporal Deep Neural Networks- Capsule Networks, Case Studies: Backpropagation neural network for Landslide monitoring,	

<b>Unit-5 - Reinforcement Learning</b>	<b>9 Hour</b>
Reinforcement Learning- Markov Decision Processes- Formalising the Problem- Bellman Equation- Learning State-Value Functions- Eligibility Traces- Learning Action-Value Functions- Balancing a Pole- Applications, Case Studies: Adaptive Traffic Signal Control, Pommerman.	

<b>Learning Resources</b>	1. Artificial Intelligence Engines: A Tutorial Introduction to the Mathematics of Deep Learning, James V Stone, Sebtel Press 2019. 2. Deep learning: Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT press 2016. 3. Dive into Deep Learning: Aston Zhang, Zachary C. Lipton, Mu Li, And Alexander J. 2018. 4. MATLAB Deep Learning-with Machine Learning, Neural Networks and Artificial Intelligence: Phil Kim, Springer 2017. 5. Machine learning with neural networks: Bernhard Mehlig, Cambridge University Press 2021. 6. <a href="https://www.elsevier.com/books/artificial-intelligence-and-data-driven-optimization-of-internal-combustion-engines/badra/978-0-323-88457-0">https://www.elsevier.com/books/artificial-intelligence-and-data-driven-optimization-of-internal-combustion-engines/badra/978-0-323-88457-0</a> 7. <a href="https://www.deeplearningbook.org/lecture_slides.html">https://www.deeplearningbook.org/lecture_slides.html</a> 8. <a href="https://d2l.ai/d2l-en-mxnet.pdf">https://d2l.ai/d2l-en-mxnet.pdf</a>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	20%	-	20%	-	20%	-		
Level 2	Understand	20%	-	20%	-	20%	-		
Level 3	Apply	30%	-	30%	-	30%	-		
Level 4	Analyze	30%	-	30%	-	30%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Dr. Kodainathan, Data Scientist Elpis IT solutions pvt Ltd	1. Dr. A. Menaka Pushpa, Assistant Professor (SG) SCOPE, VIT, Chennai Campus	1. Dr.AR. Arunarani,, SRMIST,

<b>Course Code</b>	21AIE538T	<b>Course Name</b>	ARTIFICIAL INTELLIGENCE FOR INDUSTRIAL APPLICATIONS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 3	T 0	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Analyze the various characteristics of Intelligent agents												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>										
<b>CLR-2:</b>	Understand the growth of AI Technology in Industry.																								
<b>CLR-3:</b>	Learn the technical elements and algorithm for solving problems using Artificial Intelligence.																								
<b>CLR-4:</b>	Apply knowledge to establish Industrial AI Technology and its assessment.																								
<b>CLR-5:</b>	Apply the concepts of AI to attain industrial automation and its application																								
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
<b>CO-1:</b>	Use appropriate search algorithms for any AI problem	-	-	-	3	3	-	-	-	-	1	-	2	1	2	-									
<b>CO-2:</b>	Identify appropriate AI methods and new opportunity spaces AI for industrial application.	-	-	-	2	2	-	-	-	-	1	-	1	1	2	-									
<b>CO-3:</b>	Understand the categories of Algorithm in Industrial AI.	-	-	-	2	2	-	-	-	-	1	-	1	1	3	2									
<b>CO-4:</b>	Understanding the assessment and capability to establish industrial AI.	-	-	-	2	2	-	-	-	-	1	-	2	1	2	2									
<b>CO-5:</b>	Understand the levels of automation and its application	-	-	-	2	2	-	-	-	-	-	-	2	1	2	-									

<b>Unit-1 - Introduction to AI and Production Systems</b>	<b>9 Hour</b>
Introduction to AI - Problem formulation, Problem Definition - Production systems, Control strategies, Search strategies. Problem characteristics, Production system characteristics - Specialized production systems - Problem solving methods -Problem graphs, Matching, Indexing and Heuristic functions -Hill Climbing, Depth first and Breath first, Constraints satisfaction, Knowledge Representation and Reasoning.	
<b>Unit-2 - The Development and Application of AI Technology.</b>	
Why do we need Industrial AI – New Perspective in industrial systems for AI, Basic problem in Industry, Basic method of problem solving with AI, what kind of AI Technology is most suitable for industry, Machine Intelligence meets industry, Difference between industry AI and AI, Challenge of AI in Industry, New opportunity spaces for industry AI to realize industrial value transformation. Definition and Meaning of Industrial AI – The Beginning of Industrial AI, Purpose and value of Industrial AI, GE predix success and failure.	
<b>Unit-3 - Technical Elements and Algorithm of Industrial AI</b>	
Technical Element – Data, Analytics, Platform, Operation and Human Machine Technology, CPS, Industrial AI: Categories of Algorithm, Industrial AI Algorithm: Selection and Application. Application Scenario Types of Industrial AI, Enabling Industrial AI system – Intelligence monitoring and maintenance platform for CNC machine, Intelligence operation, intelligence rail transit predictive maintenance system.	
<b>Unit-4 - How to Establish Industry AI Technology and Capability</b>	
Assessment of Basic capability Maturity during industrial intelligence transformation – Assessment Tools for global industrial AI enterprise transformation achievement – Foxconn Lighthouse factory – How to construct organizational intelligence transformation ability in industrial enterprises – Open-source industrial big data competitions.	
<b>Unit-5 - Industrial AI applications and Case studies</b>	
Applications of Industrial AI in Monitoring, optimization and control. AI applications in Industry Automation using -Natural Language Processing-Speech Recognition-Computer vision. Machine Learning Models for Industrial Applications, AI & Digital Platforms case study. A Framework for Learning System for Complex Industrial Processes.	

<b>Learning Resources</b>	1. Elaine Rich, "Artificial Intelligence", 2nd Edition, McGraw Hill, 2005 2. AI and Learning Systems - Industrial Applications and Future Directions, Konstantinos Kyprianidis and Erik Dahlquist, published in London, United Kingdom, 2021. 3. Industrial AI – Application with sustainable performance, Jay Lee, Springer Publication, 2020.	4. Anuradha Srinivasaraghavan, Vincy Joseph "Machine Learning", Wiley, 2019 5. Wolfgang Ertel, "Introduction to Artificial Intelligence", Second Edition, Springer, 2017. 6. Rajiv Chopra, "Deep Learning", 1st edition, Khanna Publishing House, 2018.
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	10%	-	20%	-		
Level 2	Understand	15%	-	10%	-	20%	-		
Level 3	Apply	30%	-	35%	-	20%	-		
Level 4	Analyze	30%	-	25%	-	20%	-		
Level 5	Evaluate	10%	-	20%	-	20%	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Naveen Baskaran, ADP Solution Chennai	1. Dr.P.SivaKumar, VIT Chennai 2. Dr.Senthil, NHCE Bangalore	1. Dr.S.Nagendra Prabhu, SRMIST

<b>Course Code</b>	21AIE539T	<b>Course Name</b>	ARTIFICIAL INTELLIGENCE IN MEDICAL IMAGING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Discuss the fundamentals of Medical Imaging												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Introduce the concepts of Diagnostic Radiology															
<b>CLR-3:</b>	Impart knowledge on Nuclear Medicine.															
<b>CLR-4:</b>	Become familiar in applying AI techniques in medical imaging.															
<b>CLR-5:</b>	Explore various future perspectives of medical imaging Technology.															

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	
<b>CO-1:</b>	Understand the fundamentals of Medical Imaging	3	2	1	-	-	-	-	-	-	-	-	-											1	2	2
<b>CO-2:</b>	Summarizes the concepts of Diagnostic Radiology	3	2	2	-	-	-	-	-	-	-	-	-											-	-	-
<b>CO-3:</b>	Utilize the features and characteristics of Nuclear Medicine	3	1	1	-	-	-	-	-	-	-	-	-											-	-	2
<b>CO-4:</b>	Articulate AI systems that are used in medical imaging.	3	1	2	-	-	-	-	-	-	-	-	-											-	-	-
<b>CO-5:</b>	Apply various AI techniques in medical imaging	3	3	3	-	-	-	-	-	-	-	-	-											-	-	2

**Unit-1 - Introduction** 9 Hour  
 Introduction to medical imaging – The modalities – Digital imaging basics – Image properties – Radiation and the atom – Interaction of radiation with matter – Image Quality – Spatial resolution – contrast resolution – Medical imaging informatics – Ontologies, standards and profiles – Algorithms for image and non-image analytics – Security and privacy.

**Unit-2 - Diagnostic Radiology** 9 Hour  
 X-Ray Production tubes and generators – Production of X-Rays – X-Ray tubes – X-Ray generators – Factors affecting X-Ray emission – Radiography – Geometry of projection radiography – scattered radiation in projection radiographic imaging – Computed Radiography – Artifacts in digital radiography – Dual energy subtraction radiography- Fluoroscopy – Computed Tomography – X-Ray Dosimetry – Magnetic Resonance Basics – Ultrasound.

**Unit-3 - Nuclear Medicine** 9 Hour  
 Radioactivity and nuclear Transformation – Radiation detection and measurement – Nuclear Imaging – The Gamma camera – Planar Nuclear Imaging – Computers in Nuclear Imaging – Nuclear Tomographic Imaging – Single Photon and Positron Emission Tomography (SPECT and PET) – Dual modality Imaging – Advances in PET Imaging.

**Unit-4 - Applying AI in Medical Imaging** 9 Hour  
 Historical perspective – Quantitative image analysis – Computer aided detection and diagnosis – Triage – image registration – Radiomics: Radiology meets Big Data – Applications beyond image interpretation – Applications beyond radiology – Case Studies: CAD in CT Colonography – CAD in Mammography – Diabetic Retinopathy

**Unit-5 - Future Perspectives** 9 Hour  
 Progress in established imaging modalities: X-Ray and CT – Magnetic Resonance Imaging – Ultra sound Imaging – PET and Multimodality Imaging – Molecular Imaging – Optical Tomography – Advanced Image processing.

<b>Learning Resources</b>	<p>1. Jerrold T. Bushberg, , J. Anthony Seibert PhD (Author), Edwin M. Leidholdt The Essential Physics of Medical Imaging, 2021 (1,2,3)</p> <p>2. Mark A.Haidekker, Medical Imaging Technology, Springer Briefs in Physics, 2013.(5)</p> <p>3. Artificial Intelligence in Medical Imaging from theory to clinical practise, Lia Morra, Silvia Delsanto, Loredana Correale, CRC Press 2019 (4)</p> <p>4. Artificial Intelligence in Medical Imaging, Opportunities, Applications and Risks, Erik R. Ranschaert, Sergey Morozov, Paul R. Algra, Springer, 2019.</p> <p>5. Haidekker, M. A., "Medical Imaging Technology", Springer, 2013.</p>
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)	Life-Long Learning CLA-2 (10%)							
		Theory	Practice	Theory	Practice				
Level 1	Remember	20%	-	10%	-	20%	-		
Level 2	Understand	20%	-	10%	-	20%	-		
Level 3	Apply	30%	-	40%	-	30%	-		
Level 4	Analyze	30%	-	40%	-	30%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.R. Durairaj, Clayfin Technologies Private Limited, Chennai	1. Dr.M.S. Bhuvaneswari, Asso. Professor, Mepco Schlenk Engineering College, Sivakasi	1. Dr.R. Beaulah Jeyavathana, SRMIST

<b>Course Code</b>	21AIE541T	<b>Course Name</b>	MULTIMODAL MACHINE LEARNING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							3	0	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Provide the basic understanding of multimodal data and its importance in various fields.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Various representations used in multimodal machine learning using different models															
<b>CLR-3:</b>	Understand the details about the translation and mapping algorithms of multimodal data															
<b>CLR-4:</b>	Create interest to develop a project using various applications of multimodal machine learning framework															
<b>CLR-5:</b>	Importance of multimodal deep learning and behavior generations functions															

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>
<b>CO-1:</b>	Outline the critical elements of multimodal data and models	3	3	3	-	-	-	-	-	-	-	-	-	1	-	-
<b>CO-2:</b>	Illustrate different kinds of unimodal and multimodal representations	3	2	2	-	-	-	-	-	-	-	-	-	2	-	-
<b>CO-3:</b>	Demonstrate multimodal translation and mapping	3	2	2	-	-	-	-	-	-	-	-	-	1	-	-
<b>CO-4:</b>	Classify machine learning techniques and frameworks of multimodal applications in real time scenario	3	2	2	-	-	-	-	-	-	-	-	-	-	-	-
<b>CO-5:</b>	Analyze various multimodal fusion and behavior generation for multimodal applications	3	2	2	-	-	-	-	-	-	-	-	-	1	-	2

**Unit-1 - Introduction** 9 Hour  
 Introduction – Multimodal, Basic Concepts - Linear models - Score and loss functions – regularization, Neural networks - Activation functions - multi-layer perceptron, Optimization - Stochastic gradient descent – backpropagation

**Unit-2 - Unimodal and Multimodal Representations** 9 Hour  
 Language representations - Distributional hypothesis and word embedding, Visual representations - Convolutional neural networks, Acoustic representations - Spectrograms – Autoencoders, Multimodal representations - Joint representations - Visual semantic spaces - multimodal autoencoder, Orthogonal joint representations - Component analysis, Parallel multimodal representations - Similarity metrics, canonical correlation analysis

**Unit-3 - Multimodal Translation and Mapping** 9 Hour  
 Language models – Unigrams – bigrams - skip-grams - skip-thought, Unimodal sequence modelling - Recurrent neural networks, LSTMs, Optimization - Backpropagation through time, Multimodal translation and mapping - Encoder-decoder models - Machine translation - Image captioning, Generative vs retrieval approaches - Viseme generation - visual puppetry, Modality alignment - Latent alignment approaches - Attention models - multi-instance learning, Explicit alignment - Dynamic time warping

**Unit-4 - Multimodal Applications** 9 Hour  
 Multimodal fusion and co-learning - Model free approaches - Early and late fusion - hybrid models, Kernel-based fusion - Multiple kernel learning, Multimodal graphical models - Factorial HMM, Multi-view Hidden CRF, Case studies - Automatic Face Recognition - Video Segmentation and Keyframe Extraction - Gesture Recognition - Biometric-based System

**Unit-5 - Deep Learning for Multimodal** 9 Hour

Deep Learning for multimodal data fusion – Basics of multimodal deep learning – Multimodal image-to-image translation networks – Multimodal encoder decoder networks, Multimodal applications - Image captioning - Video description - AVSR, Core technical challenges - Representation learning – translation – alignment - fusion and co-learning

<b>Learning Resources</b>	1. <i>Multimodal Scene Understanding: Algorithms, Applications and Deep Learning</i> , Michael Ying Yang, Bodo Rosenhahn, Vittorio Murino, Academic Press, Elsevier, 2019, ISBN:978-0-12-817358-9 (Unit V)	4. <i>Unifying Visual-Semantic Embeddings with Multimodal Neural Language Models</i> . Ryan Kiros, Ruslan Salakhutdinov, and Richard S. Zemel; TACL 2015
	2. <i>Representation Learning: A Review and New Perspectives</i> . Yoshua Bengio, Aaron Courville, and Pascal Vincent	5. <i>Multi-View Latent Variable Discriminative Models for Action Recognition</i> . Yale Song, Louis-Philippe Morency, Randall Davis, CVPR 2012
	3. <i>Visualizing and understanding recurrent networks</i> . Andrej Karpathy, Justin Johnson, Li Fei-Fei, 2015	6. M. Gori, "Machine Learning: A Constraint-Based Approach", 2017, Morgan Kauffman, ISBN: 978-0081006597
		7. F. Camastra, A. Vinciarelli, "Machine Learning for Audio, Image and Video Analysis: Theory and Applications", 2nd Edition, 2016, Springer Verlag, ISBN: 978-1447168409

Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	20%	-	20%	-	20%	-		
Level 2	Understand	20%	-	20%	-	20%	-		
Level 3	Apply	30%	-	30%	-	30%	-		
Level 4	Analyze	30%	-	30%	-	30%	-		
Level 5	Evaluate	-	-	-	-	-	-		
Level 6	Create	-	-	-	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Sanjay Hotwani, Senior Manager – Data Science, Products &Technology, PwC US	1. Dr. Tulasi Prasad Sariki, Associate Professor, VIT, Chennai, tulasiprasad.sariki@vit.ac.in	1. Dr.T.Subha, SRMIST

**ACADEMIC CURRICULA**

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(Choice Based Flexible Credit System)

Regulations 2021

Volume - 11M

(Syllabi for M.Tech (Integrated) Computer Science and  
Engineering w/s in Cyber Security & Digital Forensics  
Programme Courses)



**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

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Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

# ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021



**SRM**

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**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

<b>Course Code</b>	21CSC503T	<b>Course Name</b>	SECURITY SERVICE MANAGEMENT	<b>Course Category</b>	C	PROFESSIONAL CORE	L 3	T 1	P 0	C 4
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>	<i>The purpose of learning this course is to:</i>	Program Outcomes (PO)												<b>Program Specific outcomes</b>
		1	2	3	4	5	6	7	8	9	10	11	12	
<b>CLR-1:</b>	Understand risk management security principles and concepts, and threat modelling concepts and methodologies.													
<b>CLR-2:</b>	Explain concepts of security models, vulnerabilities of security architectures and methods of cryptanalytic attacks.													
<b>CLR-3:</b>	Study secure design principles in network architectures and Manage identification and authentication of people, devices, and services.													
<b>CLR-4:</b>	Demonstrate the knowledge and skills for Security Assessment and Testing and security audits.													
<b>CLR-5:</b>	Manage Security Operations concepts and logging and monitoring activities with various recovery plans.													

<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
<b>CO-1:</b>	Students can able to identify security principles and concepts, and threat modelling concepts and methodologies.	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
<b>CO-2:</b>	Students can obtain knowledge from vulnerabilities of security architectures and methods of cryptanalytic attacks.	-	-	2	-	-	-	-	-	-	-	-	-	-	-	3
<b>CO-3:</b>	Students can gain information from secure design principles in network architectures.	-	-	-	-	2	-	-	-	-	-	-	-	-	-	3
<b>CO-4:</b>	Students are able to gain knowledge for Security Assessment and Testing and security audits.	-	-	2	-	-	-	-	-	-	-	-	-	-	-	3
<b>CO-5:</b>	Students can enhance their knowledge of obtaining logging and monitoring activities with various recovery plans.	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-

<b>Unit-1 - Security and Risk Management</b>	<b>12 Hour</b>
security concepts, security governance principles, requirements for investigation types, security policy, standards, procedures, and guidelines, Business Continuity (BC) requirements, risk management concepts, threat modelling concepts and methodologies.	

<b>Unit-2 - Security Architecture and Engineering</b>	<b>12 Hour</b>
fundamental concepts of security models (e.g., Biba, Star Model, Bell-LaPadula), security capabilities of Information Systems (IS) (e.g., memory protection, Trusted Platform Module (TPM), encryption/decryption), vulnerabilities of security architectures, designs, and solution elements, cryptographic solutions, methods of cryptanalytic attacks, security principles to site and facility design.	

<b>Unit-3 - Communication and Network Security</b>	<b>12 Hour</b>
secure design principles in network architectures, Secure network components, secure communication channels according to design, Identity and Access Management (IAM)- Physical and logical access to assets, identification and authentication of people, devices, and services, identity with a third-party service, authorization mechanisms.	

<b>Unit-4 - Security Assessment and Testing</b>	<b>12 Hour</b>
Design and validate assessment, test, and audit strategies, conduct security control testing, collect security process data (e.g., technical, and administrative), Analyze test output and generate report, Conduct, or facilitate security audits.	

**Unit-5 - Security Operations****12 Hour**

Understand and comply with investigations, conduct logging and monitoring activities, Perform Configuration Management (CM) (e.g., provisioning, baselining, automation), Apply foundational security operations concepts, apply resource protection, conduct incident management, Implement Disaster Recovery (DR) processes, Test Disaster Recovery Plans (DRP).

<b>Learning Resources</b>	1. <a href="https://www.koenig-solutions.com/security-management-training-certification-courses">https://www.koenig-solutions.com/security-management-training-certification-courses</a> .	2. <a href="https://www.koenig-solutions.com/cissp-certification-training-course#benefits">https://www.koenig-solutions.com/cissp-certification-training-course#benefits</a>	3. <a href="https://www.linkedin.com/learning/topics/security-management-and-policy">https://www.linkedin.com/learning/topics/security-management-and-policy</a>	4. <a href="https://www.linkedin.com/learning/certified-information-security-manager-cism-cert-prep-2022-3-information-security-program?trk=learning-topics_learning-search-card_search-card&amp;upsellOrderOrigin=default_guest_learning">https://www.linkedin.com/learning/certified-information-security-manager-cism-cert-prep-2022-3-information-security-program?trk=learning-topics_learning-search-card_search-card&amp;upsellOrderOrigin=default_guest_learning</a> .
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**Learning Assessment**

Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%
Level 2	Understand	25%	-	20%	-	25%
Level 3	Apply	30%	-	25%	-	30%
Level 4	Analyze	30%	-	25%	-	30%
Level 5	Evaluate	-	-	10%	-	-
Level 6	Create	-	-	5%	-	-
	Total	100 %		100 %		100 %

**Course Designers****Experts from Industry**

1. Mr. T Ravichandran, Product Manager, Servis2 IT Team, Chennai.
2. Mr. Dhanvant Kesavan, NTT Data Cyber security analyst, Chennai.

**Experts from Higher Technical Institutions****Internal Experts**

1. Dr. P. Balamurugan, SRMIST

<b>Course Code</b>	21CSC504J	<b>Course Name</b>	ANDROID MALWARE ANALYSIS	<b>Course Category</b>	C	PROFESSIONAL CORE	L 3	T 0	P 2	C 4
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the various Android malware threats.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Gain knowledge about Sandboxing and Memory Analysis.															
<b>CLR-3:</b>	Gain knowledge about traffic analysis of Android application															
<b>CLR-4:</b>	analyze different malware families and perform static and dynamic mechanisms.															
<b>CLR-5:</b>	Explore popular security vulnerabilities in Android Application.															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
<b>CO-1:</b>	Gain knowledge about the different forms of malware.												-	-	-	-
<b>CO-2:</b>	Set up a safe virtual environment to analyze malware.												-	-	-	-
<b>CO-3:</b>	Navigate, comment, and modify android malware samples.												-	-	-	3
<b>CO-4:</b>	Use tools and perform static and dynamic analysis.												-	-	-	3
<b>CO-5:</b>	Use web view and explore Android vulnerabilities.												-	-	-	-

<b>Unit-1 - Introduction</b>	<b>15 Hour</b>
Basics- Android development tools- Risky Apps- Malware Threats- Open-Source Tools- Vulnerability research for Android OS- Antivirus Scans. Lab: Static Analysis of Android Application	
<b>Unit-2 – Advanced Static Analysis</b>	<b>15 Hour</b>
Sandbox Analysis- Emulation Analysis- Native Analysis- Reverse Engineering- Memory Analysis- Traffic Analysis of Android Devices-Passive and Active Analysis- HTTPs proxy interception- extracting sensitive files Malware Collections- Lab: Reversing of Android malware applications.	
<b>Unit-3 – Behavioral Analysis</b>	
Process Emulation- Configuring device with Genymotion- Using the ADB Tool- Capabilities and Limitations of the Emulators- Network Architecture for Sniffing in a Physical Environment- Device View- Logcat View- Application Tracing- Analysis of Results- Imaging the Device. Lab: Case study on Usbcleaver.	
<b>Unit-4 - Android Vulnerabilities</b>	<b>15 Hour</b>
SQLLite in depth- Web view vulnerability - Infecting legitimate APKs- Vulnerabilities in ad libraries- Cross-Application Scripting in Android- Lab- Exploring security vulnerabilities using Drozer and Andriller.	
<b>Unit-5 - Exploitation</b>	<b>15 Hour</b>
ARM architecture- Execution modes- Simple stack-based buffer overflow- Return-oriented programming- Android root exploits- Lab: Writing the pentest report for Android malwares.	

<b>Learning Resources</b>	<p>1. Ken Dunham, <i>Android Malware and Analysis</i>, Kindle Edition, Auerbach Publications. International Standard Book Number-13:978-1-4822-5220-0.</p> <p>2. Aditya Gupta, <i>Learning Pentesting for Android Devices Illustrated Edition</i>, Kindle Edition, ISBN-13- 978-1783288984.</p>	<p>3. Pratiyush Guleria, <i>Android for Beginners: Step by Step guide to develop Android App: Learn Step-by-Step 1st Edition</i>, Kindle Edition, and ISBN- 13 978-9388176231.</p>
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>	
<i>Bloom's Level of Thinking</i>	<i>Formative CLA-1 Average of unit test (45%)</i>	<i>Life-Long Learning CLA-2 (15%)</i>					
		<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>
Level 1	<i>Remember</i>	15%	-	-	15%	15%	-
Level 2	<i>Understand</i>	25%	-	-	20%	25%	-
Level 3	<i>Apply</i>	30%	-	-	25%	30%	-
Level 4	<i>Analyze</i>	30%	-	-	25%	30%	-
Level 5	<i>Evaluate</i>	-	-	-	10%	-	-
Level 6	<i>Create</i>	-	-	-	5%	-	-
	<i>Total</i>	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. Karthik Expert Member from k7 Computing	1. Dr Bhawana Rudra Assistant Professor (Grade II) National Institute of Technology, Warangal	1. Mr. V. Joseph Raymond, SRMIST

# ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021



**SRM**

INSTITUTE OF SCIENCE & TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

<b>Course Code</b>	21CSE531T	<b>Course Name</b>	CYBER SECURITY OPERATIONS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CLR-1:</b>	Understand the basic security operations												<b>CLR-2:</b>	Acquire knowledge in assessing security operation capabilities											
<b>CLR-3:</b>	Understand the SOC Infrastructure and security Events Generation												<b>CLR-4:</b>	Understand the security technology and preparation to operate											
<b>CLR-5:</b>	Understand the types of events and Incidents																								
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>											
<b>CO-1:</b>	Apply the knowledge of security technologies												-	2	-	Problem Analysis	1	Engineering Knowledge							
<b>CO-2:</b>	Analyze the security operation capabilities												-	-	-	Design/development of solutions	2								
<b>CO-3:</b>	Evaluate the security Events Generation												-	2	-	Conduct investigations of complex problems	3								
<b>CO-4:</b>	Analyze the preparing to operate												-	-	-	Modern Tool Usage	4								
<b>CO-5:</b>	Evaluate the Events and Incidents												-	2	-	The engineer and society	5								
														-	-	Environment & Sustainability	6								
														-	-	Ethics	7								
														-	-	Individual & Team Work	8								
														-	-	Communication	9								
														-	-	Project Mgt. & Finance	10								
														-	-	Life Long Learning	11								
														-	-	PSO-1	12								
														-	-	PSO-2									
														-	-	PSO-3									

**Unit-1 - Introduction to Security Operations and the SOC Technologies** 9 Hour

Cyber security Challenges- Introduction to Information Assurance- Introduction to Risk Management- Information Security Incident Response- SOC Generations- Characteristics of an Effective SOC-Introduction to Maturity Models - Applying Maturity Models to SOC- Phases of Building a SOC- Challenges and Obstacles-Data Collection and Analysis-Vulnerability Management-Threat Intelligence-Compliance- Ticketing and Case Management- Collaboration- SOC Conceptual Architecture

**Unit-2 - Assessing Security Operations Capabilities** 9 Hour

Assessment Methodology-Organization's Threat Landscape-SOC Sponsorship- Allocated Budget- Presenting Data Strategy Elements-SOC Model of Operation-SOC Services-SOC Capabilities Roadmap

**Unit-3 - SOC Infrastructure and Security Events Generation, Collection , Vulnerability Management** 9 Hour

Design Considerations- Model of operation-Facilities-Active Infrastructure-Data Collection- Cloud Security- Intrusion Detection and Prevention System- Network Telemetry with Network Flow - Handling Vulnerabilities- Automating Vulnerability Management- Threat Intelligence

**Unit-4 - Technology and Preparing to Operate** 9 Hour

Network- Security- Systems- Storage- Collaboration- Technologies to consider during SOC design- Breach Detection- Final SOC Architecture- Preparing to Operate-Key Challenges- Managing Challenges through a Well Managed Transition

**Unit-5 - Reacting to Events and Incidents** 9 Hour

Event Intake, Enrichment, Monitoring and Handling- Closing and Reporting on the case- Review and Assessing the SOC- Maintaining and Improving SOC

<b>Learning Resources</b>	1. Joseph Muniz, Gary McIntyre, Security Operations Center, Cisco press 2015 2. John Rittinghouse PhD CISM Captain, William M. Hancock PhD CISSP CISM, Digital Press, 2003			3. Russel C Hibler, Engineering Mechanics: Statics, Dynamics, Pearson, 14th ed., 2015 4. Robert H. Deatherage, Jr., Security Operations an Introduction to planning and Conductive Private Security Details for High-Risk Areas	
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Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
<b>Total</b>		<b>100 %</b>		<b>100 %</b>		<b>100 %</b>			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Sankaranarayanan, Security Analyst, Philips	1. Karthikeyan.C.M.T, Govt College of Engg,Bargur	1. Dr. J. Godwin Ponsam, SRMIST

<b>Course Code</b>	21CSE532T	<b>Course Name</b>	NETWORK MANAGEMENT AND PROTOCOLS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Determine the various type of Networks and the Network Management basics												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Exploring the Network Management Standards															
<b>CLR-3:</b>	Analyze the working of Simple Network Management Protocol and its various versions															
<b>CLR-4:</b>	Exploring the working of Remote Monitoring															
<b>CLR-5:</b>	Analyze the Network Management Applications															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
<b>CO-1:</b>	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>CO-2:</b>	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	3
<b>CO-3:</b>	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	3
<b>CO-4:</b>	-	3	-	-	3	-	-	-	-	-	-	-	-	-	-	-
<b>CO-5:</b>	-	-	-	-	3	-	-	-	-	-	3	-	-	-	-	-

**Unit-1 - Network Management Overview** 9 Hour  
Telephone Network Management, Distributed Computing Environment ,TCP/IP Based Networks, Communication Protocols and Standards, Protocol Layer and Services, Challenges of IT Managers, Network Management, Network and System Management, Network Management System Platform, Current status and future of Network, Management Network Management Standards, Network Management Model - Organizational model, Information Model, Management Information Trees, Communication Model, ASN.1, Terminology, Symbols and Conventions, Functional Model

**Unit-2 - SNMP and Network Management** 9 Hour  
Introduction to SNMP, SNMP v1 model, Organization Model, System overview, SNMP v1 Information model, Structure of Management Information, Managed Objects MIB-Object Group, System Group, Interfaces Group, Address Translation group, IP Group, ICMP Group, TCP Group, UDP Group, SNMP v1Communication model, Functional model, SNMPv2, System Architecture, MIB, Protocol, SNMPv3, MIB, User Based Security Model, Access Control

**Unit-3 - Remote Monitoring System** 9 Hour  
Remote Monitoring, RMON SMI and MIB, RMON1, RMON2, System Utilities for Management, Tools, Network Statistics Measurement Systems, Traffic Load, Protocol Statistics, Data and Error Statistics, Network Management System, Components, Requirements, System Management, Network Management Applications, Configuration Management, Inventory Management, Performance Management, Tools

**Unit-4 - Fault Management** 9 Hour  
Fault Management -Architecture, Fault location, Fault isolation, Algorithm, Self-healing, avoiding failures, Configuration setting, Configuration discovery and Change Control, Configuration Management Applications, Patch Management, Approaches for Performance Management, Performance Monitoring and Reporting, Performance trouble shooting, Capacity Planning, Account Management, Report Management-System and User Reports, Policy Management, Service Level Management

**Unit-5 - Network Design and Planning** **9 Hour**

Network Design and Planning, Network Design for Enterprise Network, Network Design Process, Data Collection, Data Generation, Traffic Generators, Cost Generators, Topology, Architecture, Graph, Link, Algorithms, Network Design Techniques, Performance Analysis, Queuing Essentials, Loss and Delay, Reliability, Network Cost

<b>Learning Resources</b>	1. Mani Subramanian – Network Management Principles and Practicell, Second Edition, Pearson Publication, 2012. 2. Dinesh Chandra Verma – Principles of Computer Systems and Network Management, Springer, 2009	3. Greg Tomsho, Ed Tittel, David Johnson, – Guide to Network Essentials, Fifth Edition, Cengage Learning, 2010 4. Teresa C. Pilouras, Network Design Management and Technical Perspectives, Second Edition, 2004
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)	Life-Long Learning CLA-2 (10%)							
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. Srinivasan Varadarajan, Manhattan Associates, Atlanta	1. Dr. I.Joe Louis Paul, Associate Professor, SSN College of Engineering, TamilNadu	1. Dr S. Metilda Florence, SRMIST
2. Mr. Shiva Praveen, American Express, USA	2. Dr. B. Vinayaga Sundaram, Associate Professor, Madras Institute of Technology, Chennai	

<b>Course Code</b>	21CSE533T	<b>Course Name</b>	FIREWALLS AND ACCESS CONTROLS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understanding why port-based firewalls have become obsolete & addressing the data leakage problem, device sprawl.												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Recognizing the security and business benefits of next-generation firewalls															
<b>CLR-3:</b>	Configure and troubleshoot remote connectivity through direct access and the cloud															
<b>CLR-4:</b>	Learn to interpret the SELinux log events that describe to us what activities SELinux has prevented															
<b>CLR-5:</b>	Examining the Challenges in a Global Access Controls Strategy															

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
<b>CO-1:</b>	Understanding accessibility tactics and examining the shortcomings of intrusion prevention	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-
<b>CO-2:</b>	Comparing performance between next-generation and legacy firewall architectures and knowing what features to look for in a next-generation firewall.	-	-	-	-	-	-	-	-	-	3	-	-	-	-	3
<b>CO-3:</b>	Configuring Advanced Global Protect Features, Centralizing logs, and setting up site-to-site VPNs and Large-Scale VPNs.	-	-	-	-	-	-	2	-	-	-	-	-	-	-	3
<b>CO-4:</b>	Understanding SELinux Decisions and Logging and Defining users that have sufficient rights to do their jobs, ranging from unprivileged users to fully privileged users, running almost without SELinux protection.	-	-	-	-	-	-	2	-	-	3	-	-	-	-	-
<b>CO-5:</b>	Understanding the Security Matrix and Developing a Directory-Based Access Control Strategy.	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-

#### **Unit-1 - Introduction to Firewalls** 9 Hour

Why Legacy Firewalls Are No Longer Effective - Data Leakage Is a Problem - Compliance Is Not Optional - Applications Are Not All Good or All Bad - Applications Are Evasive - Threats Are Coming Along for the Ride - Whatever Happened to the Firewall? - Traditional IPS Is a Poor Match for Today's Threats - UTM Only Makes What Is Broken Cheaper - It's Time to Fix the Firewall

#### **Unit-2 - Solving the Problem with Next-Generation Firewalls** 9 Hour

The Next-Generation Firewall - What a Next-Generation Firewall Isn't - Benefits of Next-Generation - Safe Enablement through Smart Policies Firewalls - Defining Your Requirements and Developing an RFP - Deployment Flexibility Matters - Addressing Mobile and Remote Users - Ten Evaluation Criteria for Next-Generation Firewalls-Identify Applications, Not Ports - Identify Users, Not IP Addresses - Identify Content, Not Packets – Control

#### **Unit-3 - Securing Remote Access in Palo Alto Networks** 9 Hour

Understanding log forwarding profiles and best practices - Learning about Panorama and log collectors - Forwarding logs to syslog, SMTP, and other options - Exploring log forwarding profiles - Troubleshooting logs and log forwarding - Learning about advanced configuration features - Leveraging quarantine to isolate agents - Configuring a site-to-site VPN connection - Anti Phishing with User Credential Detection - Practical troubleshooting and Best Practice Tools.

#### **Unit-4 - SELinux access controls** 9 Hour

SELinux users and roles - Jumping from one role to another - Context switching during authentication - Application-based contexts - Reading and changing file contexts - The context of a process - Dealing with types, permissions, and constraints - Integrating with Linux netfilter - Introducing labeled networking - Example – labeled IPSec

**Unit-5 - Security Controls****9 Hour**

Simplifying the Security Matrix - Understanding Identification - Understanding Authentication - Understanding Authorization - Understanding Access Control - Examining Directory Services - Understanding LDAPv3 - Understanding the Meta-Directory - Revisiting Security Policy Domains- Examining the Challenges in a Global Access - Exploring a Future with Global Access Controls-Understanding Standard Data-Related Access Rights.

<b>Learning Resources</b>	1. Lawrence C. Miller - Next-Generation Firewalls for Dummies Wiley Publishing, ISBN 978-0-470-93955-0 2. Tom Piens - Securing Remote Access in Palo Alto Networks_ Practical techniques to enable and protect remote users, improve your security posture, and troubleshoot next-generation firewalls-Packt Publication	3. Sven Vermeulen - SELinux System Administration_ A Comprehensive Guide to Walk You Through SELinux Access Controls-Packt Publishing (2013) 4. Dennis C Brewer - Security controls for Sarbanes-Oxley section 404 IT compliance _ authorization, authentication, and access-Wiley Pub (2006)
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**Learning Assessment**

Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%
Level 2	Understand	25%	-	20%	-	25%
Level 3	Apply	30%	-	25%	-	30%
Level 4	Analyze	30%	-	25%	-	30%
Level 5	Evaluate	-	-	10%	-	-
Level 6	Create	-	-	5%	-	-
	Total	100 %		100 %		100 %

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. S. Sajiv, Technical Leader, CISCO 2. Mr. Varun Subramanian, QA Automation Tester, Likewize	1. Dr. A. Balaji, School of Computing Science and Engineering (SCSE), VIT Bhopal University	1. Dr. S. Prabakeran, SRMIST

<b>Course Code</b>	21CSE534T	<b>Course Name</b>	NETWORK PROGRAMMING AND MANAGEMENT	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Explore different socket function and implement client server applications using sockets												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Analyze various application program like TELNET, DNS, DHCP															
<b>CLR-3:</b>	Create Thread and Raw Socket															
<b>CLR-4:</b>	Create Macros for including Objects In MIB Structure															
<b>CLR-5:</b>	Explore SNMPv1, v2 and v3 protocols and practical issues															
<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>															
<b>CO-1:</b>	Define elementary socket functions												-	-	-	
<b>CO-2:</b>	Implement client –server applications using Sockets												-	-	-	
<b>CO-3:</b>	Create Thread and Raw Socket												-	-	-	
<b>CO-4:</b>	Implement Macros for including Objects In MIB Structure												-	-	-	
<b>CO-5:</b>	Determine SNMPv1, v2 and v3 protocols and practical issues												-	-	-	

<b>Unit-1 – Sockets and Application Development</b>	<b>9 Hour</b>
Introduction to Socket Programming – System Calls – Address conversion functions – POSIX Signal Handling – Server with multiple clients – Boundary conditions – Server process Crashes, Server host Crashes, Server Crashes and reboots, Server Shutdown – I/O Multiplexing – I/O Models -TCP echo client/server with I/O Multiplexing	
<b>Unit-2 – Socket Options</b>	
Socket options – getsockopt and setsockopt functions – Generic socket options – IP socket options – ICMP socket options – TCP socket options – Multiplexing TCP and UDP sockets – SCTP Sockets – SCTP Client/server – Streaming Example – Domain name system – gethostbyname, gethostbyaddr, getservbyname and getservbyport functions – Protocol Independent functions in TCP Client/Server Scenario	
<b>Unit-3 – Advanced Sockets</b>	
Ipv4 and Ipv6 interoperability – Threaded servers – Thread creation and termination – TCP echo server using threads – Mutex – Condition variables – Raw sockets – Raw socket creation – Raw socket output – Raw socket input – ping program – traceroute program	
<b>Unit-4 – Simple Network Management</b>	
SNMP network management concepts – SNMPv1 – Management information – MIB Structure – Object syntax – Standard MIB's – MIB-II Groups – SNMPv1 protocol and Practical issues.	
<b>Unit-5 – SNMP V2, V3 and RMON</b>	
Introduction to SNMPv2 – SMI for SNMPV2 – Protocol – SNMPv3 – Architecture and applications – Security and access control model – Overview of RMON	

<b>Learning Resources</b>	1. W. Richard Stevens, "UNIX Network Programming Vol-I", Third Edition, PHI Pearson Education, 2003. 2. William Stallings, "SNMP, SNMPv2, SNMPv3 and RMON 1 and 2", Third Edition, Pearson Edition, 2009.			3. D... E. Comer, "Internetworking with TCP/IP Vol- III: Client-Server Programming and Application BSD Sockets Version", Second Edition, Pearson Edition, 2003. 4. Behrouz A.Forouzan , – TCP/IP protocol suitell, 4 <sup>th</sup> edition, Mc Graw Hill education private limited,2010		
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				<b>Summative Final Examination (40% weightage)</b>			
	<i>Bloom's Level of Thinking</i>	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. Srinivasan Varadarajan, Manhattan Associates, Atlanta	1. Dr. I.Joe Louis Paul, Associate Professor, SSN College of Engineering, TamilNadu	1. Dr S. Metilda Florence, SRMIST
2. Mr. Shiva Praveen, American Express, USA	2. Dr. B. Vinayaga Sundaram, Associate Professor, Madras Institute of Technology, Chennai	

<b>Course Code</b>	21CSE535T	<b>Course Name</b>	NETWORK INTRUSIONS AND COMPUTER FORENSICS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the basic of forensic investigation and its procedure												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Understand the packet capturing and Analysis															
<b>CLR-3:</b>	Acquire knowledge in location awareness and Logs															
<b>CLR-4:</b>	Understand the network Intrusions and Alerting															
<b>CLR-5:</b>	Understand the types of scanning															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12			
<b>CO-1:</b>	Apply the knowledge forensic investigation												2	-	Problem Analysis	
<b>CO-2:</b>	Implement packet capturing and analysis												-	2	Design/development of solutions	
<b>CO-3:</b>	Evaluate the different types of logs												2	2	Conduct investigations of complex problems	
<b>CO-4:</b>	Analyze the intrusion detection system												-	2	Modern Tool Usage	
<b>CO-5:</b>	Test using scanning technique												2	-	The engineer and society	
															Environment & Sustainability	
															Ethics	
															Individual & Team Work	
															Communication	
															Project Mgt & Finance	
															Life Long Learning	

<b>Unit-1 - Introduction to Network Forensics</b>	<b>9 Hour</b>
Handling Evidence-Cryptographic Hashes-Incident Response-Need for Forensic practitioners. Networking basics-Host side Artifacts-Services- Connections- Tools-netstat, nbstat, ifconfig-ntop- Task Manager/ Resource Monitor-ARP.	
<b>Unit-2 - Packet Capture and Analysis</b>	<b>9 Hour</b>
Capture Packets- Packet Analysis with wireshark- Network Miner-Attack Types –SYN Floods- Malformed Packets- UDP floods- Amplification Attacks- Distributed Attacks- Backscatter-Vulnerability Exploits-Insider Threats- Evasion- Application Attacks	
<b>Unit-3 - Location Awareness</b>	<b>9 Hour</b>
Time zones- Using Whois- Traceroute-Geo Location- Location based services- Wifi Positioning- Preparing for Attacks-Netflow- Logging- Syslog- Windows Event Logs- Firewall Logs- Router and Switch Logs- Log Servers and Monitors- Antivirus- Incident Response Preparation- Security Information and Event Management	
<b>Unit-4 - Intrusion Detection System</b>	<b>9 Hour</b>
Detection Styles- Signature Based-Heuristic- Host based versus Network based- Snort- Suricata and Sagan- Bro- Tripwire-OSSEC- Architecture- Alerting	
<b>Unit-5 - Correlating Attacks</b>	<b>9 Hour</b>
Packet Capture Times- Log Aggregation and Management- Timelines- Network Scanning- Port Scanning- Vulnerability Scanning- Port Knocking- Tunnelling- Passive Data Gathering	

<b>Learning Resources</b>	1. Network Forensics, Ric Messier, Wiley, ISBN: 978-1-119-32828-5, August 2017 2. Network Attacks and Exploitation: A Framework, Matthew Monte, Wiley, 2015	3. Computer Forensics: Investigating Network Intrusions and Cyber Crime, EC-Council. 4. Network Forensics: Tracking Hackers through Cyberspace, Sherri Davidoff and Jonathan Ham, Prentice Hall, 2015
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Learning Assessment		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Sankaranarayanan, Security Analyst, Philips	1. Karthikeyan.C.M.T, Govt College of Engg.Bargur	1. Dr. J. Godwin Ponsam, SRMIST

<b>Course Code</b>	21CSE536T	<b>Course Name</b>	MOBILE FORENSICS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the challenges of mobile forensics and the process model on mobile device forensics												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Acquire in-depth knowledge about smartphone acquisition and acquisition methods															
<b>CLR-3:</b>	Gain a solid understanding of iOS devices and guides to prepare the desktop machine for forensic work.															
<b>CLR-4:</b>	Explore the topics of Android model, file system, and its security features.															
<b>CLR-5:</b>	Explore the types of evidence available on iOS, Android, Windows, and BlackBerry mobile devices															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
<b>CO-1:</b>	Apply the mobile forensics process model on mobile device forensics															
<b>CO-2:</b>	Plan and prepare the knowledge about smartphone acquisition and acquisition methods															
<b>CO-3:</b>	Acquire the knowledge on handling iOS devices															3
<b>CO-4:</b>	Utilize the concepts of Android model, file system, and its security features.															3
<b>CO-5:</b>	Demonstrate the ability to accurately document using Android Forensics, Windows Phone Forensics and BlackBerry Forensics															

**Unit-1 – Introduction** 9 Hour  
 Introduction to Mobile Forensics -Mobile forensics – Mobile forensic challenges – Mobile phone evidence extraction process – Other sources of potential evidence -Lab:1 Study of Mobile Forensics and different tools used for forensic investigation – Practical mobile forensic approaches – Mobile operating systems overview – Mobile forensic tool levelling system- Lab 2. Implement how to Recover Deleted Files using Forensics Tools -- Data acquisition methods – Potential evidence stored on mobile phones – Good forensic practices- Lab 3: Forensics environment setup (Install Linux VM and intro to Linux command)

**Unit-2 – iOS** 9 Hour  
 Internals of iOS Devices and Data Acquisition from iOS Devices-iPhone models-iPhone operating system – The iOS architecture – iOS security -Address Space Layout Randomization – Lab 4: Using Android SDK Tools (AVD to create simulator, ADB to explore the data, etc.)-Data Acquisition from iOS Devices – Physical acquisition – The forensic environment setup – Downloading iPhone Data Protection Tools – Building the IMG3FS tool – Creating and loading the forensic toolkit – Establishing communication with the device – Lab 5: Android acquisition & analysis – Data Acquisition from iOS Backups -iTunes backup – Understanding the backup structure – Unencrypted backup – Encrypted backup – iCloud backup -Extracting iCloud backups- Lab 6: Case study on iphone

**Unit-3 – iOS Forensic Tools** 9 Hour  
 iDevices from a Forensic Point of View – The iOS architecture – The iOS filesystem – iOS platform and hardware security – Identifying stored data – iOS acquisition and forensic approaches Lab 7: iOS forensics setup – iOS Data Analysis and Recovery – Timestamps – SQLite databases – Important database files -Property lists – Important plist files- Cookies Lab 8:- iphone acquisition & analysis – iOS Forensic Tools – Elcomsoft iOS Forensic Toolkit – Oxygen Forensic Suite 2014 – Cellebrite UFED Physical Analyzer – Paraben iRecovery Stick – Lab 9: Case study on Oxygen Forensic Suite

<b>Unit-4 – Android Model</b>	<b>9 Hour</b>
Android Forensic Setup and Pre Data Extraction Techniques – The Android model – Android security – Android file system -Extended File System – Android Software Development Kit – Android Debug Bridge -Lab 10: How to View Last Activity of Your PC- Accessing the device using adb – Handling an Android device – Screen lock bypassing techniques – Smudge attack – Lab 11: Comparison of two Files for forensics investigation by Compare IT software – Gaining root access – Rooting an Android device – Imaging an Android Phone – Data extraction techniques – Lab 12: Live Forensics Case Investigation using Autopsy-Android Data Recovery Techniques	

<b>Unit-5 – BlackBerry OS</b>	<b>9 Hour</b>
Analysis and Overview of Forensic Tools on Android App, Windows Phone & BlackBerry – Reverse engineering Android apps – Forensic tools overview – Windows Phone OS – Lab 13: windows phone acquisition & analysis – Windows chambers – Windows Phone file system – Extracting the data – Lab 14 : BlackBerry Investigation – BlackBerry OS – Security features -Data acquisition – Creating a BlackBerry backup – BlackBerry analysis – BlackBerry forensic image analysis – Forensic tools for BlackBerry analysis – Lab 15: Acquiring and Analyzing a BlackBerry device	

<b>Learning Resources</b>	1. Satish Bommisetty, Rohit Tamma, Heather Mahalik, Practical Mobile Forensics – 2014 Packt Publishing. 2. Soufiane Tahiri, Mastering Mobile Forensics, Packt Publishing.	3. Mobile Forensics: Advanced Investigative Strategies, Oleg Afonin, Vladimir Katalov, Packt Publishing. 4. Lee Reiber, Mobile Forensic Investigations: A Guide to Evidence Collection, Analysis, and Presentation, Second Edition, 2 <sup>nd</sup> Edition, McGraw-Hill
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Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Sankaranarayanan, Security Analyst, Philips	1. Karthikeyan.C.M.T, Govt College of Engg,Bargur 2. Dr. Raju Abraham, NIOT, Chennai	1. Dr.M.Jeyaselvi, SRMIST 2. Mr. Joseph Raymond V, SRMIST

<b>Course Code</b>	21CSE537T	<b>Course Name</b>	DIGITAL FORENSICS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the history and purpose of digital forensics												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Acquire in-depth knowledge about workings of computer hardware and the operating systems															
<b>CLR-3:</b>	Gain knowledge about disruptive technology that is challenging in digital forensic															
<b>CLR-4:</b>	Understand the Windows Registry as a resource of digital evidence															
<b>CLR-5:</b>	Explore the knowledge in rich resources of digital evidence															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
<b>CO-1:</b>	Apply the digital forensics process model															
<b>CO-2:</b>	Plan and prepare the knowledge about Hardware and Software Environments															
<b>CO-3:</b>	Acquire the knowledge on digital Forensic Tools															3
<b>CO-4:</b>	Apply the Digital Evidence in Windows OS															3
<b>CO-5:</b>	Demonstrate the ability to accurately document using rich resources of digital evidence															

**Unit-1 - The Role of Digital Forensics and Its Environment** 9 Hour  
 Understanding the history and purpose of forensics -Defining digital forensics and its role-Looking at the history of digital forensics-Studying criminal investigations and cybercrime-Outline civil investigations and the nature of e-discovery-The role of digital forensic practitioners and the challenges they face- Special Properties of Digital Evidence-The special characteristics and technical complexities of digital evidence.

**Unit-2 - Hardware and Software Environments** 9 Hour  
 Computers and the nature of digital information – Operating systems – Filesystems that contain evidence – Locating evidence in filesystems – Explaining password security, encryption, and hidden files -Case study : linking the evidence to the user – Recovering and Preserving Digital Evidence – Understanding the chain of custody.

**Unit-3 - Physical acquisition and safekeeping of digital evidence** 9 Hour  
 Recovering digital evidence through forensic imaging processes -Acquiring digital evidence through live recovery processes -Outlining the efficacy of existing forensic tools and the emergence of enhanced processes and tools -The Need for Enhanced Forensic Tools -Digital forensics laboratories -Emerging problems with datasets -Case study : Illustrating the challenges of interrogating large datasets

**Unit-4 - Selecting and Analysing Digital Evidence** 9 Hour  
 Structured processes to locate and select digital evidence – Locating digital evidence – Selecting digital evidence – Case study : Illustrating the recovery of deleted evidence held in volume shadows – Windows and Other Operating Systems as Sources of Evidence – The Windows Registry and system files and logs as resources of digital evidence – Apple and other operating system structures – Remote access and malware threats

**Unit-5 - Examining Browsers****9 Hour**

E-mails, Messaging Systems, and Mobile Phones – Locating evidence from Internet browsing – Messaging systems – E-mail analysis and the processing of large e-mail databases – The growing challenge of evidence recovery from mobile phones and handheld devices -Case study : mobile phone evidence in a bomb hoax – Validating the Evidence – The nature and problem of unsound digital evidence ,Impartiality in selecting evidence -The structured and balanced analysis of digital evidence ,Ethical issues confronting digital forensics practitioners

<b>Learning Resources</b>	1. Practical Digital Forensics – Richard Boddington [PACKT] Publication, Open-source community 2. Warren G. Kruse II and Jay G. Heiser, "Computer Forensics: Incident Response Essentials", Addison Wesley, 2002.	3. Nelson, B, Phillips, a, Enfinger, F, Stuart, C., "Guide to Computer Forensics and Investigations, 2 <sup>nd</sup> ed., Thomson Course Technology, 2006, ISBN: 0-619-21706-5. 4. Vacca, J, Computer Forensics, Computer Crime Scene Investigation, 2 <sup>nd</sup> Ed, Charles River Media, 2005, ISBN: 1-58450-389.
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**Learning Assessment**

Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Sankaranarayanan, Security Analyst, Philips	1. Karthikeyan.C.M.T, Govt College of Engg,Bangur 2. Dr. Raju Abraham, NIOT, Chennai	1. Dr.M.Jeyaselvi, SRMIST 2. Mr. Joseph Raymond V, SRMIST

<b>Course Code</b>	21CSE538T	<b>Course Name</b>	SECURITY SCRIPTING AND ANALYSIS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Gain mastery in scripting application												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Practice computer network security scripting and packet analysis automation															
<b>CLR-3:</b>	Apply the secure web app scripting development															
<b>CLR-4:</b>	Analyze and practice exploit scripting and vulnerability analysis techniques															
<b>CLR-5:</b>	Analyze and expertise over the tool wireshark scripting															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
<b>CO-1:</b>	Experience on scripting programming for network security												-	-	-	-
<b>CO-2:</b>	Acquire knowledge on developing web servers and clients												-	-	-	3
<b>CO-3:</b>	Develop their own packet capturing and analyzing tools												-	-	-	3
<b>CO-4:</b>	Develop source code vulnerability detecting scripts												-	-	-	-
<b>CO-5:</b>	Perform exploit analysis tools and network security analysis using packet capturing tools												-	-	-	-

<b>Unit-1 – Scripting Techniques</b>	<b>9 Hour</b>
Introduction to Interpreted Language, Coding standards and data types, Mutable and immutable datatypes comparison in memory level, Variables, operators and Expressions, Program Structure and Control statements, Loops - different types of for, while, Functions and lambda expression, Examples for different types functions, Classes, Objects and Other OOPS Concepts, Scope of variables-class level, instance level and local, Inheritance and Overloading-types and examples, Exception handling, Introduction to IO streams and programming in file concepts, Directory Access and file traversing, Creation of Threads and its need, Multithreading and Concurrency using locks and synchronization, Inter Process Communication (IPC, Permissions and Controls.	

<b>Unit-2 – Computer Network Security Scripting Techniques</b>	<b>9 Hour</b>
Raw Socket programming, Packet injection using raw socket programming, Socket Libraries and its functionalities, Programming server clients using TCP, Asynchronous socket channels, Programming Servers and Clients using UDP, Multithreaded server-TCP and UDP, Example programs applying multithreaded server concepts, Scapy Introduction, Packet crafting using scapy, Programming Wired Sniffers-scapy, Packet injection –scapy wired, Programming Wireless Sniffers-scapy, Wireless sniffers examples, Programming arbitrary packet Injectors- wireless, Packet injection examples, Read and write to pcap file –scapy, Attack automation using scapy	

<b>Unit-3 – Web App Security Scripting</b>	<b>9 Hour</b>
Web Servers, Client side scripting, HTML basics, CGI scripts, Web Application Fuzzers, Types of fuzzing techniques, Types of fuzzing techniques, Scraping Web Applications- introduction, Remote file access -Urlopen, urlretrieve, Beautiful soup-urllib, HTML parsing, XML file analysis, Examples for XML file analysis, Web Browser Emulation- introduction, Mechanize- examples, Application Proxy, Own proxy creation, Attacking Web Services, Examples for attacking web services.	

**Unit-4 – Computer Network Exploit Scripting and Vulnerability Analysis****9 Hour**

Exploit Development techniques-introduction, Types of exploit development techniques, Immunity Debuggers and Libs, Attaching and detaching process, Writing plugins for Immunity debugger, Malware sample analysis, Advanced exploitation techniques, Writing payloads for exploitation, Buffer overflow attack, Example with immunity debugger, Pyhook introduction, Examples for pyhook key loggers, Source code vulnerability –introduction, Source code vulnerability analysis, Static source code vulnerability detection –scripting, Example scripts for static detection, dynamic source code vulnerability detection-scripting, Example methods for dynamic detection.

**Unit-5 – Computer Network Packet Analysis Scripting****9 Hour**

Wireshark- introduction, Capturing methodologies, Capture filters, Display filters, Searching for packets using the Find dialog, Create new Wireshark profiles, Usage of Graphs, IO, TCP, Flow Graphs, Inspection of Application Layer protocols, DNS, FTP, HTTP, SMTP, Colourcoding, Creation of colouringrules, Analyzing Transport Layer Protocol, TCP-UDP, Analyzing packets for security tasks, Security analysis methodology, Scans and sweeps, ARP ICMP TCP UDP

<b>Learning Resources</b>	1. Mike Dawson, <i>More Python programming for Absolute Beginner</i> , CengageLearning PTR; 3 <sup>rd</sup> edition, ISBN-10: 1435455002, ISBN-13: 978-14354550092, 2010. 2. <i>The Web Application Hacker's Handbook</i> , 2 <sup>nd</sup> Edition, Wiley 3. <i>Publication</i> , DafyddStuttard, Marcus Pinto	4. <i>Mastering Wireshark</i> , PACKT Publishing, By Charit Mishra, March 2016 5. James H.Baxter, <i>Wireshark essentials</i> , 2014 6. TJ. O'Connor, <i>Violent Python A Cookbook for Hackers, Forensic Analysts, Penetration Testers, and Security Engineers</i> (2013), Elsevier
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**Learning Assessment**

Bloom's Level of Thinking	Continuous Learning Assessment (CLA)					Summative Final Examination (40% weightage)
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%
Level 2	Understand	25%	-	20%	-	25%
Level 3	Apply	30%	-	25%	-	30%
Level 4	Analyze	30%	-	25%	-	30%
Level 5	Evaluate	-	-	10%	-	-
Level 6	Create	-	-	5%	-	-
	Total	100 %		100 %		100 %

**Course Designers**

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Sankaranarayanan, Security Analyst, Philips	1. Karthikeyan.C.M.T, Govt College of Engg,Bargur 2. Dr. Raju Abraham, NIOT, Chennai	1. Dr.P.Savaridassan, SRMIST

<b>Course Code</b>	21CSE539T	<b>Course Name</b>	PRINCIPLES OF SECURE CODING PRINCIPLES	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>													
<b>CLR-1:</b>	Discover the need for secure coding and proactive development process												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>												
<b>CLR-2:</b>	Demonstrate secure coding practices																										
<b>CLR-3:</b>	Implement automated tools to analyze and test the code for vulnerabilities																										
<b>CLR-4:</b>	Analyze input issues related to database and web																										
<b>CLR-5:</b>	Incorporate fundamental principles of software security engineering																										
<b>Course Outcomes (CO):</b>	<b>At the end of this course, learners will be able to:</b>												<b>Engineering Knowledge</b>	<b>Problem Analysis</b>	<b>Design/development of solutions</b>	<b>Conduct investigations of complex problems</b>	<b>Modern Tool Usage</b>	<b>The engineer and society</b>	<b>Environment &amp; Sustainability</b>	<b>Ethics</b>	<b>Individual &amp; Team Work</b>	<b>Communication</b>	<b>Project Mgt. &amp; Finance</b>	<b>Life Long Learning</b>	<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>
<b>CO-1:</b>	Acquire the knowledge on secured software development and life cycle process												-	-	2	-	-	-	-	-	-	-	-	-	-	-	
<b>CO-2:</b>	Design secure software by incorporating security principles and mitigation strategies												-	-	2	-	2	-	-	-	-	-	-	-	-	-	
<b>CO-3:</b>	Analyze vulnerable code in implemented software and describe attack consequences												-	-	2	-	2	-	-	-	-	-	-	-	-	3	
<b>CO-4:</b>	Apply mitigation and implementation practices to construct attack resistant web applications												-	-	2	-	2	-	-	-	-	-	-	-	-	3	
<b>CO-5:</b>	Apply secure design principles for developing attack resistant software applications												-	-	2	-	-	-	-	-	-	-	-	-	-	3	

<b>Unit-1 - Secure Development Techniques</b>	<b>9 Hour</b>
Introduction to secure coding principles, Need for secure systems - ideas for instilling Security culture and deploying Information Security culture frameworks, Attackers advantage and defenders dilemma, Proactive security, Design phase considerations, Development and test phase considerations, Security principles to live by – SD3, Security principles, Secure design through threat modeling, Security Techniques, Threat Modeling Tools, Security Into DevOps Processes.	

<b>Unit-2 - Secure Coding In C</b>	<b>9 Hour</b>
Character strings- Common string manipulation errors – String Vulnerabilities and exploits –Mitigation strategies for strings, Obsolete functions, and secure functions by standards – Pointers, C Dynamic Memory Management, Common errors in memory management, Instruction pointer modification, Targets for instruction pointer modification, Referencing Freed Memory, Mitigation strategies in pointer-based vulnerabilities – Buffer Overflow based vulnerabilities.	

<b>Unit-3 - Secure Coding in C++ and Java</b>	<b>9 Hour</b>
Dynamic memory management- Common errors in dynamic memory management- Memory managers, Double-free vulnerabilities, Integer Security-Mitigation strategies, Tools to check code for common programming errors - Static code checkers, Runtime code checkers.	

<b>Unit-4 - Database and Web Specific Input Issues</b>	<b>9 Hour</b>
Quoting the Input – Use of stored procedures- SQL injection – Anatomy of the vulnerability, Building SQL statements securely-XSS related attacks and remedies, Web Server and Database Attacks and Countermeasures.	

<b>Unit-5 - Software Security Engineering</b>	<b>9 Hour</b>
Requirements engineering for secure software: Misuse and abuse cases-SQUARE process model- Software security practices and knowledge for architecture and design.	

<b>Learning Resources</b>	<ol style="list-style-type: none"> <li>Michael Howard, David LeBlanc, "Writing Secure Code", Microsoft Press, 2nd Edition, 2003.</li> <li>Robert C. Seacord, "Secure Coding in C and C++", Pearson Education, 2nd edition, 2013.</li> <li>Julia H. Allen, Sean J. Barnum, Robert J. Ellison, Gary McGraw, Nancy R. Mead, "Software Security Engineering: A guide for Project Managers", Addison-Wesley Professional, 2008.</li> <li>David A. Wheeler, "Secure Programming for Linux and Unix HOWTO"</li> <li>Bryan Sullivan, Vincent Liu, "Web Application Security – A Beginner's Guide"</li> <li>Ron Ben Natan, "Implementing Database Security and Auditing: A guide for DBAs, Information security administrators and auditors", Published by Elsevier Inc., 2005</li> </ol>
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Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Praveen Kumar, Team Lead, Cognizant Technology Solutions.	1. Karthikeyan.C.M.T, Govt College of Engg, Bargur 2. Dr. Raju Abraham, NIOT, Chennai	1. Dr. Savaridassan.P, SRM IST 2. Mr. Joseph Raymond V, SRM IST

<b>Course Code</b>	21CSE540T	<b>Course Name</b>	ANDROID SECURITY AND DESIGN INTERNALS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the Android Security Model												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Develop the android security design and architecture															
<b>CLR-3:</b>	Identify various Android attacks and hacking methods															
<b>CLR-4:</b>	Understand the User Space Software and Return Oriented Programming															
<b>CLR-5:</b>	Demonstrate Network Security and PKI, Enterprise Security and Device Security															

<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		<b>Program Outcomes (PO)</b>												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>
<b>CO-1:</b>	Understand the Android Security Model															
<b>CO-2:</b>	Develop the android security design and architecture															
<b>CO-3:</b>	Explore Android attacks and hacking methods															3
<b>CO-4:</b>	Understand the User Space Software and Return Oriented Programming															3
<b>CO-5:</b>	Demonstrate Network Security and PKI, Enterprise Security and Device Security												2	-	-	-

<b>Unit-1 - Android's Security Model</b>	<b>9 Hour</b>
Android's Security Model – Android Architecture, Android's Security Model. Permissions – The Nature of Permission, Requesting Permission, Permission Management, Permission Protection Levels, Permission Assignment, Permission Enforcement, System Permission, Shared user ID, Custom Permission, Public and Private components, Activity and Service Permission, Broadcast Permission, Content Provider Permission. Package Management – Android Application package format, Code signing, APK Install Process, Package verification. User Management – Multiuser support overview, Type of users, user management, user metadata, Per User Application Management, External Storage, Other Multiuser features	

<b>Unit-2 - Android Security Design and Architecture</b>	<b>9 Hour</b>
Android Security Design and Architecture - Understanding Android System Architecture, Understanding Security Boundaries and Enforcement, Complex Security, Complex Exploits. Rooting Your Device - Understanding the Partition Layout, Understanding the Boot Process, Locked and Unlocked Boot Loaders, Rooting with an Unlocked Boot Loader, Rooting with a Locked Boot Loader, History of Known Attacks. Reviewing Application Security - Common Issues, Case Study: Mobile Security App, Case Study: SIP Client.	

<b>Unit-3 - Android Attacks and Hacking</b>	<b>9 Hour</b>
Understanding Android's Attack Surface - An Attack Terminology Primer, Classifying Attack Surfaces, Remote Attack Surfaces, Physical Adjacency, Local Attack Surfaces, Physical Attack Surfaces, and Third-Party Modifications. Finding Vulnerabilities with Fuzz Testing -Fuzzing Background, Fuzzing on Android, Fuzzing Broadcast Receivers, Fuzzing Chrome for Android, Fuzzing the USB Attack Surface. Debugging and Analyzing Vulnerabilities – Choosing a Tool Chain, Debugging with Crash Dumps, Remote Debugging, Debugging Dalvik Code, Debugging Native Code, Debugging Mixed Code, Alternative Debugging Techniques, Vulnerability Analysis.	

<b>Unit-4 - User Space Software</b>	<b>9 Hour</b>
Exploiting User Space Software - Memory Corruption Basics, A History of Public Exploits, Exploiting the Android Browser. Return Oriented Programming - History and Motivation, Basics of ROP on ARM, Case Study: Android 4.0.1 Linker. Hacking and Attacking the Kernel - Android's Linux Kernel, Extracting Kernels, Running Custom Kernel Code, Debugging the Kernel, Exploiting the Kernel.	

<b>Unit-5 - Network Security and PKI</b>	<b>9 Hour</b>
Cryptographic Providers - JCA Provider Architecture, JCA Engine Classes, Android JCA Providers, Using a Custom Provider. Network Security and PKI - PKI and SSL Overview, JSSE Introduction, Android JSSE Implementation. Credential Storage - VPN and Wi-Fi EAP Credentials, Credential Storage Implementation, Public APIs. Online Account Management - Android Account Management Overview, Account Management Implementation, Google Accounts Support. Enterprise Security – Device Administration, VPN Support, Wi-Fi EAP. Device Security - Controlling OS Boot-Up and Installation, Verified Boot, Disk Encryption, Screen Security, Secure USB Debugging, Android Backup.	

<b>Learning Resources</b>	1. <i>Android Security Internals – An In-depth Guide To Android's Security Architecture</i> , by Nikolay Elenkov, No Starch Press 2. <i>Android™ Hacker's Handbook</i> , Joshua J. Drake, Pau Oliva Fora, Zach Lanier, Collin Mulline, Stephen A. Ridley, Georg Wicherski, Welly, ISBN: 978-1-118-60864-7 3. <i>Android Security (and Not) Internals</i> , Yury Zhauniarovich, June 2014	4. <i>Android Security: Attacks and Defenses</i> , Anmol Misra, Abhishek Dubey, CRC Press, ISBN 9780367380182 5. <i>Android Security Cookbook</i> , Keith Makan , Scott Alexander-Bown, December 2013, ISBN: 9781782167167 6. <i>Android Application Security Essentials</i> , Pragati Ogal Rai, Packt Publishing (21 August 2013), ISBN: 978-1849515603
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<b>Learning Assessment</b>		<b>Continuous Learning Assessment (CLA)</b>				<b>Summative Final Examination (40% weightage)</b>	
<i>Bloom's Level of Thinking</i>	<i>Formative CLA-1 Average of unit test (50%)</i>	<i>Life-Long Learning CLA-2 (10%)</i>					
		<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>	<i>Theory</i>	<i>Practice</i>
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Dr. N. Arun, Senior Software Engineer, Quick Heal		1. Dr. Vigneshwaran P, SRMIST

# **ACADEMIC CURRICULA**

## **UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES**

**(With exit option of Diploma)**

**(Choice Based Flexible Credit System)**

**Regulations 2021**

**Volume - 11N**

**(Syllabi for M.Tech (Integrated) Computer Science and  
Engineering w/s in Data Science Programme Courses)**



**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

**(Deemed to be University u/s 3 of UGC Act, 1956)**

**Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India**

# ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021



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INSTITUTE OF SCIENCE & TECHNOLOGY

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(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

<b>Course Code</b>	21CSC501T	<b>Course Name</b>	NATURAL LANGUAGE PROCESSING TECHNIQUES	<b>Course Category</b>	C	PROFESSIONAL CORE	L 3	T 1	P 0	C 4
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	familiarize the basic concepts of NLP												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	inculcate the knowledge of preprocessing techniques of NLP												-	-	-	
<b>CLR-3:</b>	build probabilistic language models												-	-	-	
<b>CLR-4:</b>	Brief about syntax and semantic techniques												-	-	-	
<b>CLR-5:</b>	design the application models of NLP												-	-	-	
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12			
<b>CO-1:</b>	Understand Ambiguity of NLP, Challenges, and applications of NLP.												-	-	-	
<b>CO-2:</b>	Illustrate NLP Techniques such as POS, Morphology, text Preprocessing												-	-	-	
<b>CO-3:</b>	Develop applications of probabilistic models												-	-	-	
<b>CO-4:</b>	Analyze the concepts of syntax and semantics in NLP												-	-	-	
<b>CO-5:</b>	Implement the applications of NLP using Machine Learning and Deep Learning model												-	-	-	

<b>Unit-1 - NLP Overview</b> <span style="float: right;">12 Hour</span>																
History of NLP, Applications of NLP, Information Retrieval, Information Extraction, Question Answering, Sentiment Analysis, Optical Character Recognitions Summarization Spell and Grammar Checking. Text Categorization word prediction speech recognition Machine Translation, Classification of NLP, Ambiguity Lexical Ambiguity, Syntactic Ambiguity, Semantic Ambiguity, Pragmatic Ambiguity, NLP Terminology, Components of NLP																
T1: NLP Packages																
T2: Preprocessing of Text																
T3: Language Model																
<b>Unit-2 - NLP Technique</b> <span style="float: right;">12 Hour</span>																
NLP Technique, Parts of speech, Rule based POS, HMM POS, Formatting Hidden, Markov Model Taggers, Phonology, Veterbi Algorithm for HMM Tagging, Probabilistic Speech Recognition, Morphology, Finite state Morphological Parsing, Text Preprocessing, Tokenization, Stemming, Lemmatization, Regular expressions, Finite State Automata, Deterministic Automata, Non-Deterministic Automata.																
T4: Implementation of POS Tagging																
T5: Tools of Morphology																
T6: Implementation of Regular Expression																

<b>Unit-3 - Probabilistic Language Model</b>	<b>12 Hour</b>
Potter Stemmer, Detection and Correction of Spelling Errors, Minimum Edit Distance, Application of Probabilistic of Model, Bag of words with N-Gram, The Chain Rule, Language model with N-Gram, N-Gram, Language Model applications, Unigram model, Bigram Model, Unsmoothed N-Grams, Evaluating N-Grams perplexity, Smoothing: Laplace Smoothing, Interpolation, Likelihood computation, Context free grammar, Top Down parsing.	
T7: Spelling Correction	
T8: N-Gram Model	
T9: Probabilistic Language Model	
<b>Unit-4 - Natural Language and Neural Networks</b>	<b>12 Hour</b>
Introduction to Neural Networks, Network Architecture, Recurrent Neural Networks in NLP, WordSense, WordNet, Learning Representation, Back propagation errors, Vectorization, Information extraction, Backdrop, Dependency Parsing, Fast and Accurate Dependency Parser using Neural Networks, Globally Normalized Transition Based Neural Networks.	
T10: NN Architecture	
T11: Distributed Representation	
T12: Word embedding	
<b>Unit-5 - NLP and Deep learning</b>	<b>12 Hour</b>
Introduction to NLP and Deep Learning, Word Vectors, Distributed Representations of Words and Phases, Word representations in vector space Word vector, Glove vectors for word representation, improving distributional similarity, Evaluation methods for Unsupervised word embedding.	
T13: Pretrained Language model	
T14: Transfer Learning	
T15: Long Short-Term Memory	

<b>Learning Resources</b>	1. Daniel Jurafsky and James H Martin. <i>Speech and Language Processing</i> , 2e, Pearson Education, 2009 2. James A... <i>Natural language Understanding</i> 2e, Pearson Education, 1994	3. Bharati A., Sangal R., Chaitanya V... <i>Natural language processing: a Paninian perspective</i> , PHI, 2000 4. Siddiqui T., Tiwary U. S... <i>Natural language processing and Information retrieval</i> , OUP, 2008.
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<b>Learning Assessment</b>						
<i>Bloom's Level of Thinking</i>	Continuous Learning Assessment (CLA)				<i>Summative Final Examination (40% weightage)</i>	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%
Level 2	Understand	25%	-	20%	-	25%
Level 3	Apply	30%	-	25%	-	30%
Level 4	Analyze	30%	-	25%	-	30%
Level 5	Evaluate	-	-	10%	-	-
Level 6	Create	-	-	5%	-	-
	Total	100 %		100 %		100 %

<b>Course Designers</b>	<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
	1.		1. Dr. R. Rajkumar, SRMIST

<b>Course Code</b>	21CSC502J	<b>Course Name</b>	APPLIED DEEP LEARNING	<b>Course Category</b>	C	PROFESSIONAL CORE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the theoretical foundations, algorithms, and methodologies of convolutional neural networks												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Identify and apply appropriate recurrent neural networks for analyzing the data for variety of problems.															
<b>CLR-3:</b>	Understand the principles and applications of computer vision															
<b>CLR-4:</b>	Construct Generative Adversarial Networks to solve real - world problems.															
<b>CLR-5:</b>	Understand different methodologies to create application using deep nets.															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
<b>CO-1:</b>	Recognize the characteristics of convolutional neural networks and the use of optimizers.												-	1	-	-
<b>CO-2:</b>	Analyze various recurrent neural networks models.												-	2	-	-
<b>CO-3:</b>	Apply the Deep Learning models for Computer Vision.												-	2	-	-
<b>CO-4:</b>	Solve various real - world problems using Generative Adversarial Networks.												-	2	-	-
<b>CO-5:</b>	Build a Deep Reinforcement Learning models for solving various problems.												-	-	-	1

**Unit-1 - Convolutional Neural Networks** 9 Hour  
 Introduction to Convolutional neural networks – Autoencoders: types, denoising, Convolutional autoencoder example, Uses and limitations – Variational autoencoders: Parameters to define a normal distribution, VAE loss function, Kullback-Leibler divergence, Training the VAE, The reparameterization trick – Applications of autoencoders – Optimizers: Gradient Descent, RMSProp, Adam

**Tutorial:**

T1. To build a convolutional autoencoder model for the MNIST dataset, T2. To build a convolutional variational autoencoders for the MNIST dataset, T3. Experiment with different learning rates and objective functions for gradient descent

**Unit-2 - Recurrent Neural Networks** 9 Hour  
 Recurrent Neural Networks: Overview, Neural Networks with and without Hidden States, RNN-based Character-Level Language Models - Implementation: RNN Model, RNN-based Language Model, Gradient Clipping, Training, Decoding - Long Short-Term Memory (LSTM), Gated Recurrent Units (GRU)

**Tutorial:**

T1. To implement the RNN model using the H. G. Wells' The Time Machine data set. T2. To implement the LSTM model using the H. G. Wells' The Time Machine data set. T3. To implement the GRU model using the H. G. Wells' The Time Machine data set

**Unit-3 - Deep Learning for Computer Vision** 9 Hour  
 Image Augmentation - Object Detection and Bounding Boxes - Anchor Boxes - Multiscale Object Detection - Region-based CNNs: R-CNNs, Fast R-CNN, Faster R-CNN, Mask R-CNN

**Tutorial:**

T1. To demonstrate object detection model banana detection dataset. T2. To implement the classification model for CIFAR-10 dataset. T3. To implement the classification model for Dog Breed Identification dataset

<b>Unit-4 - Generative Adversarial Networks</b>	<b>9 Hour</b>
Generative Adversarial Networks: Generator, Discriminator, Loss function, Generator loss, Discriminator loss, Training - Deep Convolutional Generative Adversarial Networks: Wasserstein GAN, BEGAN, Cycle GAN - Conditional GANs: Pix2Pix	
<b>Tutorial:</b>	
T1. To build a model using GAN to resemble MNIST digits. T2. To implement a Deep Convolutional GAN to generate complex color images. T3. To implement a Deep Convolutional GAN on Fashion-MNIST data set using ReLU as activation function for generator, leaky ReLU as activation function for discriminator.	
<b>Unit-5 - Deep Reinforcement Learning</b>	<b>9 Hour</b>
Stateless Algorithms: Na'ive Algorithm, $\varepsilon$ -Greedy Algorithm, Upper Bounding Methods - The Basic Framework of Reinforcement Learning: Challenges, Simple Reinforcement Learning for Tic-Tac-Toe, Role of Deep Learning, and a Straw-Man Algorithm	
<b>Tutorial:</b>	
T1. Self-Learning Robots - Case Study , T2. Building Conversational Systems: Deep Learning for Chatbots - Case Study, T3. Self-Driving Cars - Case Study	

<b>Learning Resources</b>	1. Iffat Zafar, Giounona Tzanidou, Richard Burton, Nimesh Patel, Leonardo Araujo, Hands-On Convolutional Neural Networks with TensorFlow, Packt Publishing, 2018. (Unit I) 2. Aston Zhang, Zack C. Lipton, Mu Li, Alex J. Smola, Dive into Deep Learning, arXiv preprint, 2021 ( <a href="http://d2l.ai/index.html">http://d2l.ai/index.html</a> ) (Unit II, III & IV) 3. Charu C. Aggarwal, Neural Networks and Deep Learning - A Text Book, Springer Nature, 2018. (Unit	4. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, the MIT Press, 2017. 5. Umberto Michelucci, Applied Deep Learning – A Case-Based Approach to Understanding Deep Neural Networks, Apress, 2018. 6. François Chollet, Deep Learning with Python, Manning Publications, 2018.
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Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	15%	-	-	15%	15%	-		
Level 2	Understand	25%	-	-	20%	25%	-		
Level 3	Apply	30%	-	-	25%	30%	-		
Level 4	Analyze	30%	-	-	25%	30%	-		
Level 5	Evaluate	-	-	-	10%	-	-		
Level 6	Create	-	-	-	5%	-	-		
	Total	100 %		100 %		100 %			

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. N. Mohanraj, Software Engineer 2, PayPal Inc.,	1. Dr. M. Vinoth Kumar, Associate Professor, Department of Information Science and Engineering, Dayananda Sagar Academy of Technology & Management	1. Dr. M. Prakash, SRMIST 2. Dr.G.Vadivu, SRMIST

# ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021



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(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,  
India

<b>Course Code</b>	21CSE521T	<b>Course Name</b>	ADVANCED ALGORITHMS ANALYSIS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the fundamentals of algorithms and its complexity												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Analyse algorithm design strategies															
<b>CLR-3:</b>	Implement graph and network algorithms															
<b>CLR-4:</b>	Design the Parallel and Distributed algorithms															
<b>CLR-5:</b>	Utilize the search algorithms															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12			
<b>CO-1:</b>	Develop algorithms and analyze its complexity												3	Problem Analysis	Engineering Knowledge	
<b>CO-2:</b>	Utilize appropriate design strategies												-	Design/development of solutions		
<b>CO-3:</b>	Implement the graph and network algorithms												-	Conduct investigations of complex problems		
<b>CO-4:</b>	Design and analysis of paradigms for sequential and parallel models												-	Modern Tool Usage		
<b>CO-5:</b>	Implement search algorithms												-	The engineer and society		
		-	-	-	-	-	-	-	-	-	-	-	-	Environment & Sustainability		
		-	-	-	-	-	-	-	-	-	-	-	-	Ethics		
		-	-	-	-	-	-	-	-	-	-	-	-	Individual & Team Work		
		-	-	-	-	-	-	-	-	-	-	-	-	Communication		
		-	-	-	-	-	-	-	-	-	-	-	-	Project Mgt. & Finance		
		-	-	-	-	-	-	-	-	-	-	-	-	Life Long Learning		

**Unit-1 - Introduction to Algorithms** 9 Hour  
 Introduction to Preliminaries - Design and Analysis Fundamentals - Mathematical Tools for Algorithm Analysis - Trees and Applications to Algorithms - More on Sorting Algorithms - Probability and Average Complexity of Algorithms.

T 1: Implementation of Sorting Algorithms

T 2: Implementation of Greedy algorithm

T 3: Implementation of Divide and Conquer algorithm

**Unit-2 - Design Strategies** 9 Hour

Major Design Strategies - The Greedy Method – Divide and Conquer - Dynamic Programming - Backtracking and Branch and Bound

T 4: Implementation of Dynamic Programming algorithm

T 5: Implementation of Backtracking algorithms

T 6: Implementation of Branch and Bound algorithms

**Unit-3 - Graph and Network Algorithms** 9 Hour

Graph and Network Algorithms - Graphs and Digraphs - Minimum Spanning Tree and Shortest Path Algorithms - Graph Connectivity and Fault-Tolerance of Networks - Matching and Network Flow Algorithms – Case study on water management system

T 7: Implementation of Minimum spanning Tree

T 8: Implementation of Shortest Path algorithms

T 9: Implementation of Network Flow algorithm

<b>Unit-4 - Parallel and Distributed Algorithms</b>	<b>9 Hour</b>
Parallel and Distributed Algorithms - Introduction to Parallel Algorithms and Architectures - Parallel Design Strategies - Internet Algorithms -Distributed Computation Algorithms - Distributed Network Algorithms.	
T 10: Implementation of Parallel algorithms	
T 11: Implementation of Internet algorithms	
T 12: Implementation of Distributed Network Algorithms	
<b>Unit-5 - Search Algorithms</b>	<b>9 Hour</b>
String Matching and Document Processing - Balanced Search Trees - The Fast Fourier Transform - Heuristic Search Strategies: A* - Search and Game Trees 24 - Probabilistic and Randomized Algorithms - Lower-Bound Theory - NP-Complete Problems - Approximation Algorithms – case study on bin packing, Dock management system.	
T 13: Implementation of String-Matching Algorithms	
T 14: Implementation of Randomized algorithms	
T 15: Case study for NP Complete Problem	

<b>Learning Resources</b>	1. Kenneth A. Berman, Jerome L. Paul, "Algorithms: Sequential, Parallel, and Distributed", Amazon Bestsellers, 2004. 2. Russ Miller, Laurence Boxer, "Algorithms Sequential and Parallel: A Unified Approach", Prentice Hall, 1 edition, 1999. 3. Dimitri P. Bertsekas and John N. Tsitsiklis, "Parallel and Distributed Computation: Numerical Methods", Prentice Hall, 1989.	4. Michael Goodrich, Roberto Tamassia, "Algorithm Design" Wiley Student Edition 5. Horowitz, Sahni, Mehta: Fundamentals of Data Structures in C++, 2nd edition, University Press, 2007
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Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%
Level 2	Understand	25%	-	20%	-	25%
Level 3	Apply	30%	-	25%	-	30%
Level 4	Analyze	30%	-	25%	-	30%
Level 5	Evaluate	-	-	10%	-	-
Level 6	Create	-	-	5%	-	-
	Total	100 %		100 %		100 %

Course Designers	Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
			Dr. Radha R, SRMIST

<b>Course Code</b>	21CSE522T	<b>Course Name</b>	FUNCTIONAL PROGRAMMING	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	T	P	C
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Learn the purpose of functional programming paradigm and Scala basic constructs												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Comprehend the different types of functions in scala															
<b>CLR-3:</b>	Utilize traits and mixins in functional programming															
<b>CLR-4:</b>	Learn the basics of lists and collections data structures															
<b>CLR-5:</b>	Explore the functors, monads, and monoids															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12			
<b>CO-1:</b>	Identify and apply the appropriate construct in functional programming															
<b>CO-2:</b>	Construct programs using different types of functions															
<b>CO-3:</b>	Create programs using traits and mixins															
<b>CO-4:</b>	Construct programs using lists and different types of collections															
<b>CO-5:</b>	Create programs using functors, monads, and monoids															

<b>Unit-1 - Programming Paradigms</b>	<b>9 Hour</b>
Different types of programming paradigms - Functional vs OOP-Scala Language Basics - Variables, Expressions, Functions-Recursion-Call By Name-Call By Value-Conditionals-Looping – for each and for - Significance of vals- Classes - Types - Fields - Methods - Variable scope - Objects - Singleton object, Variables of objects	
T1: Scala language basic constructs	
T2: Loops and Classes in Scala	

<b>Unit-2 - Functions</b>	<b>9 Hour</b>
Modules, Objects and Namespaces, Objects and Namespaces - Anonymous Functions - Polymorphic Functions, Nested Functions - Closures - Repeated Parameters - Tail Recursion - Define a tail recursive function - Tracing tail recursive functions - Limits of tail recursive functions - Higher Order Functions Definition , Uses and Examples	
T3: Scala language basic constructs	
T4: Loops and Classes in Scala	

<b>Unit-3 - Interfaces</b>	<b>9 Hour</b>
Traits Purpose and Syntax - Define a trait - Interface types - Interface types examples - Thick Interfaces - Thin Interfaces - Comparison of Thick vs Thin Interfaces - Ordered trait - Trait Comparisons - Traits for modifying interfaces - Stacking modifications - Mixin Purpose & Composition, Example	
T5: Mixin Development	
T6: Trait Development	

<b>Unit-4 – Data Structures</b>	<b>9 Hour</b>
Lists definitions and usage - Working with Lists - Constructing Lists - Basic operations on lists - head, tail, isEmpty demo - List Patterns - Lists First Order methods - Lists Higher Order methods - Sequences Overview and operations - Tuples Overview and operations - Sets and Maps – Lists and Collections	
T7: Lists and basic operations in lists	
T8: Tuples and Collections	
<b>Unit-5 – Applicative Development</b>	<b>9 Hour</b>
Functors Purpose and Use - Writing a simple functor - Functor Laws - Applicatives Concepts and use - Defining an applicative - Demo of Applicatives - Monads - Defining Monads - Monad Laws - Demo of Monads and Monad Laws - Monoid Concept, Purpose, and Use - Examples of Monoid	
T9: Applicatives development	
T10: Traversable functors development	

<b>Learning Resources</b>	1. Chiusano.P, Bjarnason R, Functional Programming in Scala, Manning Publications, 2015 2. Oderskey M, SpoonL, Venners B, Programming in Scala, Third edition.	3. Hortsmann, C., Scala for the Impatient, 2nd ed., Addison-Wesley, 2016. 4. Raychaudhuri R, Scala in Action, 1st ed. Manning Publications, 2013.
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)	Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice		
Level 1	Remember	40%	-	20%	-	40%	
Level 2	Understand	40%	-	20%	-	40%	
Level 3	Apply	10%	-	20%	-	10%	
Level 4	Analyze	10%	-	20%	-	10%	
Level 5	Evaluate	-	-	10%	-	-	
Level 6	Create	-	-	10%	-	-	
	Total	100 %		100 %		100 %	

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
		1. Dr. K. Sornalakshmi, SRMIST

<b>Course Code</b>	21CSE524T	<b>Course Name</b>	COMPUTER VISION TECHNIQUES	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	L 2	T 1	P 0	C 3
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<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b>	<i>The purpose of learning this course is to:</i>	Program Outcomes (PO)												<b>Program Specific outcomes</b>
		1	2	3	4	5	6	7	8	9	10	11	12	
<b>CLR-1:</b>	Recognize and describe both the theoretical and practical aspects of computing with images. Connect issues from Computer Vision to Human Vision													
<b>CLR-2:</b>	Describe the foundation of image formation and image analysis. Understand the basics of 2D and 3D Computer Vision.													
<b>CLR-3:</b>	Become familiar with the major technical approaches involved in computer vision. Describe various methods used for registration, alignment, and matching in images.													
<b>CLR-4:</b>	Get an exposure to advanced concepts leading to object and scene categorization from images.													
<b>CLR-5:</b>	Build computer vision applications.													

<b>Course Outcomes (CO):</b>	<i>At the end of this course, learners will be able to:</i>	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
<b>CO-1:</b>	understand computer vision including fundamentals of image formation	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
<b>CO-2:</b>	Learn about image formation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
<b>CO-3:</b>	Apply image processing techniques	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
<b>CO-4:</b>	Calibrate computational photography	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
<b>CO-5:</b>	learn about Image rendering	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1

<b>Unit-1 - Introduction to Computer Vision</b>	<b>9 Hour</b>
Review of image processing techniques – classical filtering operations – thresholding techniques – edge detection techniques – corner and interest point detection.	
T1: Implementation of 2D and 3D Projections	
T2: Build a color constancy algorithm that uses the assumption that the spatial average of reflectance is constant. Use finite-dimensional linear models.	
<b>Unit-2 – Image Formation</b>	
Points and patches-An Introduction - Binary shape analysis – connectedness – object labeling and counting – size filtering – distance functions – skeletons and thinning – deformable shape analysis – boundary tracking procedures – active contours – shape models and shape recognition - Feature detectors -Feature descriptors, Matching - Feature tracking - Edge detection - Edge linking - Successive approximation - Hough transforms -Hough Transform (HT) for line detection – foot-of-normal method – line localization – line fitting – RANSAC for straight line detection – HT based circular object detection – accurate center location – speed problem – ellipse detection – Case study: Human Iris location – hole detection – generalized Hough Transform (GHT) – spatial matched filtering – GHT for ellipse detection – object location – GHT for feature collation. Vanishing points	
T3: Implementation Two-dimensional Fourier transforms, Wiener filtering	
T4: Write a program that produces a Gaussian pyramid from an image	

<b>Unit-3 – Image Processing Techniques</b>	<b>9 Hour</b>
Active contours - Snakes -Dynamic snakes and Condensation - Scissors, Level Sets - Split and merge - Mean shift and mode finding - Normalized cuts - Graph cuts and energy-based methods - 2D and 3D feature-based alignment - Pose estimation	
T5: Obtain an implementation of Canny's edge detector	
T6: Implement a Hough transform based line finder	
<b>Unit-4 – Computational Photography</b>	<b>9 Hour</b>
Triangulation - Two-frame structure from motion - Projective reconstruction - Self-calibration - Perspective and projective factorization - Bundle adjustment - Exploiting sparsity - Constrained structure and motion - Hierarchical motion estimation - Fourier-based alignment - Incremental refinement	
T7: Count lines with an HT line finder. How well does it work?	
T8: Implement a mean shift segmenter.	
<b>Unit-5 – Image Rendering</b>	<b>9 Hour</b>
Motion models - Planar perspective motion - Rotational panoramas - Gap closing - Cylindrical and spherical coordinates - Bundle adjustment - Parallax removal - Recognizing panoramas – Compositing	
T9: Case Study	
T10: Case Study	

<b>Learning Resources</b>	1. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2010. 2. Forsyth/Ponce, "Computer Vision: A Modern Approach", Pearson Education India, 2nd edition (2015) 3. S. Nagabushana, "Computer Vision and Image Processing", New Age International Pvt Ltd, First edition (2005)	4. Rafael C. González, "Digital Image Processing", Pearson Education, Fourth edition (2018)
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<b>Learning Assessment</b>		<b>Continuous Learning Assessment (CLA)</b>				<b>Summative Final Examination (40% weightage)</b>			
		<b>Formative CLA-1 Average of unit test (50%)</b>		<b>Life-Long Learning CLA-2 (10%)</b>					
		<b>Theory</b>	<b>Practice</b>	<b>Theory</b>	<b>Practice</b>				
Level 1	Remember	15%	-	15%	-	15%	-		
Level 2	Understand	25%	-	20%	-	25%	-		
Level 3	Apply	30%	-	25%	-	30%	-		
Level 4	Analyze	30%	-	25%	-	30%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	5%	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Mr. N. Mohanraj, Software Engineer 2, Pay Pal Inc, Chennai	1. Dr. A.P. Shanthi, CEG Campus Anna University	1. Dr. T. Veeramakali, SRMIST

<b>Course Code</b>	21CSE527T	<b>Course Name</b>	TEXT MINING AND ANALYTICS	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Understand the fundamentals of text mining												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Utilize text for prediction techniques															
<b>CLR-3:</b>	Understand the relevance between information retrieval and text mining															
<b>CLR-4:</b>	Understand the goals of information extraction															
<b>CLR-5:</b>	Analyze different case studies related to text mining															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
<b>CO-1:</b>	Acquire knowledge on fundamentals of text mining															1
<b>CO-2:</b>	Perform prediction from text and evaluate it															2
<b>CO-3:</b>	Perform document matching															2
<b>CO-4:</b>	Identify patterns and entities from text															2
<b>CO-5:</b>	Understand how text mining is implemented															1

<b>Unit-1 - Overview of Text Mining</b> <span style="float: right;"><b>9 Hour</b></span>																
Overview of text mining-Special about Text Mining-Structured Data-Unstructured Data-Is text different from numbers-Types of Problem can be solved. -Document Classification-Informational Retrieval-Prediction and Evaluation From Textual Information to Numerical Vectors-Collecting Documents-Document Standardization-Tokenization-Lemmatization-Inflectional Stemming-Stemming to a Root-Vector Generation for Prediction-Multiword Features																
T1 - String Tokenization- Stemming																
T2- Root vector Generation																
T3 – Multiword Features																
<b>Unit-2 - Textual Predication</b> <span style="float: right;"><b>9 Hour</b></span>																
Labels for the Right Answers-Feature selection by attribute ranking-Sentence-Boundary Determination-Part of speech Tagging-Word Sense Disambiguation-Phrase Recognition-Named Entity Recognition-Parsing-Feature Generation-Using text for prediction-Recognizing that document Fit a pattern-Document Classification-Learning to Predict from Text-Similarity and Nearest-Neighbor Method-Document Similarity-Decision Rules-Decision Trees-Scoring by Probabilities																
T4 - Attribute Ranking using Feature Selection																
T5 – Text Similarity Practice																
T6- Decision Tree																

<b>Unit-3 - Information Retrieval for Text Mining</b>	<b>9 Hour</b>
Linear scoring Methods-Evaluation of Performance-Estimating current and future performance-Getting the most from a Learning Method-Errors and Pitfalls in Big data Evaluation-Graph models for social Networks-Information Retrieval and Text Mining-Keyword Search-Nearest- Neighbor Methods-Measuring Similarity-Shared Word Count-Word count and Bonus-Cosine Similarity-Web based Document Search-Link Analysis-Document Matching-Inverted List-Evaluation of Performance	
T7- Assigning Scores using Linear Scoring method,	
T8 - Finding Cosine Similarity of Given Text	
T9 – Web Based Document Search	
<b>Unit-4 - Finding Structure in Document Collection</b>	<b>9 Hour</b>
Clustering Documents by similarity-Similarity of composite documents-K-means Clustering-Hierarchical Clustering-The EM Algorithm-Goals for Information Extraction-Finding Patterns and Entities from Text-Entity Extraction as Sequential Tagging-Tag Prediction as Classification-The maximum Entropy method-Linguistic Features and Encoding-Local Sequence Prediction Models-Global sequence Prediction Models-Reference and relationship Extraction-Template Filling And Database Construction-Commercial Extraction System: Application-Criminal Justice : Application-Intelligence Application	
T10- Implementing K-means Clustering	
T11- EM Algorithm implementation	
T12 – Template Filling and Database Construction practice	
<b>Unit-5 - Case Studies</b>	<b>9 Hour</b>
Ideal Model of Data-Practical Data Sourcing-Prototypical Examples-Hybrid Example-Mixed Data in Standard Table Format-Case study: Market Intelligence from the web-Case Study: Lightweight Document Matching for Digital Libraries-Generating Model cases for Help desk Application: case study-Assigning topics to news articles: Case study-E-mail Filtering: Case study-Search Engines : case study Extracting Named Entities from Documents-Mining Social Media-Customized Newspapers-Emerging Directions-Different ways of collecting samples-Learning to-Unlabeled data-Distributed Text Mining	
T13- Case study Analysis for Search Engines	
T14- Hybrid Exercise Practice	
T15- social media – Data customized	

<b>Learning Resources</b>	1. By Sholom M. Weiss, Nitin Indurkha, Tong Zhang.,Fundamentals of Predictive Text Mining 2010 2. Text Mining Classification, Clustering, and Applications,By Ashok N. Srivastava, Mehran Sahami,2009	3. Springer- ISBN:9781849962261, 184996226X
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<b>Learning Assessment</b>						
Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%
Level 2	Understand	25%	-	20%	-	25%
Level 3	Apply	30%	-	25%	-	30%
Level 4	Analyze	30%	-	25%	-	30%
Level 5	Evaluate	-	-	10%	-	-
Level 6	Create	-	-	5%	-	-
	Total	100 %		100 %		100 %

<b>Course Designers</b>		
<b>Experts from Industry</b>	<b>Experts from Higher Technical Institutions</b>	<b>Internal Experts</b>
1. Ms.Sabna Sulaiman,Nokia	1. Dr.M.Venkatesan, IITM	1. Dr.A.Murugan,SRMIST

<b>Course Code</b>	21CSE529T	<b>Course Name</b>	WEB INTELLIGENCE	<b>Course Category</b>	E	PROFESSIONAL ELECTIVE	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
							2	1	0	3

<b>Pre-requisite Courses</b>	Nil	<b>Co- requisite Courses</b>	Nil	<b>Progressive Courses</b>	Nil
<b>Course Offering Department</b>	School of Computing	<b>Data Book / Codes / Standards</b>			Nil

<b>Course Learning Rationale (CLR):</b> <i>The purpose of learning this course is to:</i>		<b>Program Outcomes (PO)</b>												<b>Program Specific outcomes</b>		
<b>CLR-1:</b>	Learn the Environment and Foundations of Business Intelligence												<b>PSO-1</b>	<b>PSO-2</b>	<b>PSO-3</b>	
<b>CLR-2:</b>	Know to explore Web Usage Data Pre-processing															
<b>CLR-3:</b>	Utilize Sentimental Analysis in applications															
<b>CLR-4:</b>	Explore the Web Usage Based Adaptive Systems															
<b>CLR-5:</b>	Implement Recommender Systems in applications															
<b>Course Outcomes (CO):</b> <i>At the end of this course, learners will be able to:</i>		1	2	3	4	5	6	7	8	9	10	11	12			
<b>CO-1:</b>	Discover Foundations in Web Intelligence															
<b>CO-2:</b>	Explore web Usage data Preprocessing and its tools															
<b>CO-3:</b>	Explore and Implement Sentimental Analysis using Web intelligence															
<b>CO-4:</b>	Implement Web Usage Based Adaptive Systems															
<b>CO-5:</b>	Develop Web Intelligence based Recommendation Systems															

<b>Unit-1 - Introduction: Web Intelligence</b>	<b>9 Hour</b>
Web Information System Environment and Foundations: Web information description and query languages- the semantic Web-Web information system development tools, Web Human-Media Engineering: Web page design-information representation-information processing-visualization of Web information, Web Information Management: information transformation, Internet and Web-based data management: OLAP (online analytical processing)- Web knowledge management- web page automatic generation and updating-Web security, integrity, privacy and trust. The Web Operation- Parsing Common Document Types: Representing Styled Text- Approaches for Modeling the Web User Behaviour	
T1: Ruby's TextResource class: Plain Text, Binary Document Formats, HTML and XHTML, OpenDocument, RSS	
T2: Handling Document Formats (PDF)	
T3: Handling Document Formats (Word)	
<b>Unit-2 - Web Usage Data Pre-processing</b>	<b>9 Hour</b>
Data Sources and Collection: Nature of Web Usage Data- Merging and Cleaning Data, Web Session Reconstruction and User Identification: Heuristics and Methods for Sessionization- Dealing with Incomplete Information- Model Assessment for Sessionization Algorithms. Discovering Usage Patterns for Web: Web Usage Data Collection- Web Usage Data Preprocessing- Web Usage Pattern Discovery - Application of Web Usage Patterns.	
Cleaning, Segmenting, and Spell-Checking Text: Extracting All Text from Any XML File- Segmenting Text- Stemming Text.	
T4: Spell-Checking Text	
T5: Recognizing and Removing Noise Characters from Text	
T6: Custom Text Processing	

<b>Unit-3 - Sentimental Analysis</b>	<b>9 Hour</b>
Web Opinion Mining (WOM): Aspect-Based Opinion Mining- Document Level Opinion Mining. Sources for Web Opinion Mining: Blogs, News and Forums, Twitter, Other Media. Natural Language Processing: Automating Text Categorization: Using Word-Count Statistics for Categorization- Bayesian Classifier for Categorization- LSI for Categorization, Clustering Text Documents: K-means Document Clustering	
T7: Supporting Indexing and Search.	
T8: Using Web Scraping to Create Semantic Relations.	
T9: Taking Advantage of Linked Data	
<b>Unit-4 - Web Usage Based Adaptive Systems</b>	<b>9 Hour</b>
An Overview on Web Usage Based Adaptive Systems- Web Usage Based Adaptive Systems Evolution- Process Framework: Domain Model- User Model- Adaptation Model- Approaches for Web Usage Based Systems: Content Adaptation- Navigation Adaptation- Presentation Adaptation- Privacy Issues in User Data Collection and Usage.	
T10: Using RDF and RDFS Data Formats	
T11: Data Quality Evaluation Tweets Performing SPARQL Queries	
T12: Code Implementing SPARQL Endpoint Web Portals	
<b>Unit-5 - Recommender Systems</b>	<b>9 Hour</b>
Introduction - Classification of Recommender Systems: Rule-Based Recommender Systems- Content-Based Recommender Systems- Collaborative Filtering Recommender Systems- Hybrid Recommender Systems- Sources of Knowledge for Recommender Systems: Ratings- Implicit Feedback- Social Tags- Online Social Networks – Context- Heterogeneous Sources of Knowledge.	
Evaluation Metrics for Recommender Systems: Prediction-Based Metrics- Information Retrieval Related Metrics- Diversity, Novelty and Coverage-	
T13: Learning user profiles	
T14: Extracting Significant Information from Tweets	
T15: Combining the TextResource Class with NLP	

<b>Learning Resources</b>	1. Marks Watson, "Scripting Intelligence: Web 3.0 Information Gathering and Processing", Apress,2009 2. Juan D. Velásquez, Vasile Palade, and Lakhmi C. Jain," Advanced Techniques in Web Intelligence-2 Web User Browsing Behaviour and Preference Analysis" 3. Ning Zhong, Jiming Liu, Yiyu Yao," Web Intelligence",Springer, 2003	4. Shroff, Gautam (January 2014). <i>The Intelligent Web: Search, smart algorithms, and big data</i> , Oxford University Press 5. Richard Chbeir, Youakim Badr, Ajith Abraham Aboul-Ella Hassani, "Emergent Web Intelligence: Advanced Information Retrieval" Springer,2010
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<b>Learning Assessment</b>		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)			
	Bloom's Level of Thinking	Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)					
		Theory	Practice	Theory	Practice				
Level 1	Remember	40%	-	20%	-	40%	-		
Level 2	Understand	40%	-	20%	-	40%	-		
Level 3	Apply	10%	-	20%	-	10%	-		
Level 4	Analyze	10%	-	20%	-	10%	-		
Level 5	Evaluate	-	-	10%	-	-	-		
Level 6	Create	-	-	10%	-	-	-		
	Total	100 %		100 %		100 %			

<b>Course Designers</b>		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
		1. Dr. Paul T Sheeba, SRMIST



**SRM INSTITUTE OF SCIENCE AND TECHNOLOGY**

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