University of Mumbai

Syllabus

B. Tech Computer Engineering
(Last Year Semester VII and VIII)

From
Academic Year 2020 - 21
(KJSCE 2018 CBGS Pattern)
LY B. Tech / COMP / Revision 2.0
Approved by Academic Board
LY B. Tech / COMP / 29/06/2020

K. J. Somaiya College of Engineering, Vidyavihar, Mumbai – 77
(Autonomous College Affiliated to University of Mumbai)

Preamble

Academic Autonomy conferred by the University of Mumbai from the Academic Year 2014-15, gave us the freedom to develop and implement our own curriculum KJSCE2014 with features such as inclusion of choice based Interdisciplinary Course (IDC), Audit Courses, Add on Credit Courses, Exposure Courses, etc. Distinct assessment and evaluation methods were also designed based on focus of individual course. In addition, the outcome of these entire exercises, either by way of student placements or by way of the feedback received from all stakeholders is quite encouraging.

At present, Industry is moving towards Industrial revolution 4.0. Knowing very well that every country's education system forms the basis of its progress and the groundwork for its future, we need to be making engineering graduates equipped to take industrial challenges. A common feature in successful education systems is the balance between tradition and the capacity to be flexible and able to adapt to current social trends. To achieve this, AICTE has taken necessary initiative in January 2018 by introducing model syllabus for undergraduate courses having a focus on the changing industrial scenario.

Our new revision in syllabus *KJSCE2018*, introduced from the academic year 2018-19, has been designed based on the revised AICTE guidelines as well as various accrediting bodies.

The said syllabus is a result of expert advice from members of Board of Studies and Academic Council; both having due representation from academia as well as appropriate industries. Subsequently faculty members of the college have put in efforts to document it in the form, which has been presented here.

Some of the highlights of the *KJSCE2018* syllabus are Introduction of wide choice for branch specific electives, more number of open or interdisciplinary electives, opportunities for internships, etc.

Focus of academic processes in KJSCE is such that, by the time student completes the requirements of the degree, he/ she will be able to acquire attributes required for profession as an engineer. Outcomes are defined to acquire these attributes, which lead to the development of curriculum, pedagogy and assessment tools. These tools need to be updated based on the experiences of teacher and learner. Hence teaching -learning -evaluation paradigm is going to be a mix of traditional as well as use of ICT tools. Role of the faculty member changes from tutor to trainer / instructor/ facilitator / mentor based on the outcomes targeted.

For measuring learning outcomes of students, traditional methods like tests, laboratory work and End Semester Examinations (ESE) are implemented. Continuous Assessment (CA) is carried out through In Semester Examination (ISE) and internal assessment (IA) like quizzes, case studies, mini projects etc. These IA tools not only contribute to marks but also enables the student to learn through solutions discussed, improvisations suggested, feedback given by faculty members. Through these assessment methods students get opportunity for reading research papers, presenting ideas and working in a team.

Since the assessments are distributed throughout the term, the learning process is continuously monitored and graded.

The Department of Computer Engineering courses focus on thrust areas of Department. These areas are Intelligent System and Data Processing, Network System and Security, Image Analysis and Interpretation and System & Software Engineering.

College promotes co-curricular, extra-curricular activities as well as sports; making life outside classroom exciting and rewarding. What makes these activities very effective is the fact that these do not focus only on winning trophies but try to nurture generic skills such as leadership, effective communication, teamwork etc. which are essential skills for a bright professional career.

Along with my colleagues, I welcome you to the Department of Computer Engineering and look forward to lead you towards professional career.

Dr. Deepak Sharma
Head,
Department of Computer Engineering

Vision

To become a center of excellence in discipline of Computer Engineering for developing technically adept professionals with ethical and leadership qualities in service of society.

Mission

- Provide sound technical foundation in Computer Engineering through comprehensive curriculum and application oriented learning.
- Provide ambience for professional growth and lifelong learning for adapting to challenges in rapidly changing technology
- Inculcate social and ethical values and leadership qualities

Program Educational Outcomes (PEO)

A graduate of Computer Engineering will

PEO1. Solve problems in diverse fields using knowledge of Computer Engineering.
PEO2. Excel in professional career, exhibit leadership qualities with ethics &soft skills.
PEO3. Pursue higher education, research or entrepreneurship, engage in professional development, adapt to emerging technologies.

Program Outcomes (PO)

After successful completion of the program Computer Engineering Graduate will be able to:

PO1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and

norms of the engineering practice.

PO9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSO)

PSO1: Apply acquired skills of Information Systems, Networking, Image processing in solving problems of varying complexities.

PSO2: Pursue higher studies in the field of Computer Science & Engineering and be employable in industries.

Acronym for category of courses		Acronyms used in syllabus document	
Acronym	**Definition**	**Acronym**	**Definition**
BS	Basic Science Courses	**CA**	Continuous Assessment
ES	Engineering Science	**ESE**	End Semester Exam
HS	Humanities and Social Sciences including Management Courses	**IA**	Internal Assessment
PC	Professional Core Courses	**O**	Oral
PE	Professional Elective courses	**P**	Practical
OE	Open Elective Courses	**P&O**	Practical and Oral
LC	Laboratory Courses	**TH**	Theory
PR	Project	**TUT**	Tutorial
AC	Audit Course	**TW**	Term work
AOCC	Add on Credit Course	**ISE**	In- Semester Examination
AOAC	Add on Audit Course	**CO**	Course Outcome
AVAC	Add on Value Audit Course	**PO**	Program Outcome
EX	Exposure Course	**PSO**	Program specific Outcome
I	Interdisciplinary courses		

Acronyms used in Course code e.g. 2UCC501/ 2UCE601

Position of Digit	Acronym	Definition
1	**2**	Second revision after autonomy KJSCE 2018 (First revision KJSCE 2014)
2	**U**	Undergraduate
3	**T**	Department of Computer Engineering
	S	Common to All
4	**C**	Core Course
	E	Elective Course
	L	Laboratory Course
	T	Tutorial
	ST	Open Elective Technical
	SH	Open Elective Humanities/Management/SWAYAM-NPTEL
	M	Mandatory Non Credit Course
	N	Internship
	P	Project
5	**5/6**	Semester Number
	G/Y	Management Elective/ Humanity Elective
6, 7	**01**	Course Number

LY BTech Semester VII

Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH – P – TUT	Total (Hrs.)	Credits Assigned TH – P – TUT	Total Credits	Course Category
2UCC701	Project Management	3 – 0 – 0	3	3 – 0 – 0	3	PC
2UCE71X	Departmental Elective-III	3 – 0 – 0	3	3 – 0 – 0	3	PE
2UCE72X	Departmental Elective-IV	3 – 0 – 0	3	3 – 0 – 0	3	PE
2UST7XX	Open Elective Technical-III	3 – 0 – 0	3	2 – 0 – 0	2	PE
2USH701	Open Elective Humanities/ management/Swayam NPTEL course (8weeks)	2 – 0 – 0	2	2 – 0 – 0	2	HS
2UCP701	Project – I [%]	0– 6 – 0	6	0 – 3– 0	3	PR
2UCL701	Project Management Lab	0 – 2 – 0	2	0– 1 – 0	1	PC
2UCL702	Elective–III laboratory	0 – 2 – 0	2	0– 1 – 0	1	PE
2UCL703	Elective- IV laboratory	0 –2 – 0	2	0– 1 – 0	1	PE
Total		**14 –12 – 0**	**26**	**14–6–0**	**19**	**--**

%- For Students opting for one semester internship for semester VIII, project I will not continue to Project II.

Examination Scheme

Course Code	Course Name	Examination Scheme							
		Marks							
		CA		ESE	TW	O	P	P&O	Total
		ISE	IA						
2UCC701	Project Management	30	20	50					100
2UCE71X	Departmental Elective-III	30	20	50					100
2UCE72X	Departmental Elective-IV	30	20	50					100
2UST7XX	Open Elective Technical	30	20	--					100
2USH701	Open Elective Humanities/ management/Swayam NPTEL course (8weeks)	30	20	--					50
2UCP701	Project – I %	--	--	--	25	25			50
2UCL701	Project Management Lab	--	--	--	25	25			50
2UCL702	Elective–III laboratory	--	--	--	25	25			50
2UCL703	Elective- IV laboratory	--	--	--	25	25			50
Total		120	80	150	150	100			600

%- For Students opting for one semester internship for semester VIII, project I will not continue to Project II

Departmental Elective -III & IV for VII Semester			
Course Code	Name of Elective	Course Code	Name of Elective
2UCE711	Big Data Analytics	2UCE712	Data Science
2UCE713	Cloud Computing Emerging Technologies	2UCE714	Block Chain Technology
2UCE715	Cyber Security, Forensics and Cyber Law	2UCE716	Computer Vision
2UCE717	Geographic Information System and Spatial Computing	2UCE718	Computer Simulation and Modeling
2UCE719	User Experience Design	2UCE720	C# Programming and. Net Technology

Open Electives Technical for VII Semester			
Course Code	Name of Elective	Course Code	Name of Elective
2UST701	Genetics Algorithm and Applications	2UST702	Web Analytics and Web Intelligence
2UST703	Reinforcement Learning	2UST704	Massive Graph Analysis

LY BTech VIII Semester

Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH – P – TUT	Total (Hrs.)	Credits Assigned TH – P – TUT	Total Credits	Course Category
2UCP801	Project- II/ Semester long Internship	0 – 14 – 0	14	0 – 7 – 0	7	PR
2UECE81X	Departmental Elective- V / Swayam NPTEL course*	3 – 0 – 0	3	3 – 0 – 0	3	PE
2UECE82X	Departmental Elective- VI/ Swayam NPTEL course*	3 – 0 – 0	3	3 – 0 – 0	3	PE
Total		6 – 14 – 0	20	6 – 7 – 0	13	--

*For students selected for semester long internship.

Examination Scheme

Course Code	Course Name	Examination Scheme							
		Marks							
		CA		ESE	TW	O%	P	P&O#	Total
		ISE	IA						
2UCP801	Project- II/ Semester long Internship	--	--	--	100	100	--	--	200
2UCE81X	Departmental Elective- V / Swayam NPTEL course*	30	20	50	--	--	--	--	100
2UCE82X	Departmental Elective- VI/ Swayam NPTEL course*	30	20	50	--	--	--	--	100
Total		**600**	**40**	**100**	**100**	**100**			**400**

Departmental Elective – V & VI for VIII Semester			
Course Code	**Name of Electives**	**Course Code**	**Name of Electives**
2UCE811	Bioinformatics	2UCE812	Game Programming
2UCE813	Advanced Algorithms: Design and Analysis	2UCE814	IoT Security
2UCE815	Internet of Everything	2UCE816	Cyber Physical System
2UCE817	Deep Learning	2UCE818	Speech and Language Processing
2UCE819	Software Architecture and Design Thinking	2UCE820	High Performance Computing

SEMESTER VII

B. Tech Computer Engineering
(KJSCE 2018)

Course Code	Course Title						
2UCC701	Project Management						
	TH		P		TUT		Total
Teaching Scheme(Hrs.)	03		--		--		03
Credits Assigned	03		--		--		03
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course prerequisites (if any):
-

Course Objectives
The objective of this course is to introduce Concepts of project management. Introduce characteristics of a project manager.

Course Outcomes
At the end of successful completion of the course the student will be able to

CO1: Identify the phases of Projects
CO2 Plan various project activities based on efforts and duration estimations by analyzing risks involved in it.
CO3 Understand Practices, Tools & Techniques in the area of Project Management.
CO4 Evaluate and assess the projects and to estimate the project cost using cost benefit evaluation techniques.
CO5 Understand the selection of the most appropriate people for the project.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Project management**		**03**	**CO 1**
		What is Project? What is Project Management? Need for Project Management? Project Phases, Project stake holders, Key general Management Skills.		
2	**Project Management Process**		**05**	**CO2**
		Project Process, Process Groups, Process Interactions, Customizing Process Interactions, Mapping of Project Management Process. Organizational influence. Agile Methodology, Scrum, Kanban.		
3	**Project Management Knowledge areas**		**12**	**CO 3**
		Project Integration Management, Project Scope Management , Project Time Management, Project Cost Management, Project Quality Management, Project Human Resource Management, Project Communication Management, Project Risk Management, , Project Procurement Management		
4	**Project Management in the Corporate context**		**12**	**CO 4**
		The Management of Project Management, Portfolio Management, International Project Management, Elements of Budgets & Estimates, Cost Estimation & Budgeting, Project Cost Accounting Systems, Cost schedules & forecast. PERT & CPM		
5	**Managing People in Project**		**07**	**CO 5**
		Managing Contracts, The Oldham-Hackman job Characteristics Model, Working in Groups, working in team, Stress, Health and Safety		
6	**Case Studies**		**06**	**CO 2,3,4 5**
		Case studies : ITIL Framework for Service Management (ITIL- Information Technology Infrastructure Library)		
		#Self-Learning: ISO Standards for processes in Project Management		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	John M. Nicholas, Herman Steyn	Project Management for Engineering, Business and Technology	Routledge Taylor & Francis Group, London	4th Edition
2.	Bob Hughes Bob Hughes, Mike cotterell, Rajib Mall	Software Project Management	Tata McGraw Hill, Special Indian Edition	5th Edition,
3.		A guide to the Project management Body of knowledge	Project Management Institute, USA	2000 Edition
4.	Avraham Shtub**,** Jonathan F. Bard, Shlomo Gloerson	Project Management, Processes, Methodologies & Economics	Pearson Education	2nd Edition
5.	Cohn, M	Agile estimating and planning	Pearson education	2nd Edition
6.	Schwaber, K. & Beedle, M	Agile software development using Scrum	Prentice Hall	2001 Edition

Departmental Elective III and IV

Course Code	Course Title						
2UCE711	Big Data Analytics						
	TH		P		TUT		Total
Teaching Scheme(Hrs.)	03		--		--		03
Credits Assigned	03		--		--		03
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course prerequisites (if any):
Database management system

Course Objectives
1. To provide an overview of an exciting growing field of big data analytics.
2. To introduce the tools required to manage and analyze big data like Hadoop, NoSql MapReduce.
3. To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
4. To enable students to have skills that will help them to solve complex real-world problems in for decision support.

Course Outcomes
At the end of successful completion of the course the student will be able to

CO1: Understand the fundamental enabling techniques like Hadoop, MapReduce in achieving Big data analytics.
CO2 Associate appropriate technique for finding similarity and dimensionality reduction.
CO3 Demonstrate the statistical analysis techniques for decision making.
CO4 Interpret business models and scientific computing paradigm for solving real world problems.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Big Data and mining large scale system**		11	CO1
	1.1	Introduction to Big Data, Big Data characteristics, types of Big Data, Traditional vs. Big Data business approach, Case Study of Big Data Solutions.		
	1.2	Introduction to Hadoop and its components		
	1.3	Distributed File Systems: Physical Organization of Compute Nodes, Large-Scale File-System Organization MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping With Node Failures.		
	1.4	Algorithms Using MapReduce: Matrix-Vector Multiplication by MapReduce, Relational-Algebra Operations, Computing Selections by MapReduce, Computing Projections by MapReduce, Union, Intersection, and Difference by MapReduce, Computing Natural Join by MapReduce, Grouping and Aggregation by MapReduce, Matrix Multiplication, Matrix Multiplication with One MapReduce Step.		
2	**Finding Similar Items and Dimensionality Reduction**		08	CO2
	2.1	Applications of Near-Neighbor Search- Jaccard Similarity of Sets, Similarity of Documents, Collaborative Filtering as a Similar-Sets Problem.		
	2.2	Distance Measures: Definition of a Distance Measure, Euclidean Distances, Jaccard Distance, Cosine Distance, Edit Distance, Hamming Distance.		
	2.3	Shingling of Documents, Similarity-Preserving Summaries of Sets, Locality-Sensitive Hashing for Documents, Applications of Locality-Sensitive Hashing		
	2.4	Dimensionality Reduction: Eigenvalues and Eigenvectors of Symmetric Matrices, Principal-Component Analysis, Singular-Value Decomposition CUR Decomposition		
		#Self-learning : Latent factor models, Methods of High degree of similarity		
3	**Mining Data Streams**		06	CO3
	3.1	The Stream Data Model: A Data-Stream-Management System, Examples of Stream Sources, Stream Query, Issues in Stream Processing.		
	3.2	Sampling Data in a Stream: Obtaining a Representative Sample, The General Sampling Problem, Varying the Sample Size.		
	3.3	Filtering Streams: The Bloom Filter, Analysis		
	3.4	Counting Distinct Elements in a Stream: The Count-Distinct Problem, The Flajolet-Martin Algorithm,		

		Combining Estimates, Space Requirements. Estimating Moments Counting Ones in a Window: The Cost of Exact Counts, The Datar-Gionis-Indyk-Motwani Algorithm.		
		Self-learning: Query Answering in the DGIM Algorithm, Decaying Windows.		
4	**Link Analysis And Frequent Itemsets**		**08**	**CO3**
	4.1	PageRank Definition, Structure of the web, dead ends, Using Page rank in a search engine, Efficient computation of Page Rank: PageRank Iteration Using MapReduce, Use of Combiners to Consolidate the Result Vector. Topic sensitive Page Rank,Hubs and Authorities		
	4.2	Handling Larger Datasets in Main Memory Algorithm of Park, Chen, and Yu, All or Most frequent itemsets in two passes.		
		The SON Algorithm and MapReduce, Toivonen's Algorithm		
		Self-learning: link spam, The Multistage Algorithm, The Multihash Algorithm. Counting Frequent Items in a Stream Sampling Methods for Streams, Frequent Item sets in Decaying Windows		
5	**Clustering and Mining Social Network and graphs**		**12**	**CO4**
	5.1	CURE Algorithm, Clustering in Non-Euclidean Spaces Stream-Computing , A Stream-Clustering Algorithm, Initializing & Merging Buckets, Answering Queries		
	5.2	Recommendation Systems – A model for Recommendation systems, Content based recommendation, Collaborative Filtering		
	5.3	Mining Social-Network Graphs – Social networks as graphs, Clustering, Direct discovery of communities, Partitioning of Graphs, Finding overlapping of communities, SimRank, Counting Traingles,		
		#Self-learning : Counting Traingles, Neighborhood properties of graph, Adversting on Web		
		Total	**45**	

 # Students should prepare all Self Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Anand Rajaraman and Jeff Ullman	Mining of Massive Datasets	Cambridge University Press	Second Edition , 2014
2.	Alex Holmes	Hadoop in Practice	Manning Press, Dreamtech Press.	Second Edition , 2015
3.	Bill Franks	Taming The Big Data Tidal Wave: Finding Opportunities In Huge Data Streams With Advanced Analytics	Wiley	2012
4.	Chuck Lam	Hadoop in Action	Dreamtech Press	2011
5.	Radha Shankarmani M. Vijaylakshmi	Big Data Analytics	Wiley	2st edition, 2018

Course Code	Course Title						
2UCE712	Data Science						
	TH		P		TUT		Total
Teaching Scheme(Hrs.)	03		--		--		03
Credits Assigned	03		--		--		03
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course prerequisites (if any):
Students are expected to have basic knowledge of algorithms and programming experience.

Course Objectives
To develop practical data analysis skills, which can be applied to practical problems.
To develop fundamental knowledge of mathematical concepts needed for data science applications.
To develop practical skills needed in data analytics.

To explain how math and information sciences can be used for developing better algorithms and software.

To develop applied experience with data science software, programming, applications and Processes.

Course Outcomes
At the end of successful completion of the course the student will be able to

CO1	Explain the basic terms of Statistical Inference and commonly used probability distributions for fitting data.
CO2	Use R Programming to carry out basic statistical modelling and analysis.
CO3	Explain the significance of exploratory data analysis (EDA) in data science.
CO4	Describe the Data Science Process and how its components interact.
CO5	Apply basic tools to carry out EDA for the Data Science process.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Applied Data Science**		**09**	**CO1**
	1.1	Introduction to Applied Data Science: What is Data Science? - Big Data and Data Science, Datafication - Current landscape of perspectives - Skill sets needed and various application areas. Challenges and skill Sets needed and various applications areas.		
	1.2	Impact of applying Data Science in business scenario.		
	1.3	Introduction to need of estimation and validation for added value due to data science		
2	**Introduction to Mathematical Foundation**		**10**	**CO2**
	2.1	Introduction to R Programming Language		
	2.2	Introduction to the mathematical foundations required for data science. Statistical Inference: Populations and samples, Statistical modeling, Probability distribution, Fitting a model.		
3	**Exploratory Data Analysis**		**09**	**CO3**
	3.1	Exploratory Data Analysis and the Data Science Process		
	3.2	Basic tools (plots, graphs and summary statistics) of EDA		
	3.3	The Data Science Process : Linear Regression, k-Nearest Neighbors (k-NN), k-means, Naive Bayes) for predictive modeling		
4	**Introduction to Basic Machine Learning Algorithms**		**09**	**CO4**
	4.1	Linear Regression and k-NN comparison for various applications and its flows		
	4.2	Data Wrangling: APIs and other tools for scrapping the Web		
5	**Data Visualization**		**08**	**C05**
	5.1	Introduction to Feature Generation and Feature Selection (Extracting Meaningful Data)		
	5.2	Overview/Introduction to Feature Selection algorithms.		
	5.3	Data Visualization - Basic principles, ideas and tools for data visualization and its applications		
		# Self Learning –Mini Project		
		Total	**45**	

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Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Han, J., Kamber, M., Pei, J.	Data mining concepts and techniques	Morgan Kaufmann	2011
2.	James, G., Witten, D., Hastie, T., Tibshirani, R.	An introduction to statistical learning with applications in R	Springer	2013
3.	Cathy O'Neil and Rachel Schutt	Doing Data Science, Straight Talk From The Frontline	O'Reilly	2014
4.	Kevin P. Murphy	Machine Learning: A Probabilistic Perspective	ISBN 0262018020	2013
5.	Mohammed J. Zaki and Wagner Miera Jr.	Data Mining and Analysis: Fundamental Concepts and Algorithms	Cambridge University Press	2014
6.	Avrim Blum, John Hopcroft, and RavindranKannan	Foundations of Data Science	ONLINE	2014

Course Code	Course Title							
2UCE713	Cloud Computing Emerging Technologies							
	TH		P	TUT				Total
Teaching Scheme (Hrs.)	03		--	--				03
Credits Assigned	03		--	--				03
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	-	-	-	-	100

Course prerequisites:

- Fundamental knowledge on Operating system.
- Basics of client/server programming and network protocols.

Course Objectives:

Cloud computing has evolved as a very important computing model, which enables information, software, and other shared resources to be provisioned over the network as services in an on-demand manner. Students will be exposed to the current practices in cloud computing. Topics may include distributed computing models and technologies, Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), Software-as-a-Service (SaaS), virtualization, performance and systems issues, capacity planning, federated clouds, challenges in implementing clouds, data centers, hypervisor CPU and memory management, cloud hosted applications, and other advanced and research topics in cloud computing.

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1 : Describe fundamental and core concepts of cloud computing
CO2: Investigate the system virtualization and outline its role in enabling the cloud computing system model.
CO3 : Develop cloud applications using Aneka platform
CO4 : Analyze and apply cloud programming models to solve problems
CO5 : Configure and experiment with advanced cloud technologies

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction**		**8**	
	1.1	Cloud Computing at a Glance, Historical Developments, Building Cloud Computing Environments, Computing Platforms and Technologies - Microsoft Azure, Hadoop, Force.com and Salesforce.com, Manjrasoft Aneka		**CO1**
2	**Virtualization**		**12**	
	2.1	Introduction, Characteristics of Virtualized Environments , Taxonomy of Virtualization Techniques, Virtualization and Cloud Computing, Pros and Cons of Virtualization,		**CO2**
	2.2	Technology Examples: Xen: Para virtualization, VMware: Full Virtualization, Microsoft Hyper-V		
	2.3	Cloud Computing Architecture : Cloud Reference Model, Types of Clouds, Economics of the Cloud, Open Challenges,		
		#Self-Learning – Virtual Machine Provisioning and Migration services		
3	**Aneka: Cloud Application Platform**		**10**	
	3.1	Framework Overview, Anatomy of the Aneka Container, Building Aneka Clouds : Infrastructure Organization, Logical Organization, Private Cloud Deployment Mode, Public Cloud Deployment Mode, Hybrid Cloud Deployment Mode		**CO3**
	3.2	Cloud Programming and Management - Aneka SDK, Management Tools		
		#Self-Learning - CometCloud: An Autonomic Cloud Engine		
4	**Cloud Infrastructure and Platforms in Industry.**		**7**	
	4.1	Open Stack: Introduction to open stack, Components of open stack, Amazon Web Services: Compute Services; Storage Services;		**CO4**
	4.2	Google Cloud Platform, Google AppEngine: Architecture and Core concepts; Application Life Cycle		
		#Self-Learning - The MapReduce Programming Model and Implementation		
5	**Advanced Topics in Cloud Computing**		**8**	
	5.1	Energy Efficiency in Clouds, Market Based Management of Clouds, Federated Clouds / Inter Cloud, Third Party Cloud Services: MetaCDN, SpotCloud		**CO5**
	5.2	Dockers and Containers, Micro Services, Cloud automation tools and DevOps concepts		

	5.3	Mobility as a Service (MAAS), JUJU, MBASS		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Rajkumar Buyya, Christian Vecchiola, S Thamarai Selvi	Mastering Cloud Computing	McGraw Hill Education Private Limited	2013
2.	Judith Hurwitz, R.Bloor,M.Kanfman, F.Halper	OpenStack Cloud Computing Cookbook	PACKT Publishing BIRMINGHAM - MUMBAI	Third Edition
3.	J.Vette, Toby J. Vette, Robert Elsenpeter	Cloud Computing: A Practical Approach	Tata McGraw Hill)	1st, 2009
4.	Rajkumar Buyya, James Broberg, Andrzej Goscinski	Cloud Computing, Principles and Paradigms	Wiley	1st ,2013
5.	Tim Mathar, S. Kumaraswammy, S.Latif	Cloud Security & Privacy	O'REILLY	1st , 2009

Course Code	Course Title							
2UCE714	Block Chain Technology							
	TH			P		TUT		Total
Teaching Scheme(Hrs.)	03			--		--		03
Credits Assigned	03			--		--		03
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course prerequisites:
Networking Concepts, Object Oriented Programming Skills, Cryptography and Network Security Concepts.

Course Objectives:

The objective of the Course is to explore the Bitcoin protocol followed by the Ethereum protocol – to lay the foundation necessary for developing applications and programming. Course will give the idea about the decentralized peer-to-peer network, an immutable distributed ledger and the trust model that defines a blockchain.

This course explains basic components of a blockchain (transaction, block, block header, and the chain) its operations (verification, validation, and consensus model) underlying algorithms, and essentials of trust (hard fork and soft fork).

Course Outcomes:

CO1 Build your own Blockchain businesses with acquired knowledge.

CO2 Learn Solidity language & Multiple Technology-based developments.

CO3 Apply the algorithm and techniques used in Blockchain.

CO4 Grasp the in-depth understanding of Blockchain, Smart Contracts & how it works

CO5 Describe the methods of mining.

Module No.	Unit No.	Details	Hrs.	CO
		Block Chain Technology		
1	**Blockchain Basics**		**8**	**CO1**
	1.1	Introduction to Blockchain, what is Block? Registry of Transaction, Blockchain Structure, Basic Operations, Blockchain & Distributed Ledger Technology (DLT), Elements of Distributed Computing.		
	1.2	Elements of Cryptography, Elements of Game Theory, Cryptocurrencies, Tokens, and ICOs.		
	1.3	Blockchain Defined: Bitcoin & Blockchain.		
2	**Mining and Consensus**		**9**	
	2.1	Decentralized Consensus, Mining Node, The Coinbase Transaction.		CO5
	2.2	Mining the Block, Validating New Block, Blockchain Forks, Mining Pool.		
	2.3	Changing the consensus Rules, Hard Fork and Soft Fork,		
3	**Building Smart Contracts : Using Ethereum, Solidity**		**12**	**CO4**
	3.1	Smart Contract Basics: Why Smart Contracts? Smart Contracts Defined, Processing Smart Contracts, Deploying Smart Contracts.		
	3.2	Ethereum Blockchain, Ethereum Structure, Ethereum Operations, Interactive Model,		
	3.3	Solidity: Structure, Basic Data Types & Statements (Bidder Data & Functions Demos), Specific Data Types , Data Structures, Access Modifiers & Applications		
4	**Algorithm and Techniques , Trust Essentials**		**8**	**CO3**
	4.1	Public-Key Cryptography, Hashing, Transaction Integrity, Security Blockchain		
	4.2	Trust Essential: Decentralized Systems, Consensus Protocol, Robustness, Forks,		
5	**Applications and Case studies**		**8**	
	5.1	Developing Smart Contracts, Time Elements, Validation & Test, Client Application.		CO2
	#Self-Learning 5.2:			
	5.2	Case Studies: Government, Energy supply, Supply Chain, Insurance, Border Control, Waste Management, Shipping, Land Registry, HealthCare, Music, Real Estate, Fishing, Tourism, National Security etc.		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Andreas M. Antonopoulos	Mastering the Bitcoin: Programming the Open Blockchain	O' Reilly	2nd Edition, 2017
2.	Melanie Swan	BlockChian	O'Reilly	2015
3.	Nitin Gaur, Luc Desrosiers, Petr Novotny, Venkatraman Ramakrishna	Hands-On Blockchain with Hyperledger: Building decentralized applications with Hyperledger Fabric and Composer	Packt	Kindle Edition, 2018
4.	*Stephen Fleming business ecosystems*	*Blockchain Technology: Introduction to Blockchain Technology and its impact on*	Stephen Fleming	2017
5.	*Zeeshan-ul- hassan Usmani*	*Introduction to lockchain with Case Studies*	Guhftgu Publication	2018

Course Code	Course Title						
2UCE715	Cyber Security, Forensics and Cyber Law						
	TH		P		TUT		Total
Teaching Scheme(Hrs.)	03		--		--		03
Credits Assigned	03		--		--		03
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	50

Course prerequisites (if any):
Computer Organization & Architecture, Cryptography & System Security, Computer Networks.

Course Objectives
The objective of the course is to enable students to understand the basic principles of cyber security, computer crimes and methods of defense. The course introduces the process of digital forensic investigation, extraction of evidences using appropriate tools. It covers the techniques of data hiding, recovery, disk analysis, volatile data extraction. Further, it explores different network based attacks, tools to monitor/mitigate such attacks. Tools such as metasploit, interfaces to dark web and deep web explore the conducive environment for attackers. Cyber laws, IT Acts enable the student to understand the legal aspects of various cyber-crimes.

Course Outcomes
At the end of successful completion of the course the student will be able to

CO1	Identify various security goals, computer crimes & methods of defense.
CO2	Understand the fundamentals of digital forensics
CO3	Analyze and interpreted the results of disk forensic operations
CO4	Apply forensic tools to extract and investigate the evidences from network
CO5	Relate the corresponding computer security acts with the crimes

Module No.	Unit No.	Details	Hrs.	CO
1	**Cyber Security and Digital Forensics**		06	CO1
	1.1	Security Attacks, security goals, security services, security mechanisms, malwares, types of malwares, data privacy.		
	1.2	Cyberspace and criminal profiling, methods of defense		
	1.3	Incidence-response, CERT and its role.		
		#Self-Learning: Types of contemporary cyber crimes		
2	**Digital Forensics Foundations.**		10	CO2
	2.1	Introduction, six A's of digital forensics, digital investigations, digital crime scene investigation process		
	2.2	Computer evidence – introduction, types, rules and guidelines for procuring evidences, establishing chain of custody, admissibility of evidences in the court of law.		
	2.3	Evidence sources – computer generated, user generated, data generated by peripheral devices, hand-held devices, wireless devices, telecommunication devices.		
		#Self-Learning: Use of Tools for digital forensics		
3	**Information retrieval and recovery**		11	CO3
	3.1	Cloning, imaging, tools for cloning, hidden locations – slack space, unallocated disk space		
	3.2	Passwords – Brute force, dictionary based attack, password cracking		
	3.3	Disk Analysis – carving, hashing, FAT, NTFS file systems and analysis		
	3.4	Registry Analysis – introduction, structure, windows registry, volatile data, live analysis		
		#Self-Learning: Use of Tools for disk analysis		
4	**Network Forensics**		10	CO4
	4.1	Network forensics methodology, Network based attacks – MITM, OWASP, ARP spoofing, IP and MAC spoofing, DNS attacks, SYN flooding attacks, port scanning, DOS, DDOS.		
	4.2	Network penetration testing – threat assessment, penetration testing tools, threat matrices		
	4.3	Tools & Applications – Browser forensics, email forensics, Nmap, Nessus, Wireshark, Metasploit, Kali Linux, Deep-Web, Dark-Web, Ransomwares		
		#Self-Learning: Use of Tools related to network forensics		

5	**Cyber laws, compliances and standards**		**08**	**CO5**
	5.1	Indian IT Act 2000, 2008 (Amended)		
	5.2	DMCA, CAN-SPAM Act, trade secrets, IPR		
	5.3	Compliances and standards – IT service management, COBIT, RA (Risk Analysis/Assessment)		
		Total	**45**	

 # Students should prepare all Self Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.

Recommended Books:

Sr. No	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Bill Nelson, Amelia Phillips, Christopher Steuart.	*Guide to Computer Forensics and Investigations*	Cengage Learning, USA.	3rd Edition paperback, 2002.
2.	Jason T. Luttgens, Mathew Pepe, Kevin Mandia	*Incident Response and Computer Forensics*	Tata McGraw Hill Education	3rd Edition, 2014.
3.	Marie-Helen Maras	*Computer Forensics: Cybercriminals, Laws and Evidences*	Jones and Bartlett Learning	2nd Edition, 2014
4.	Pawan Duggal	*Cyber Law – The Indian Perspective*	Saakshar Law Publications	2002

Course Code	Course Title						
2UCE716	Computer Vision						
	TH		P		TUT		Total
Teaching Scheme(Hrs.)	03		--		--		03
Credits Assigned	03		--		--		03
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course prerequisites (if any):
Computer Graphics, Image Processing with basic mathematical operations on vectors, matrices.

Course Objectives
In this course, students will learn basic principles of image formation, image processing algorithms and different algorithms for 3D reconstruction and recognition from single or multiple images (video). This course emphasizes the core vision tasks of scene understanding and recognition. Applications to 3D modelling, video analysis, video surveillance, object recognition and vision based control relevant to real world case studies.

Course Outcomes
At the end of successful completion of the course the student will be able to

CO1	Implement fundamental image processing techniques required for Computer Vision.
CO2	Understand image formation process.
CO3	Extract features from images and do analysis of images.
CO4	Understand video processing and object recognition techniques.
CO5	Apply the algorithms for real world application processing.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Computer Vision**		06	CO 1
	1.1	Image Processing, Computer Vision and Computer Graphics , What is Computer Vision - Low-level, Mid-level, High-level , Overview of Diverse Computer Vision Applications: Document Image Analysis, Biometrics, Object Recognition, Tracking, Medical Image Analysis, Content-Based Image Retrieval, Video Data Processing, Multimedia, Virtual Reality and Augmented Reality		
2	**Image Formation Models**		12	CO 2
	2.1	Digital Image Formation and low level processing, Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing.-level processing,		
	2.2	Camera model and Camera calibration, Binocular imaging systems, Multiple views geometry, Structure determination, shape from shading, Photometric Stereo, Depth from Defocus, Construction of 3D model from images.		
		#Self-learning : 3D transformations and projections.		
3	**Feature Extraction, Shape representation and Segmentation**		12	CO 3
	3.1	Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.		
	3.2	Contour based representation, Region based representation, Deformable curves and surfaces , Snakes and active contours, Level set representations, Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection.		
4	**Motion Estimation and Object Recognition**		10	CO 4
	4.1	Regularization theory , Optical computation, Stereo Vision , Motion estimation , Structure from motion		
	4.2	Hough transforms and other simple object recognition methods, Shape correspondence and shape matching, Principal component analysis, Shape priors for recognition.		
		#Self-learning : Pattern recognition.		

5	**Applications**		**5**	**CO 5**
		Applications: 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		
		Total	**45**	

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Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Robert Haralick and Linda Shapiro	"Computer and Robot Vision", Vol I, II.	Addison-Wesley	1993
2.	Richard Szeliski	Computer Vision: Algorithms and Applications	Springer-Verlag London Limited electronic copy available at (http://szeliski.org/Book)	2011
3.	D. Forsyth, J. Ponce	Computer Vision - A modern approach	Pearson Education	2003
4.	E. R. Davies	Computer & Machine Vision	Academic Press	Fourth Edition, 2012.
5.	R.C. Gonzalez and R.E. Woods	Digital Image Processing	Addison- Wesley.	1992.

Course Code	Course Title						
2UCE717	Geographic Information System and Spatial Computing						
	TH		P		TUT		Total
Teaching Scheme(Hrs.)	03		--		--		03
Credits Assigned	03		--		--		03
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	-	--	--	--	100

Course prerequisites:
Students are expected to have some knowledge of DBMS and skills of programming.

Course Objectives:
The objectives of this course are to

- Introduce spatial data concepts and Map referencing.
- Provide knowledge to spatial data processing for collecting, modeling and structuring.
- Develop the skills of spatial data visualization and data presentation.
- Develop the skills to analyze spatial data using different tools
- Develop the skills for designing GIS database for small applications.

Course Outcomes
At the end of successful completion of the course the student will be able to

CO1	Describe spatial data concepts and Map reference systems in GIS applications
CO2	Apply GIS modeling and Terrain modeling using spatial data and perform interpolation using different GIS tools
CO3	Analyze and visualize the spatial data and its quality
CO4	Implement small decision support system applications by creating GIS database.
CO5	Develop small GIS applications using Open standards

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to GIS**		8	CO 1
	1.1	Introduction to GIS		
	1.2	Spatial data concepts		
	1.3	Map reference systems		
2	**Spatial Data Processing**		10	CO2
	2.1	Spatial data - sources, models, structures		
	2.2	Analysis and Interpolation		
	Self-Learning Topic: Study of different data interpolation methods.			
3	**Terrain Modeling and Visualization**		10	CO3
	3.1	Terrain modeling		
	3.2	Visualization and measures to analyze data Quality		
4	**GIS Decision Support System**		10	CO 4
	4.1	Spatial decision support systems		
	4.2	Introduction to Global positioning systems		
	Self-Learning Topic: Study of open source software QGIS : Installation, configuration, feature extraction using in built functions			
5	**GIS Applications and Open-source Tools**		7	CO 5
	5.1	GIS applications with open source tools such as QGIS		
		Total	45	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with Country	Edition and Year of Publication
1.	P. A. Burrough and R. A. McDonnell	Principles of Geographic Information Systems	Oxford University Press	1999
2.	DeMers M.N.	Fundamentals of Geographic Information Systems	John Wiley & Sons, Inc., New York	2000
3.	R. Laurini and D. Thompson,	Fundamentals of Spatial Information Systems	Academic press,	1994
4.	Longley P.A., Goodchild M.F., Maguire D.J. and Rhind D.W.	Geographical Information Systems Principles ,Techniques, Management and Applications,	Second Edition, Abridged, John Wiley & Sons, NJ	2005

Course Code	Course Title							
2UCE718	Computer Simulation and Modeling							
	TH		P		TUT		Total	
Teaching Scheme(Hrs.)	03		--		--		03	
Credits Assigned	03		--		--		03	
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course prerequisites (if any):

Understanding of basic concepts of Database Management System and algorithms and Data structures.

Course Objectives:

This computer simulation and modeling course presents an introduction to discrete event simulation systems. The course discusses the modeling techniques of entities, queues, resources and entity transfers in discrete event environment. The course will teach the students the necessary skills to formulate and build valid models, implement the model, perform simulation analysis of the system and analyze results properly.

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1 Understand the concepts of discrete event simulation and its importance in business, science, engineering, industry and other services.

CO2 Ability to analyse and apply general principles of event scheduling algorithm & various statistical methods on different applications.

CO3 Generate pseudorandom numbers and perform statistical tests to measure the quality of a pseudorandom number generator.

CO4 Analyze the systems for input modeling, output analysis and validation.

CO5 Apply simulation and modelling concepts and techniques on various real time applications.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Simulation, Simulation Examples & general principles**		12	CO1 & CO2
	1.1	Introduction to Simulation: advantages, disadvantages, types of models & steps in simulation study.		
	1.2	Simulation Examples: Manual Simulation: Queuing and Inventory problems		
	1.3	General Principles: Event Scheduling Algorithm/Time advance algorithm, Simulation using time advance algorithm.		
2	**Statistical & Queuing Models**		08	CO2
	2.1	Statistical Models in simulation: Discrete and Continuous Distributions.		
	2.2	Queuing Models: M/G/1, M/M/1		
3	**Random Number Generation**		10	CO3
	3.1	Random Number Generation Techniques		
	3.2	Testing random numbers: Chi square, K-S, Runs up and Down test.		
	3.3	Random Variate Generation: Inverse transform technique, Convolution Method & Acceptance-Rejection Technique		
4	**Analysis of simulation data**		10	CO4
	4.1	**Input Modeling** : Data collection, Identifying the Distribution with Data, Parameter Estimation, Goodness-of-Fit Tests, Selecting Input Models without Data and Multivariate and Time-Series Input Models		
	4.2	**Verification and Validation of Simulation Models:** Verification, Calibration and Validation of Simulation models.		
	4.3	**Output Analysis:** Estimation of absolute performance, Output Analysis Concepts		
5	**Applications:**		05	CO5
	5.1	Simulation of Manufacturing and Material-Handling Systems		
		#Self-learning: Simulation tools		
		Total	**45**	

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Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Jerry Banks, John Carson, Barry Nelson, and David M. Nicol	Discrete Event System Simulation	Prentice-Hall	Third Edition
2.	Jerry Banks, John Carson, Barry Nelson, and David M. Nicol	Discrete Event System Simulation	Prentice-Hall	Fifth Edition
3.	Averill M Law	System Modeling & Analysis;	Tata McGraw Hill	Fourth Edition
4.	Lawrence M. Leemis Stephen K. Park	Discrete-Event Simulation: A First Course	Pearson	First Edition
5.	Banks C M , Sokolowski J A	Principles of Modeling and Simulation	Wiley	2010

Course Code	Course Title							
2UCE719	User Experience Design							
	TH		P			TUT		Total
Teaching Scheme(Hrs.)	03		--			--		03
Credits Assigned	03		--			--		03
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course prerequisites (if any):
Software Engineering.

Course Objectives

The focus of this course is to introduce the learner to User Experience (UX) Design. User Experience design is design that is user centered. The goal is to design artifacts that allow the users to meet their needs in the most effective efficient and satisfying manner. Every digital interface/interaction (e.g. web and mobile application, car dashboard, smart appliance) is designed to solve a problem or to make our lives better, easier, more successful. User Interface (UI) design refers to the way the interface looks (the actual layout of its elements). User Experience (UX) design tackles how it feels to use the product (what do we do? how do we feel?). This course teaches the principles and practice of UI/UX design.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1 Understand the fundamentals of human-computer interaction and its impact on UX design.
CO2 Outline the importance of user centric design.
CO3 Illustrate the working of UX design process.
CO4 Analyze tools and techniques for prototyping and designing applications.
CO5 Summarize the applications of UX design.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to User Interface Design**		06	CO1
	1.1	What is user experience design? What makes up user experience? Evolution of UX Design, Elements of user experience, requirements, strategy, design principles, user centric design.		
2	**User Research and Journey**		12	CO2
	2.1	Types of users, problem formulation for users (stakeholders), need finding, planning and execution for a user centered design.		
	2.2	5S model, User research, user research goals, heuristic analysis, user personas, identifying and recruiting users for the research.		
	2.3	User research methodologies - Qualitative and Quantitative analysis, user interviews, focused group discussion, expert reviews, tools for user research.		
3	**UX Design Process**		10	CO3
	3.1	Defining the UX Design Process and its Methodology, Understanding user needs, Flow chart, Six stages of UX Design process.		
	3.2	The four quadrants of empathy map, emotional mapping using an empathy map, Design Thinking, Wicked problems, Ideation.		
4	**Wireframing and Prototyping.**		12	CO4
	4.1	Visual design principles, Interaction design, Information design and data visualization, Information architecture.		
	4.2	Wireframing and storyboards, Digital Designs, Elements and Widgets, Screen design and layout, prototyping tools.		
	4.3	Usability testing – types and process.		
5	**Applications and Future of UXD**		5	CO5
	5.1	Introduction to Augmented Reality (AR) and Virtual Reality (VR), UXD and XR, present and future of XR.		
		#Self-learning: Case studies on UXD.		
		Total	45	

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Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Don Bradman	The Design of Everyday Things	Basic Books	Reprint Edition 2002.
2.	Allan Cooper, Robert Reimann, David Cronin, Christopher Noessel.	About Face: The Essentials of Interface Design, 4ed (WILEY)	Wiley Publications.	4th Edition, 2016.
3.	Steve Krug	Don't Make Me Think, Revisited: A Common Sense Approach to Web Usability	Pearson Education	Third Edition, 2015.
4.	Daniel Kahneman	Thinking, Fast And Slow	Penguin Press	2012 Edition
5.	Russ Unger, Carolyn Chandler	A Project Guide to UX Design: For user experience designers in the field or in the making (Voices That Matter)	New Riders	2nd Edition, 2012.

Course Code	Course Title						
2UCE720	C# Programming and. Net Technology						
	TH		P		TUT		Total
Teaching Scheme(Hrs.)	03		--		--		03
Credits Assigned	03		--		--		03
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30*	20	50	--	--	--	--	100

Course prerequisites (if any):
Fundamentals of Object Oriented Programming concepts.

Course Objectives:

- Creating Form based application using WPF and .net Controls.
- Creating ASP.Net applications using standard .net controls.
- Connecting to data sources and managing them.
- Understand the fundamentals of developing modular application by using object oriented methodologies

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Course Outcomes

At the end of successful completion of the course the student will be able to

CO1	Understand .NET framework & fundamentals.
CO2	Implement object-oriented concept in C#.
CO3	Develop desktop applications & Multi-threaded programs in C#.
CO4	Implement ADO.NET and LINQ concept in C#.
CO5	Demonstrate the web application using ASP.NET.

*** The ISE and End Semester Exam is conducted in Lab for with Onscreen Mode with guidelines and instructions provided during/before the examination.**

Module no	Unit No	Details	Hrs.	CO
1		**Introduction of .NET framework, Language fundamentals and OOPs**	**5**	**CO1**
	1.1	Concepts .NET framework: What is .net, CLR, MSIL, JIT, CLS, CTS, Namespaces, Assembly		
	1.2	Language fundamentals: Data types, Operators, Conditional statements, Looping, statements, Arrays, Structures, and Enumerators		
	1.3	OOPs Concepts: Encapsulation, Abstraction, Inheritance, Overloading Class and object, Types of classes, Creating and using namespaces, passing arguments to methods – pass by in, out, param, address.		
2		**Working with Collections and File Handling Collection Classes**	**6**	**CO2**
	2.1	ArrsayList, Hash Table, Stack, Queue, Dictionaries etc. Working with Generic Collection Classes		
	2.2	File Handling: Introduction to streams, System.IO namespace, Path, File,and Directory classes,Reding And writing files, streamReader and streamWriter class.		
3		**Windows Forms and WPF**	**14**	**CO2,CO4**
	3.1	Introduction, Controls:, ToolTip, RichTexBox etc... Menus Strip, Toolbar Strip, Dialog box, MDI Applications, deploying windows application, Creating .dll file.		
	3.2	Introduction to WPF (Windows presentation Foundation), Control Menus, Layout, Input, Styles, Resources and theme, Data Binding, Control templates, Documents, Navigation based Application, Animation and media,		
	3.3	**Database programming with ADO.NET and LINQ** Overview of ADO.NET, Namespaces, Classes, Data retrieval methods – connected, disconnected, Data table, Dataset, Using the Data Controls, LINQ Architecture, LINQ to object, LINQ to SQL, LINQ to Dataset		
4		**Multithreading, XML and working with Excel in C#:**	**10**	**CO3**
	4.1	Multithreading : Introduction, Application Domains, Creating and Managing Threads, Threads Priority , Thread States, Thread Synchronization & Interthread Communication, Using Monitor		

	4.2	XML: Reading and Writing XML, Important Classes in the System.XML Namespace, Read and Write XML Nodes and Attributes.		
	4.3	Creating , Opening , Reading an Excel file in C# , Format an Excel file using C# , Insert a picture in excel from C# App , Insert a background picture in excel, Creating Excel Chart from C#, Export excel chart from C#, Export database to excel file, Export DataGridView to excel file		
5		**ASP.NET**	**10**	**CO5**
	5.1	ASP.NET Architecture, control based programming, ASP.NET working with DATA: Data Binding, State Management, Validation, Caching		
	5.2	ASP.NET Security: IIS 6 & IIS7 URL Authorization, Forms authentication, Role-based authorization, Trimming site maps with roles, Config file encryption, ASP.NET Membership, Resources and Internationalization		
	5.3	ASP.NET MVC, ASP.NET Ajax, ASP.NET Advanced Topics:		
	5.4	**#Self-learning:** HTTP pipeline, custom control, Web parts, Web Services		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Christian Nagel, Bill Evjen, Jay Glynn, Karli Watson, Morgan Skinner	Professional C# 2008	Wiley	1st , 2008
2.	Deitel	C# How to Program	Pearson	6th ,2016
3.	Mattew Macdonlads	Pro ASP.NET 3.5 in C# 2008	Apress	2nd, 2007
4.	Anne Boehm, Joel Murach	Murach's C# 2015	Mike Murach & Associates	6th Edition, 2016
5.	Matthew MacDonald	Pro WPF in C# 2008	Apress	3rd , 2009

Open Elective Technical

Course Code	Course Title						
2UST701	Genetic Algorithm and Applications						
	TH		P		TUT		Total
Teaching Scheme(Hrs.)	03		--		--		03
Credits Assigned	02		--		--		02
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	--	--	--	--	--	50

Course Objectives

The objective of this course is to introduce optimization techniques and application of genetic algorithms. The course also familiarizes students with the concepts of various operators and their implementation. Course mainly focuses on applying the genetic algorithm for a real life application.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1	Understand the concept of Genetic Algorithm
CO2	Describe Various Operators of GA
CO3	Understand the biological background and its technology
CO4	Solve and implement problem by GA techniques

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction**		07	CO
	1.1	Introduction, History, Basic concepts – Creation of Off springs		
	1.2	Working principle, Encoding – binary encoding – octal encoding – hexadecimal encoding, Permutation encoding- Value encoding		
	1.3	Tree encoding, Fitness function		
2	**GA Operators**		08	CO
	2.1	Reproduction, Roulette-wheel Selection – Boltzmann Selection- Tournament Selection, Rank Selection – Steady –state selection, Elitism – generation gap and steady-state selection		
	2.2	Inheritance operators –Crossover, Single-point crossover – Two-point cross over – Multi-point cross over, Uniform Cross over –Matrix Cross Over – Cross Over rate		
	2.3	Mutation operators, Mutation – Mutation rate		
3	**Genetic Modelling**		08	CO
	3.1	Inversion – deletion and duplication - deletion and regeneration, Segregation – crossover and inversion		
	3.2	Bit-wise operators – one's complement operator, Logical bit-wise operators, Shift operators – bit-wise operators used in GA		
	3.3	Generational cycle Derivation, Convergence of GA		
	3.4	Differences and Similarities between GA and Other Traditional Methods		
4	**Applications Of GA**		08	CO
	4.1	The rise of GA, GA application of Historical Interaction		
	4.2	Dejung & Function optimization, Current applications of GA		
	4.3	Techniques in genetic search :Dominance, Diploidy & abeyance, Multi objective optimization		
	4.4	Knowledge-Based Techniques, GA & parallel processes, Real Life Problem		
5	**Genetics-Based Machine Learning**		10	CO

	5.1	Genetics – Based Machined learning Classifier system, Rule & Message system		
	5.2	Apportionment of credit: The bucket brigade – Genetic Algorithm, A simple classifier system in Pascal		
	5.3	Results using the simple classifier system, The Rise of GBMC, Development of CS-1, the first classifier system		
	5.4	Smitch's Poker player, Applications		
#Self-Learning Topic- Multiobjective Evolutionary Optimization				
			45	

 # Students should prepare all Self Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	David E. Goldberg	*Genetic Algorithms in Search, Optimization and Machine Learning*	Pearson Education	2001
2.	S.Rajesekaran, G.A.Viijayalakshmi Pai	*Neural Networks, Fuzzy Logic and Genetic Algorithms*	Pearson Education	2003
3.	Banzhaf, Nordin, Keller and Francone, Morgan-Kaufmann	*Genetic Programming: An Introduction*	Morgan Kaufmann	February 1998
4.	Riccardo Poli, Willian B. Langdon, Nicholas Freitag McPhee	*A Field Guide to Genetic Programming*	Lulu.com	March 2008
5.	Clinton Sheppard	*Genetic Algorithms With Python*	Createspace Independent Pub	April 2016

Course Code	Course Title						
2UST702	Web Analytics and Web Intelligence						
	TH		P		TUT		Total
Teaching Scheme(Hrs.)	03		--		--		03
Credits Assigned	02		--		--		02
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	--	--	--	--	--	50

Course Objectives

Web Analytics is the measurement, collection, analysis, and reporting of Internet data for purposes of understanding and optimizing Web usage. Web Analytic is a tool that can measure Web site traffic. Businesses can also use it as a tool for business and market research.
Course includes definition and categories of Web Analytics, some examples of Web-based Analytics such as Google Analytics, and usage of EDDIE Tool.

Course Outcomes:

At the end of successful completion of the course the student will be able to

CO1 Know the concepts and terminologies related to web analytics.
CO2 Explore various parameters used for web analytics and their impact.
CO3 Explore the use of tools and techniques of web analytics.
CO4 Get experience on websites, web data insights and conversions.

Module No.	Unit No.	Details	Hrs.	CO
1	**Web Analytics**		08	CO 1
	1.1	Basics , Traditional Ways , Expectations		
	1.2	Data Collection , Clickstream Data , Weblogs , Beacons		
	1.3	JavaScript Tags , Packet Sniffing		
	1.4	Outcomes data , Competitive data , Search Engine Data		
2	**Qualitative Analysis**		08	CO1
	2.1	Customer Centricity ,Site Visits		
	2.2	Surveys , Questionnaires , Website Surveys, Post visits, Creating and Running, Benefits of surveys		
	2.3	Critical components of successful strategy		
3	**Web Analytic**		10	CO2
	3.1	URLS, Cookies, Time on site , Page views , Understand standard reports		
	3.2	Website content quality, Navigation reports (top pages, top destinations, site overlay)		
	3.3	Search Analytics , Internal search, SEO and PPC, Measuring Email and Multichannel Marketing		
	3.4	Competitive intelligence and Web 2.0 Analytics – Segmentation – Connectable reports		
4	**Google Analytics**		10	CO3
	4.1	Analytics , Cookies , Accounts vs Property		
	4.2	Tracking Code,Tracking Unique Visitors , Demographics		
	4.3	Page Views & Bounce Rate Acquisitions , Custom Reporting		
5	**Goals & Funnels**		09	CO4
	5.1	Filters , Ecommerce Tracking ,Real Time Reports,Customer Data Alert		
	5.2	Adwords Linking, Adsense Linking , Attribution Modeling		
	5.3	Segmentation ,Campaign Tracking , Multi-Channel Attribution		
#Self learning : Web Intelligence 4.1 EDDIE Tool				
		Total	45	

 # Students should prepare all Self Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Avinash Kaushik	Web Analytics 2.0: The Art of Online Accountability and Science Of Customer Centricity	Sybex	1st edition, 2009
2.	Michael Beasley	Practical Web Analytics for User Experience: How Analytics can help you Understand your Users	Morgan Kaufmann	2013.
3.	Magy Seif El-Nasr, Anders Drachen, Alessandro Canossa, eds.	Game Analytics: Maximizing the Value of Player Data	Springer	2013
4.	Bing Liu	Web Data Mining: Exploring Hyperlinks, Content, and Usage Data	Springer	2 nd Edition, 2011
5.	Justin Cutroni	Google Analytics	O'Reilly	2010
6.	Eric Fettman, Shiraz Asif, Feras Alhlou	Google Analytics Breakthrough	John Wiley & sons	2016

Course Code	Course Title						
2UST703	Reinforcement Learning						
	TH		P		TUT		Total
Teaching Scheme(Hrs.)	03		--		--		03
Credits Assigned	02		--		--		02
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	--	--	--	--	--	50

Course prerequisites:
Linear algebra
Probability and statistics
Multivariate calculus
Algorithms
Programming language such as Python

Course Objectives
1. Comprehension of fundamentals of reinforcement learning
2. Application of various RL methods for
3. Analysis using temporal difference and deep learning methods
4. Evaluation of various methods of RL for application development

Course Outcomes
At the end of successful completion of the course the student will be able to
CO1. Interpret fundamentals of Reinforcement learning methods
CO2. Apply various dynamic programming and Monte-Carlo methods
CO3. Analyze for information extraction using RL methods.
CO4. Evaluate the synthesized information for statistical interpretation.
CO5. Design and develop RL based applications.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Reinforcement Learning**		08	CO 1
	1.1	Elements of Reinforcement Learning		
	1.2	Markov Decision Processes to solve real-world problems, Policies and value functions		
	1.3	Derivation of Bellman equations		
2	**Dynamic Programming and Monte Carlo Methods**		10	CO2
	2.1	Iterative policy evaluation, Policy improvement, Policy iteration and value iteration		
	2.2	Evolutionary algorithms, stochastic policy search, Reinforce algorithm		
	2.3	Classic Monte Carlo prediction and control methods, Greedy and epsilon-greedy policies, Exploration-Exploitation Dilemma and its solutions		
3	**Temporal Difference Learning**		10	CO3
	3.1	Q-Learning		
	3.2	Generalization		
	3.3	Sarsa-Learning		
4	**Deep Learning with PyTorch**		08	CO4
	4.1	Building and training neural networks and convolutional neural networks in PyTorch.		
	4.2	Deep Deterministic Policy Gradients (DDPG) algorithm		
	Self-Learning Topic: Study of Deep Convolutional Neural Network (DCNN)			
5	**Deep Q-Learning**		09	CO 5
	5.1	Extend value-based reinforcement learning methods to complex problems using deep neural networks		
	5.2	Deep Q-Network (DQN), Double-DQN, Dueling-DQN, and Prioritized Replay		
	5.3	Introduction to Multi-Agent RL, Deep RL applications in Gaming, Robotics, etc.		
	Self-Learning Topic: Deep learning model design using Python library functions from Tensorflow and Keras			
		Total	45	

*** Term-Work will consist of Tutorials covering entire syllabus. Students will be graded based on continuous assessment of their term work**

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Stuart Russell and Peter Norvig	Artificial Intelligence: A Modern Approach	Pearson	3 rd edition, 2010
2.	Robert Tibshirani, and Jerome Friedman	The Elements of Statistical Learning, Trevor Hastie	Springer	2nd edition, 2009
3.	M. Gopal	Applied Machine Learning	Mc-Graw Hill Education India Pvt. Ltd.	Print edition: ISBN-13: 978-93-5316-025-8,
4.	Chris Bishop	Pattern recognition and machine learning (PRML)	Springer	ISBN-13: 978-0387-31073-2, 2006
5.	Hal Daume III	Primary reference: A course in machine learning	CIML	2012

Course Code	Course Title							
2UST704	Massive Graph Analysis							
	TH			P		TUT		Total
Teaching Scheme(Hrs.)	03			--		--		03
Credits Assigned	02			--		--		02
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	--	--	--	--	--	50

Course Objectives

1. To explore the concept of Graphs and related algorithms
2. To learn new ways to model, store, retrieve and analyze graph-structured data.
3. To understand the advanced concepts in graph analytic techniques and its applications.

Course Outcomes

At the end of successful completion of the course the student will be able to

1. Explore graph analytics techniques and its applications
2. Model a problem into a graph database
3. Analyze the graph in a scalable manner.
4. Apply Graph theoretical techniques in a massive network

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction - Large Scale Graphs**		**5**	**CO**
	1.1	Characteristics of large scale graph, Complex data sources, Social Networks, Simulations, Bioinformatics; Categories- Social, Endorsement, Location, Cooccurrence graphs; Graph Data structures, Parallel, Multicore, & Multithreaded Architectural Support for Graph Processing, Mapping Graph Algorithms to Architectures, applications of large scale graphs		
2	**Basic and Advanced Large-scale Graph Analysis**		**12**	**CO**
	2.1	Parallel Prefix & List Ranking, Link Analysis, Page Ranking Algorithms		
	2.2	Parallel BFS, Spanning Tree, Connected Components, Minimum Spanning Tree Matroid Algorithms		
	2.3	Social Networking Algorithms, Parallel Betweenness Centrality.		
3	Dynamic Parallel Algorithms		**10**	**CO**
	3.1	Streaming Data Analysis -Data Structures for Streaming Data -Tracking Clustering Coefficients -		
	3.2	Tracking Connected Components -Anomaly Detection, Massive-Graphs in Computational Biology, Genome Assembly.		
		#Self –learning : Clustering algorithms for graph data		
4	Distributed Computation for Massive Data Sets		**8**	**CO**
	4.1	Spectral, Modularity-based Clustering, Random Walks; Large Graph Representation and Implementation- V-Graph Representation, Map Reduce, Surfer, Graph Lab.		
		#Self-Learning: Query language and access method for graph databases		
5	Advanced Massive Graph Analysis		**10**	**CO**

	5.1	Power Law Distribution, Game-Theoretic Approach, Rank Aggregation and Voting Theory, Recommendation Systems, Social network analysis: case study -Facebook, LinkedIn, Google+, and Twitter.		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Matthew O. Jackson	Social and Economic Networks	Princeton University Press	2010
2.	Stanley Wasserman, Katherine Faust	Social Network Analysis: Methods and Applications	Cambridge University Press	1995
3.	Tanja Falkowski,	Community Analysis in Dynamic Social Networks	University Magdeburg	2009
4.	Ladislav Novak, Alan Gibbons	Hybrid Graph Theory and Network Analysis	Cambridge Tracts in Theoretical Computer Science	2009
5.	Eric D. Kolaczyk	Statistical Analysis of Network Data Methods and Models	Springer Series in Statistics	2009
6.	Charu. C. Aggarwal, Haixun Wang	Managing and mining graph data	Springer-Verlag New York Inc.	2010

Course Code	Course Title							
2USH701	Open Elective Humanities/Management/Swayam NPTEL Course (8 weeks)							
	TH		P		TUT		Total	
Teaching Scheme(Hrs.)	02		--		--		02	
Credits Assigned	02		--		--		02	
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	--	--	--	--	--	50

Course Code	Course Title							
2UCP701	PROJECT I							
	TH		P		TUT		Total	
Teaching Scheme(Hrs.)	--		06		--		03	
Credits Assigned	--		06		--		03	
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	--	--	--	25	25	--	--	50

*Based on periodic assessment of progress of project.
%- For Students opting for one semester internship for semester VIII, project I will not continue to Project II.

Course Outcomes:
After successful completion of the course the student will be able to :
CO1. Identify and formulate problem definition of real world Problems.
CO2. Design hardware and software components and systems to meet specifications of identified problem.
CO3. Apply project management principles to plan the execution of entire project work.
CO4. Use hardware and software tools for efficient implementation of project work.

Term work:
The final year students have experienced project in their second and third year in Mini Project course. In final year, a group of maximum four students will be completing a comprehensive project work. Project work may be internally assigned or may be externally assigned by the research institutes, industry etc. Each group will be assigned one faculty advisor / guide. This project work in final year may be extension of the Mini Project work done in pre-final year. The students may choose their problem statements in consultation with faculty members. The main intention of Project work is to enable students to apply the knowledge and skills learned out of courses studied to solve/implement predefined practical problem. The Project work may be beyond the scope of curriculum of courses taken or may be based on the courses but thrust should be

- Learning additional skills
- Ability to define, design, analyze and implement the solution to problems
- Learn the behavioral science by working in a group
- The project area may be selected in which the student intends to do further education and/or may be either intend to have employment or self-employment
- The topic of project should be different and / or may be advancement in the same topic of Mini Project
- The students may use this opportunity to learn different computational techniques / software tools / platforms etc. as well as some model development.

Students are expected to report to the faculty advisor about the progress of the work. A continuous assessment record of the progress of the project will be maintained by concerned faculty members The TW will be examined by approved internal faculty appointed by the head

of the institute. A Report in prescribed format must be submitted. The oral examination is a presentation by the group members on the project along with demonstration of the work done. In the examination each individual student will be assessed for his/her contribution, understanding and knowledge gained. There will also be an intermediate evaluation at the mid of the semester by a panel of examiners.

Course Code	Course Title							
2UCL701	Project Management Lab							
	TH		P		TUT		Total	
Teaching Scheme(Hrs.)	--		02		--		02	
Credits Assigned	--		01		--		01	
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	--	--	--	25	25	--	-	50

Term Work:
Note: The faculty should conduct 8-10 experiments and case study based on the syllabus.
Term Work will consist of Practical covering entire syllabus of "Project Management".
Students will be graded based on continuous assessment of their term work.
Practical which will demonstrate the Project Management concepts

Course Code	Course Title							
2UCEL711	Big Data Analytics lab							
	TH			P		TUT		Total
Teaching Scheme(Hrs.)	--			02		--		02
Credits Assigned	--			01		--		01
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	--	--	--	25	25	--	-	50

Term Work:
Note: The faculty should conduct 8-10 experiments and case study based on the above syllabus.
The programs should be implemented in C, C++, Java or Python.
Term Work will consist of Practical covering entire syllabus of "Big Data Analytics". Students will be graded based on continuous assessment of their term work.
Practical which will demonstrate the big data analytics concepts.

Course Code	Course Title							
2UCEL712	Data Science Lab							
	TH		P		TUT		Total	
Teaching Scheme(Hrs.)	--		02		--		02	
Credits Assigned	--		01		--		01	
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	--	--	--	25	25	--	-	50

Term Work:
Note: The faculty should conduct 8-10 experiments and case study based on the syllabus. Term Work will consist of Practical covering entire syllabus of "Data Science". Students will be graded based on continuous assessment of their term work.
Practical which will demonstrate the Data Science concepts

Course Code	Course Title							
2UCEL713	Cloud Computing and Emerging technology Lab							
	TH			P		TUT		Total
Teaching Scheme(Hrs.)	--			02		--		02
Credits Assigned	--			01		--		01
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	--	--	--	25	25	--	-	50

Term Work:

Note: The faculty should conduct 8-10 experiments and case study based on the syllabus.

Term Work will consist of Practical covering entire syllabus of "Cloud Computing and Emerging Technology". Students will be graded based on continuous assessment of their term work.

Practical which will demonstrate the Cloud Computing and Emerging Technology concepts

Course Code	Course Title							
2UCEL714	Block Chain Technology Lab							
	TH		P		TUT		Total	
Teaching Scheme(Hrs.)	--		02		--		02	
Credits Assigned	--		01		--		01	
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	--	--	--	25	25	--	-	50

Term Work:
Note: The faculty should conduct 8-10 experiments and case study based on the syllabus.
Term Work will consist of Practical covering entire syllabus of "Block Chain Technology".
Students will be graded based on continuous assessment of their term work.
Practical which will demonstrate the Block Chain Technology concepts

Course Code	Course Title							
2UCEL715	Cyber Security, forensic and Cyber Law Lab							
	TH			P		TUT		Total
Teaching Scheme(Hrs.)	--			02		--		02
Credits Assigned	--			01		--		01
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	--	--	--	25	25	--	-	50

Term Work:
Note: The faculty should conduct 8-10 experiments and case study based on the syllabus.
Term Work will consist of Practical covering entire syllabus of "Cyber Security, Forensic and Cyber Law". Students will be graded based on continuous assessment of their term work.
Practical which will demonstrate the Cyber Security, Forensic and Cyber Law concepts

Course Code	Course Title							
2UCEL716	Computer Vision Lab							
	TH		P		TUT		Total	
Teaching Scheme(Hrs.)	--		02		--		02	
Credits Assigned	--		01		--		01	
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	--	--	--	25	25	--	-	50

Term Work:
Note: The faculty should conduct 8-10 experiments and case study based on the syllabus.
Term Work will consist of Practical covering entire syllabus of "Computer Vision". Students will be graded based on continuous assessment of their term work.
Practical which will demonstrate the Computer Vision concepts

Course Code	Course Title							
2UCEL717	GIS and Spatial Computing Lab							
	TH			P		TUT		Total
Teaching Scheme(Hrs.)	--			02		--		02
Credits Assigned	--			01		--		01
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	--	--	--	25	25	--	-	50

Term Work:
Note: The faculty should conduct 8-10 experiments and case study based on the syllabus. Term Work will consist of Practical covering entire syllabus of "GIS and Spatial Computing". Students will be graded based on continuous assessment of their term work. Practical which will demonstrate the GIS and Spatial Computing concepts

Course Code	Course Title							
2UCEL718	Computer Simulation and Modeling Lab							
	TH			P		TUT		Total
Teaching Scheme(Hrs.)	--			02		--		02
Credits Assigned	--			01		--		01
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	--	--	--	25	25	--	-	50

Term Work:
Note: The faculty should conduct 8-10 experiments and case study based on the syllabus. Term Work will consist of Practical covering entire syllabus of "Computer Simulation and Modeling". Students will be graded based on continuous assessment of their term work. Practical which will demonstrate the Computer Simulation and Modeling concepts

Course Code	Course Title							
2UCEL719	User Experience and Design Lab							
	TH			P		TUT		Total
Teaching Scheme(Hrs.)	--			02		--		02
Credits Assigned	--			01		--		01
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	--	--	--	25	25	--	-	50

Term Work:
Note: The faculty should conduct 8-10 experiments and case study based on the syllabus. Term Work will consist of Practical covering entire syllabus of "User Experience and Design". Students will be graded based on continuous assessment of their term work. Practical which will demonstrate the User Experience and Design concepts

Course Code	Course Title							
2UCEL720	C# Programming and .Net Technology Lab							
	TH		P		TUT		Total	
Teaching Scheme(Hrs.)	--		02		--		02	
Credits Assigned	--		01		--		01	
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	--	--	--	25	25	--	-	50

Term Work:
Note: The faculty should conduct 8-10 experiments and case study based on the syllabus. Term Work will consist of Practical covering entire syllabus of "C# Programming and .net Technology". Students will be graded based on continuous assessment of their term work. Practical which will demonstrate the C# Programming and .net Technology concepts

Semester VIII
B.Tech Computer Engineering
(KJSCE 2018)

LY BTech VIII Semester

Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) TH – P – TUT	Total (Hrs.)	Credits Assigned TH – P – TUT	Total Credits	Course Category
2UCP801	Project- II/ Semester long Internship	0 – 14 – 0	14	0 – 7 – 0	7	PR
UECE81X	Departmental Elective- V / Swayam NPTEL course*	3 – 0 – 0	3	3 – 0 – 0	3	PE
UECE82X	Departmental Elective- VI/ Swayam NPTEL course*	3 – 0 – 0	3	3 – 0 – 0	3	PE
Total		6 – 14 – 0	20	6 – 7 – 0	13	--

*For students selected for semester long internship

Examination Scheme

Course Code	Course Name	Examination Scheme							
		Marks							
		CA		ESE	TW	O	P	P&O	Total
		ISE	IA						
2UCP801	Project- II/ Semester long Internship	--	--	--	100	100	--	--	200
2UCE81X	Departmental Elective- V / Swayam NPTEL course*	30	20	50	--	--	--	--	100
2UCE82X	Departmental Elective- VI/ Swayam NPTEL course*	30	20	50	--	--	--	--	100
Total		**600**	**40**	**100**	**100**	**100**			**400**

Departmental Elective – V & VI for VIII Semester			
Course Code	**Name of Electives**	**Course Code**	**Name of Electives**
2UCE811	Bioinformatics	2UCE812	Game Programming
2UCE813	Advanced Algorithms: Design and Analysis	2UCE814	IoT Security
2UCE815	Internet of Everything	2UCE816	Cyber Physical System
2UCE817	Deep Learning	2UCE818	Speech and Language Processing
2UCE819	Software Architecture and Design Thinking	2UCE820	High Performance Computing

Course Code	Course Title							
2UCP801	PROJECT – II / Semester Long Internship$							
	TH			P		TUT		Total
Teaching Scheme(Hrs.)	--			14		--		14
Credits Assigned	--			07		--		07
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	--	--	--	100	100	--	--	200

*Based on periodic assessment of progress of project/ Internship

Course Outcomes:

After successful completion of the course the student will be able to :

CO1. Design, implement and test the hardware / software components of system to meet desired specifications
CO2. Analyze, interpret results and correspondingly modify the designed system/ components to achieve desired results.
CO3. Identify limitations of work done and suggest scope for future development.
CO4. Write technical report and present the work done in appropriate format.
CO5. Demonstrate individual, group and leadership skills during project execution

Term work:

The final year students have already under gone project assignment in their seventh semester and in this semester the students are expected to continue the project work of stage I. Students are expected to report to the faculty advisor about the progress of the work. A continuous assessment record of the progress of the project will be maintained by concerned faculty members. The TW should be examined by approved internal faculty appointed by the head of the institute on the basis of following:

- Scope and objective of the project work.
- Extensive Literature survey.
- Progress of the work (Continuous assessment)
- Design, implementation, and analysis of the project work.
- Results, conclusions and future scope.
- A Technical Report in prescribed format.

An approved external examiner and internal examiner appointed by the head of the institute together will assess during oral examination. The oral examination is a presentation by the group members on the project along with demonstration of the work done. In the examination each individual student should be assessed for his/her contribution, understanding and knowledge gained. There will also be an intermediate evaluation at the mid of the semester by a panel of examiners.

$ - Semester Long Internship Policy (SLIP) will be applicable for Semester Long Internship

Departmental Elective - V and VI

Course Code	Course Title						
2UCE811	Bioinformatics						
	TH		P		TUT		Total
Teaching Scheme(Hrs.)	03		--		--		03
Credits Assigned	03		--		--		03
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course prerequisites (if any):
Basic concepts of Programming

Course Objectives

The objective of this course will be to introduce students to the fundamentals of molecular biology and recent advances in genomics technology. The development of bioinformatics as an interdisciplinary field has introduced many sophisticated tools and techniques, to organize the information associated with biological molecules and contribute to our understanding of biological processes. On a larger scale, this has led to many practical applications, not only providing greater depth to biological research but also adding other dimensions to engineering applications. This course also aims to provide students with a practical and hands-on experience with common bioinformatics tools and databases.

Course Outcomes
At the end of successful completion of the course the student will be able to

CO1 Understand the scope of Bioinformatics
CO2 Understand popular bioinformatics database
CO3 Learn Fundamentals of Databases and Sequence alignment
CO4 Process, analyze, and manage biological information through Machine Learning Algorithms.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Bioinformatics**		**08**	**CO 1**
	1.1	Bioinformatics- History, Computational biology, Biological computing, Applications		
	1.2	Human Genome Project: History, Significance & applications. Introduction to important bioinformatics databases (NCBI, Uniprot, PDB and others)		
2	**Algorithms for biological sequence analysis**		**09**	**CO2**
	2.1	Introduction to python for bioinformatics, Visualization of Genomics, Sequencing technologies: Overview, Genome Assembly, Genome Annotation, Comparing Genomes		
	2.2	Pairwise sequence analysis, Multiple sequence analysis		
3	**Introduction to protein structure prediction**		**08**	**CO3**
	3.1	Predictive methods using protein sequences – protein identification, physical properties, motifs and patterns		
	3.2	3D structure prediction techniques, structure classification, Secondary structure prediction**,** Tertiary structure prediction		
4	**Machine Learning for Bioinformatic**s		**12**	**CO4**
	4.1	Intelligent systems, Hidden Markov model(HMM), Bayesian network(BN), Symbolic machine learning(Decision and identification trees), Application of Artificial intelligence(AI) for bioinformatics,		
	4.2	Application of Artificial intelligence (AI) for bioinformatics, Artificial neural network (ANN), Stochastic context free grammar(SCFG), Genetic and Lamarckian algorithms.		
5	**Applications of Bioinformatics**		**08**	**CO4**
	5.1	Secondary Structure Prediction of Protein Secondary structure: basic principles on which the prediction methods of first, second and third generation are based		
	5.2	Algorithm of Chou-Fasman, GOR methods, other methods, predicting secondary structures using these methods and analysis		
	5.3	Concepts in measuring the accuracy of prediction (Q3, segment overlap, Mathew's correlation coefficient etc.)		
		#Self learning : Comparative and Functional Genomics		
		Total	**45**	

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Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Pierre Baldi	Bioinformatics: The Machine Learning Approach (Adaptive Computation and Machine Learning series	Bradford	2008
2.	Dan E. Krane	Fundamental Concepts of Bioinformatics	Pearson	2009
3.	Andreas Baxevanis	Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins	Wiley-Interscience	2001

Course Code	Course Title							
2UCE812	Game Programming							
	TH			P		TUT		Total
Teaching Scheme(Hrs.)	03			--		--		03
Credits Assigned	03			--		--		03
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course prerequisites (if any):
Computer Graphics, Mathematics, Basic Physics, Data Structure and Algorithms

Course Objectives
Understand the concepts of Game design and development. Learn the processes, mechanics and issues in Game Design. Be exposed to the Core architectures of Game Programming. Know about Game programming platforms, frame works and engines.

Course Outcomes
At the end of successful completion of the course the student will be able to

CO1	Understand and choose appropriate game architecture
CO2	Design a game using appropriate development environment
CO3	Implement a game with detailed components
CO4	Optimize, debug and publish an ethical games

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to game programing**		**04**	**CO1**
	1.1	Game Architecture Applying the Game Architecture Application Layer Game Logic Game View for the Human Player Game Views for AI Agents Networked Game Architecture Design Philosophy of DirectX		
2	**Hardcore Game Programming**		**03**	**CO 2**
	2.1	Introduction to Game Design Data Structures and Algorithms for Game Programming The Mathematical Side of Games Introduction to Physics Modeling		
3	**Building Your Game**		**10**	**CO 2**
	3.1	Creating a Project Source Code Repositories and Version Control Building the Game: A Black Art? Creating Build Scripts Game Initialization and Shutdown		
4	**Game Actors and Component Architecture and Controlling the Main Loop**		**15**	**CO3**
	4.1	Game Actors and Component Architecture A First Attempt at Building Game Actors Component Architecture Creating Actors and Components Defining Actors and Components Storing and Accessing Actors Putting It All Together Data Sharing		
	4.2	Controlling the Main Loop Organizing the Main Loop Playing Nicely with the OS Using the DirectX Can I Make a Game Yet? Creating Game Mission** **#Self Learning :** Creating Sound		
5	Loading and Caching , optimization , debugging and publishing		**13**	**CO**
	5.1	Loading and Caching Game Data Game Resources: Formats and Storage Requirements Resource Files The Resource Cache Out of Cache		
	5.3	Optimization and Debugging The Art of Handling Failure		

		Debugging Basics Graphics and Shader Debugging Debugging Techniques Building an Error Logging System . Different Kinds of Bugs Profiling Game Publishing		
	5.3	Game engine, Game Server and Client		
	5.4	The Ethics of Computer Games Applying Ethics Unethical Game Content and Effect Studies The Ethics of Game Design		
		#Self learning : Case Studies: Ethical and Unethical games		
		Total	**45**	

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Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Mike “MrMike” McShaffry and David “Rez” Graham	Game Coding Complete	Cengage Learning. USA	Fourth Edition 2013
2.	André LaMoth	Game Programming All in One	Premier Press, Inc, USA	Second Edition , 2002

Course Code	Course Title						
2UCE813	Advanced Algorithms: Design and Analysis						
	TH		P		TUT		Total
Teaching Scheme(Hrs.)	03		--		--		03
Credits Assigned	03		--		--		03
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course prerequisites (if any): Data structures, Analysis of algorithms

Course Objectives

This course is concerned with the study of algorithms for solving practical problems efficiently, and the theoretical analysis of their performance. There will also be a brief introduction to complexity theory, the formal study of algorithm performance. The algorithm categories considered for study are greedy algorithms, dynamic programming, network flow algorithms, graph algorithms, intelligent algorithms and approximation algorithms.

The goal of this course is to develop the appropriate background, foundation and experience for advanced study in Computer algorithms and their performance. Students will develop the necessary skills from both a theoretical perspective as well as applying their knowledge on various problem solving strategies.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1	Derive complexity of algorithms using various techniques
CO2	Analyze and solve problems for various problem solving strategies
CO3	Solve path computation and network flow problems using various approaches
CO4	Identify appropriate data structure and design techniques for different problems
CO5	Analyze performance of randomization and intelligent algorithms over traditional solutions

Module No.	Unit No.	Details of Topic	Hrs	CO
1		**Introduction to analysis of Algorithms**		CO 1
	1.1	Design and Analysis Fundamentals, Performance analysis, space and time complexity, classes of Problems	9	
	1.2	Growth of a function: Big Oh,, Omega, theta notation, Mathematical Background for algorithm analysis, recursive algorithms		
	1.3	Algorithm analysis: Master's theorem, Substitution and Recursion tree methods		
2		**Algorithmic strategies for problem solving**		CO 2
		Divide and Conquer, Greedy strategy, Dynamic Algorithms, backtracking, branch and bound : Searching and Sorting, Travelling Salesman problem, 0/1 Knapsack, Matrix Chain Multiplication, 8 queens problem	10	
3		**Graph algorithms**		CO 3
	3.1	Path computation algorithms: Floyd Warshall shortest path algorithm, Johnson's method	9	
	3.2	Flow Networks: The Ford Fulkerson method, maximum bipartite matching, Push relabel algorithms, The relabel to front algorithm		
4		**Advanced Data Structure**		CO 4
	4.1	Introduction to trees and heap Red-Black Trees: properties of red-black trees ,Operations on Red-black trees	9	
	4.2	Binomial Heaps: Binomial trees and binomial heaps, Operation on Binomial heaps		
5		**Randomization and Intelligent Algorithms**		CO 5
	5.1	Randomized quick sort, Las Vegas algorithm, Monte Carlo algorithm	8	
	5.2	MinMax, Alpha-Beta Pruning, Facebook graph search		
	#Self learning : Approximation Algorithms			
		Total	**45**	

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Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein	Introduction to Algorithms	PHI, India	Second Edition
2	Rajeev Motwani, Prabhakar Raghavan,	Randomized Algorithm	Cambridge University Press	First Edition/ South Asia Edition
3	Peter Norvig and Stuart J. Russell	Artificial Intelligence: A Modern Approach	Pearson Education	5th Edition
4	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein,	Introduction to Algorithms	PHI	2nd Edition
5	Horowitz, Sahani and Rajsekaran	Fundamentals of Computer Algorithms	Galgotia	2nd Edition
6	Harsh Bhasin,	Algorithms – Design and Analysis‖,	Oxford	1st Edition, 2015

Course Code	Course Title						
2UCE814	IoT Security						
	TH		P		TUT		Total
Teaching Scheme(Hrs.)	03		--		--		03
Credits Assigned	03		--		--		03
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course prerequisites (if any): Microcontroller and embedded system, Security

Course Objectives

To expose students to new developments in the areas of cybersecurity for the Internet of Things (IoT).

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1 Understand IoT background in terms of applications and challenges
CO2 Analyze possible approaches and practices to meet IoT security challenges
CO3 Comprehend proposed frameworks to address IoT security

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to IoT**		**12**	**CO 1**
	1.1	The Internet of Things Today and Tomorrow		
	1.2	Characteristics of IoT		
	1.3	IoT Layered Architecture		
	1.4	IoT Function View		
	1.5	IoT Application Areas and IoT Smart-X Applications		
	1.6	Security, Privacy and Trust		
2	**IoT challenges**		**08**	**CO1**
	2.1	IoT Threats to Individuals and Organizations		
	2.2	IoT challenges for Governance, Security and Privacy		
	2.3	Challenges to Secure IoT Deployments		
		#Self-Learning –Readings: Internet of Things – New security and privacy challenges-Paper by Rolf H. Weber		
3	**Recommended Security Approaches**		**08**	**CO2**
	3.1	Analyze privacy impacts to stakeholders and adopt a Privacy-by-Design approach to IoT development and deployment		
	3.2	Threat Modeling		
	3.3	Implement layered security protections to defend IoT assets		
	3.4	Define Life Cycle Security Controls for IoT devices		
		#Self-Learning – Readings: IoT System Security Issues and Solution Approaches (Paper)		
4	**Implement data protection best practices to protect sensitive information**		**03**	**CO 3**
	4.1	Data Management		
		Data Identification, Classification, Security		
		#Self-Learning- Readings: Security of Smart Objects in IOT		
5	**IoT Security Framework**		**08**	**CO 3**
	5.1	Dynamic Context- Aware Scalable and trust-based IoT Security, Privacy Framework- Concepts and Motivation of		

		Framework		
	5.2	A Policy-based Framework for Security and Privacy in IoT		
	5.3	An authentication/authorization framework for the organization's IoT Deployments		
	5.4	A Logging and Audit Framework for the Organization's IoT Ecosystem		
6	**OWASP – IoT**		**06**	**CO 3**
	6.1	OWASP IoT Top Ten Attacks, IoT Vulnerabilities		
	6.2	IoT Framework assessment		
	6.3	IoT Security Guidance		
		Total	**45**	

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Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Marina Ruggieri, Homayoun Nikookar,	"Internet of Things - From Research and Innovation to Market"	River Publisher,	2014
2.	Sebastien Ziegler	"Internet of Things security and data protection"	Springer	2017
3.	Shancang Li,Li Da Xu	"Securing the Internet of Things"	Syngress	April 2015
4.	Sridipta Misra, Salman Hashmi, Muthucumaru Maheswaran	Security Challenges and Approaches in Internet of Things	Springer	Sept 2016
5.	Sunil Cheruvu, Ned Smith, Anil Kumar, David M. Wheeler	Demystifying Internet of Things Security: Successful IoT Device/Edge and Platform Security Deployment	Apress Open	August 2019

Course Code	Course Title							
2UCE815	Internet of Everything							
	TH		P		TUT		Total	
Teaching Scheme(Hrs.)	03		--		--		03	
Credits Assigned	03		--		--		03	
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course prerequisites (if any):
Microcontroller and Embedded system

Course Objectives
The objectives of this course are to learn concepts of Internet of things and analyze IoT application data using Analytics for designing and developing small IOT applications.

Course Outcomes
At the end of successful completion of the course the student will be able to

CO1 Interpret the Internet of Things concepts and challenges
CO2 Evaluate the software and hardware platforms for IoT Technologies
CO3 Analyze IoT application data using IoT Analytics.
CO4 Design and develop small IoT applications.

Module No.	Unit No.	Details	Hrs.	CO
1		**Introduction to Internet of Things**	**04**	**CO1**
	1.1 1.2 1.3.	Physical Design Logical Design IoT Enabling Technologies		
2		**Domain Specific IoTs**	**10**	**CO1**
	2.1 2.2 2.3 2.4	Home Automation. Environment, Energy Retail & Logistics Health & Life Style		
3		**IoT & M2M**	**05**	**CO2**
	3.1 3.2	Difference Between IoT & M2M SDN & NFV for IoT		
4		**IoT Physical Devices**	**10**	**CO2**
	4.1 4.2 4.3 4.4 4.5	Basic Arduino Programming Extended Arduino Libraries, Arduino – Based Internet Communication, Raspberry PI Sensors and Interfacing.		
5		**IoT design Methodology**	**07**	**CO4**
	5.1 5.2	Generic Design Methodology Application Development Steps		
6		**IOT Analytics**	**05**	**CO3**
	6.1 6.2 6.3	Business Process in IoT IoT Analytics with cloud Edge analytics		
7		**Self learning :Case Study**	**04**	**CO4**
	7.1 7.2 7.3	Agriculture Industrial Application Cities		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Arshdeep Bhaga and Vijay Madisetti	"Internet of Things (A Hands-on-Approach)",University Press	Tata McGraw-Hill ,India	4th edition ,2015
2.	Hakima Chaouchi	"The Internet of Things (Connecting objects to the web)"	Wiley publication	1st edition,2014
3.	Hakim Cassimally and Adrian McEwen	" Designing the Internet of things"	Wiley publication	1st edition,2013
4.	Marina Ruggieri, Homayoun Nikookar,	"Internet of Things - From Research and Innovation to Market"	River Publisher,	1st edition,2014
5.	Ahriram K Vasudevan,Abhishek Nagarajan,RMD Sundaram	Internet of Things	Wiley Publication	1st edition ,2019

Course Code	Course Title						
2UCE816	Cyber Physical System						
	TH		P		TUT		Total
Teaching Scheme(Hrs.)	03		--		--		03
Credits Assigned	03		--		--		03
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	--	--	--	--	--	50

Course Objectives

CPS mainly consists of physical systems tightly integrated and/or controlled by software, are ubiquitous in many safety critical domains, including automotive, avionics, railways, healthcare, atomic energy, power, and industrial automation. The principles of design and implementation of cyber-physical systems are remarkably different from that of other embedded systems because of the tight integration of real valued and dense time real time systems with software based discrete automated control. The objective of this course is to develop an exposition of the challenges in implementing a cyber-physical system from a computational perspective, but based equally on the principles of automated control. The course aims to expose the student to real world problems in this domain and provide a walk through the design and validation problems for such systems.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1	Understand the basic principles of CPS
CO2	Identify the CPS components and relevant dynamical aspects
CO3	Develop an exposition of the challenges in implementing a cyber-physical system
CO4	Understand Intelligent CPS models and controls
CO5	Understand CPS security and safety aspects

Module No.	Unit No.	Details	Hrs.	CO
1	Introduction to Cyber-Physical Systems		2	
	1.1	Cyber-Physical Systems (CPS) in the real world, Basic principles of design and validation of CPS, Industry 4.0, AutoSAR, IIOT implications, Building Automation, Medical CPS		
2	**CPS Components**		10	
	2.1	**CPS - Platform components** – CPS HW platforms - Processors, Sensors, Actuators, CPS Network - WirelessHart, CAN, Automotive Ethernet, Scheduling Real Time CPS tasks		
	2.2	**Principles of Dynamical Systems-** Dynamical Systems and Stability, Controller Design Techniques, Performance under Packet drop and Noise		
3	**CPS implementation issues**		12	
	3.1	From features to automotive software components, Mapping software components to ECUs, CPS Performance Analysis - effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion, BUilding real-time networks for CPS		
4	**Intelligent CPS**		10	
	4.1	Safe Reinforcement Learning- Robot motion control, Autonomous Vehicle control, Gaussian Process Learning- Smart Grid Demand Response, Building Automation		
5	**Secure Deployment of CPS**		11	
	5.1	Secure Task mapping and Partitioning, State estimation for attack detection, Automotive Case study : Vehicle ABS hacking, Power Distribution Case study : Attacks on SmartGrids		
		#Self-Learning: Latest trends in CPS, Securing CPS systems using ML		
		Total	45	

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Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	E. A. Lee, Sanjit Seshia	Introduction to Embedded Systems – A Cyber–Physical Systems Approach	MIT Press	Second Edition, 2017
2.	Rajeev Alur	Principles of Cyber-Physical Systems	MIT Press	Kindle Edition , 2015
3.	Andr´e Platzer	Logical Analysis of Hybrid Systems: Proving Theorems for Complex Dynamics	Springer	Kindle Edition, 2010
4.	Houbing Song, Danda B. Rawat, Sabina Jeschke, Christian Brecher	Cyber-Physical Systems: Foundations, Principles and Applications	Academic Press	Ist Edition, 2016
5.	Houbing Song, Glenn A. Fink, Sabina Jeschke	Security and Privacy in Cyber-Physical Systems: Foundations, Principles, and Applications	Wiley-IEEE Press	1st Edition, 2017

Course Code	Course Title							
2UCE817	Deep Learning							
	TH		P		TUT		Total	
Teaching Scheme(Hrs.)	03		--		--		03	
Credits Assigned	03		--		--		03	
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course prerequisites:

Linear Algebra, Calculus (vectors, matrices, basic integrals), Probability (Bayes theorem, expectation, variance)&Basic machine learning (linear models, regression, decision trees)

Course Objectives:

This course covers the basics of machine learning, neural networks and deep learning. Model for deep learning technique and the various optimization and generalization mechanisms are included. Major topics in deep learning and dimensionality reduction techniques are covered. The objective of this course is:

1. To present the mathematical, statistical and computational challenges of building neural networks
2. To study the concepts of deep learning
3. To introduce dimensionality reduction techniques
4. To enable the students to know deep learning techniques to support real-time applications
5. To examine the case studies of deep learning techniques

Course Outcomes:

At the end of successful completion of the course the student will be able to

1. Describe basics of deep learning.
2. Design & implement various deep learning models
3. Apply Realignment on high dimensional data using reduction techniques
4. Analyze optimization and generalization in deep learning
5. Apply a variety of deep learning techniques to design efficient algorithms for real-world applications.

Module No.	Unit No.	Details	Hrs.	CO
Name of the subject: Deep Learning				
1	**Introduction to machine learning**		**08**	**CO1**
	1.1	Introduction to machine learning models.		
	1.2	Intro to Neural Nets: What a shallow network computes- Training a network: loss functions		
	1.3	Back propagation and stochastic gradient descent		
	1.4	Learning rates and data normalization, activation functions, Optimizers, Regularization, Dropout, Momentum & Batch Norm.		
2	**Deep Networks**		**10**	**CO2 & CO5**
	2.1	History of Deep Learning- A Probabilistic Theory of Deep Learning, Neural Nets-Deep Vs Shallow Networks-		
	2.2	Convolutional Neural Networks: Motivation, Convolution operations, Pooling		
	2.3	Image classification		
	2.4	Modern CNN architectures (VGG, ResNet, etc.)		
3	**Deep Unsupervised Learning**		**10**	**CO3 & CO5**
	3.1	Auto encoders		
	3.2	Dimensionality reduction in networks		
	3.3	Adversarial Generative Networks		
4	**Recurrent Neural Networks**		**10**	**CO2 & CO5**
	4.1	Motivation		
	4.2	Vanishing/Exploding gradient problem		
	4.3	Applications to sequences (text)		
	4.4	Modern RNN architectures (LSTM, GRU, etc.)		
5	**Optimization and Generalization**		**07**	**CO4 & CO5**
	5.1	Optimization in deep learning		
	5.2	Non-convex optimization for deep networks-		
	5.3	Stochastic Optimization & Generalization in neural networks.		
	5.4	**#Self Learning topic:** Applications of Deep Learning to Computer Vision : Image segmentation, object detection, automatic image captioning, video to text with LSTM models		
		Total	**45**	

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Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Ian Goodfellow, YoshuaBengio, Aaron Courville	*Deep Learning*	An MIT Press book	2016
2.	Deng & Yu	*Deep Learning: Methods and Applications*	Now Publishers	2013
3.	Michael Nielsen	*Neural Networks and Deep Learning*	Determination Press	2015
4.	Josh Patterson , Adam Gibson	*Deep Learning: A Practitioner's Approach*	Shroff/O'Reilly	First edition (2017)
5.	Nikhil Buduma, Nicholas Locascio	*Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms*	O'Reilly Media	First edition (June 29, 2017)

Course Code	Course Title							
2UCE818	Speech and Language Processing							
	TH			P		TUT		Total
Teaching Scheme(Hrs.)	03			--		--		03
Credits Assigned	03			--		--		03
Examination Scheme	Marks							
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course Objectives:

To introduce students the challenges of empirical methods for natural language processing (NLP) applications. And to provide students with the knowledge on designing procedures for natural language resource annotation and the use of related tools for text analysis and hands-on experience of using such tools

.

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1	Model linguistic phenomena with formal grammars.
CO2	Design, implement, and analyze NLP algorithms
CO3	Apply NLP techniques to design real world NLP applications, such as machine translation, text categorization, text summarization, information extraction...etc.

Module No.	Unit No.	Details	Hrs.	CO
1	**Introduction to Natural Language Processing**		02	CO1
	1.1	History of NLP, Generic NLP system, levels of NLP, Knowledge in language processing, Ambiguity in Natural language, Stages in NLP, challenges of NLP Applications of NLP.		
2	**Regular Expression and Finite Automata**		12	CO1
	2.1	Basic regular expression patterns, Disjunction, grouping and precedence, Regular expression substitution, memory and ELIZA		
	2.2	Finite State Automata: Using FSA to recognize Sheeptalk, formal languages, Non deterministic FSA's, using NFSA to accept strings, regular languages and FSA's		
	2.3	Morphology analysis –survey of English Morphology, Inflectional morphology & Derivational morphology.		
	2.4	Finite state transducers (FST), Morphological parsing with FST, Lexicon free FST -Porter stemmer. N –Grams-N-gram language model , N-gram for spelling correction		
3	**Probabilistic model of Pronunciations and spellings**		10	CO2
	3.1	Dealing with spelling errors, spelling error patterns, detecting Non-Word errors.		
	3.2	Probabilistic models, applying Bayesian method to spelling, minimum edit distance, Bayesian method for pronunciation, Decision tree models, weighted automata		
	3.3	N-grams: Counting words in Corpora, Smoothing, N-gram for spelling and pronunciation, context sensitive spelling error correction, N-gram for spelling error correction		
4	**Syntax and Semantic Analysis**		12	CO2
	4.1	Part-Of-Speech tagging(POS)- Tag set for English (Penn Treebank), Rule based POS tagging, Stochastic POS tagging, Issues –Multiple tags & words, Unknown words, Class based N–grams .		
	4.2	Context Free Grammar for English - Constituency, Context free rules & trees, Sentence level construction , Noun Phrase, coordination, agreement, the verb phrase & sub categorization		
	4.3	Attachment for fragment of English- sentences, noun phrases, Verb phrases , prepositional phrases		

	4.4	Relations among lexemes & their senses –Homonymy, Polysemy, WordNet: A database of Lexical relations, Internal structure of words, Thematic roles, semantic Fields		
5	**Word Sense Disambiguation**		**9**	**CO3**
	5.1	Word sense disambiguation, Selectional Restriction-Based disambiguation, Robust WSD –machine learning approaches and dictionary based approaches.		
	5.2	Information retrieval-The Vector Space model, Term Weighting, Homonymy, Polysemy and Synonymy		
	5.3	Pragmatics : Discourse Reference resolution, reference phenomenon , syntactic & semantic constraints on co reference, preferences in pronoun interpretation , algorithm for interpretation.		
		#Self-Learning Topic: Applications of NLP- Machine translation, question answering system Information retrieval, Text categorization, text summarization & Sentiment Analysis		
		Total	**45**	

 # Students should prepare all Self Learning topics on their own. Self-learning topics will enable students to gain extended knowledge of the topic. Assessment of these topics may be included in IA and Laboratory Experiments.

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Daniel Jurafsky, James H. Martin	Speech and Language Processing	Prentice Hall	Second Edition, 2008
2.	Christopher D.Manning and HinrichSchutze	Foundations of Statistical Natural Language Processing	MIT Press	1999
3.	Siddiqui and Tiwary U.S.	Natural Language Processing and Information Retrieval	Oxford University Press	2008
4.	Daniel M Bikel and ImedZitouni	Multilingual natural language processing applications	Pearson	2013
5.	Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin(Editor)	The Handbook of Computational Linguistics and Natural Language Processing	ISBN	978-1-118

Course Code	Course Title						
2UCE819	Software Architecture and Design Thinking						
	TH		P		TUT		Total
Teaching Scheme(Hrs.)	03		--		--		03
Credits Assigned	03		--		--		03
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course prerequisites (if any):

Students should be familiar with basic concepts of Software Engineering

Course Objectives

1. Develop architectural thinking applicable in building large and complex systems.
2. Structural and behavioral models in design notations such as Architecture description languages (ADLs)
3. Analyzing role of architectures in various environments

Course Outcomes

At the end of successful completion of the course the student will be able to

CO1	Design the architecture of software systems in various architectural styles
CO2	Analyze software architecture using analysis techniques
CO3	Analyze non-functional properties in the architectural design
CO4	Design domain models for domain specific software engineering and architecture

Module No.	Unit No.	Details	Hrs.	CO
1	**Software Architecture and Design Thinking**		**10**	
	1.1	Basic Concepts, Designing Architectures, Conventional Architectural styles : Concepts of Software Architecture, Models, Processes, Stakeholders		
	1.2	Styles and Architectural Patterns, Pipes and Filters, Event- based		
	1.3	Implicit Invocation, Layered systems, Repositories, Interpreters		
	#SELF LEARNING: Architecture Design Process, Architectural Conception			
2	**Connectors :**		**12**	
	2.1	Connector Foundations, Connector Roles		
	2.2	Connector Types and Their Variation Dimensions		
3	**Modeling , Analysis :**		**10**	
	3.1	Modeling Concepts, Ambiguity, Accuracy, and Precision,		
	3.2	Complex Modeling: Mixed Content and Multiple Views. Analysis Goals, Scope of Analysis, Architectural Concern being		
	3.3	Analyzed, Level of Formality of Architectural Models, Type of Analysis, Analysis Techniques **#SELF LEARNING**: SAAM		
4	**Designing for Non-Functional Properties and implementation:**		**6**	
	4.1	Efficiency, Complexity, Scalability and Heterogeneity, Adaptability, Dependability		
	4.2	**#SELF LEARNING** Existing Frameworks		
5	**Domain-Specific Software Engineering**		**7**	
	5.1	Domain-Specific Software Engineering in a Nutshell, Domain-Specific Software Architecture, DSSAs.		
	5.2	**#SELF LEARNING** Product Lines, and Architectural Styles		
		Total	**45**	

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Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Richard N. Taylor, Nenad Medvidovic, Eric Dashofy	, "Software Architecture: Foundations, Theory, and Practice"	**Publisher**: Wiley. ISBN: 978-0-470-16774-8	*10th* Edition, 2010
2.	M. Shaw	"Software Architecture Perspectives on an Emerging Discipline"	Prentice-Hall of India Pvt.Ltd	1996, 1st Edition
3.	Len Bass, Paul Clements, Rick Kazman	Software Architecture in Practice	O Reilly	3rd Edition

Course Code	Course Title						
2UCE820	High Performance Computing						
	TH		P		TUT		Total
Teaching Scheme (Hrs./Week)	03		--		--		03
Credits Assigned	03		--		--		03
Examination Scheme	Marks						
	CA		ESE	TW	O	P	P&O	Total
	ISE	IA						
	30	20	50	--	--	--	--	100

Course prerequisites: Microprocessor and Fundamentals of computer programming

Course Objectives:

Purpose of this course is to study parallel architectures and Design and Development of parallel algorithms and programs. This course introduces parallel programming paradigms using tools like MPICH and OpenMP and multicore program approaches using CUDA platform.

Course Outcomes:

1. Understand different parallel processing approaches and issues involved in it to achieve high computing performance.
2. Evaluate the parallel computing performance with different processors architectures.
3. Design and development on parallel platform

Module No.	Unit No.	Details	Hrs.	CO
		Parallel processing approaches		
1			10	
	1.1	Introduction to parallel processing: Levels of parallelism (instruction, transaction, task, thread, memory, and function).		
	1.2	Models (SIMD, MIMD, SIMT, SPMD, Dataflow Models and Demand-driven Computation etc).		
	1.3	Parallel platforms: Message-passing interface (MPI), Shared-memory thread-based OpenMP programs, and hybrid (MPI/OpenMP) programs, Hadoop, Cloud computing, Multi-core Processors (GPUs),Virtual GPUs, Field programmable gate array(FPGA), Tensor Processing Unit (TPU)		
2	**Fundamental Design Issues and limitations in Parallel Computing**		10	
	2.1	Issues: Synchronization, Scheduling, Job Allocation, Job Partitioning, Dependency Analysis.		
	2.2	Mapping Parallel Algorithms onto Parallel Architectures, Performance Analysis of Parallel Algorithms.		
	2.3	Limitations: Bandwidth Limitations, Latency Limitations, Latency Hiding/Tolerating Techniques and their limitations.		
3	**CUDA : GPU Parallel development environment**		10	
	3.1	**C**ompute Unified Device Architecture **(**CUDA) Architecture, CUDA programming model, execution model.		
	3.2	Thread organization: Concept of grid, block and thread.		
	3.3	Thread index generation, warp;		
4	**GPU primitives, algorithms and applications**		10	
	4.1	GPU primitives: scan (exclusive or inclusive), scatter, gather, reduce, memory model.		
	4.2	Introduction to global, shared, local memories, usage of cache, texture cache, constant memory.		
	4.3	CUDA structure, API and library (CUDPP, CUBLAS, FFT etc.) details.		
5	**GPU parallel programming and application**		05	
	5.1	CUDA example programs (Vector dot product, Matrix multiplication (with the usage of tiling and shared memory) etc.		
	5.2	Graph algorithms, molecular dynamics, n-body simulations, dense linear algebra etc. using GPU. Virtual GPUs.		
		#Self-Learning: Tensor Processing Unit (TPU), Application of AI in HPC		
		Total	**45**	

Recommended Books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Kai Hwang , Faye A. Briggs	Computer Architecture and Parallel Processing	McGraw-Hill	
2.	Edward Kandrot and Jason Sanders	CUDA by Example: An Introduction to General-Purpose GPU Programming	Addison-Wesley Professional	2010
3.	Alex Holmes	Hadoop in Practice	Manning Press, Dream tech Press	
4.	David Kirk, Wen-mei	UDA: Programming Massively Parallel Processors: A Hands-On Approach Hwu	ELSEVIER Inc	
5.	Michael J. Quinn	Parallel Programming in C with MPI and OpenMP	Tata McGraw-Hill Edition	
6.	Kai Hwang	Scalable Parallel Computing	McGraw Hill	1998
7.	Ananth Grama, Anshul Gupta, George Karypis, and Vipin Kumar	Introduction to Parallel Computing	Addison-Welsey,	2nd edition, 2003

Thrust Area-wise distribution of Departmental Electives of TY and LY

Sem	Intelligent System and Data Processing	Network System and security	Image analysis and interpretation	System and software engineering
V	Soft Computing		Computer Graphics & Visualization	Microprocessors
	Advanced Databases and Data Warehousing			
VI	Data Mining and Business Intelligence	Wireless Sensor Networks and IOT		Compiler Construction
	Machine Learning	Mobile Communication and Adhoc Networks	Audio Signal Processing	STQA
				Micro Services and DevOPS
VII	Big Data and Analytics	Cloud Computing & Emerging Technologies	Computer Vision	CSM
	Data Science	Blockchain Technology	GIS and Spatial Computing	User Experience and Design
		Cyber Security, Forensics and Cyber Law		C# Programming and . Net Technology
VIII	Bioinformatics	IoT security	Deep Learning	Software Architecture and Design Thinking
	Game Programming	Internet of Everything	Speech and language Processing	High Performance Computing
	AADA (Adv. Algorithm)	Cyber Physical Systems		