Sri Sivasubramaniya Nadar College of Engineering

(An Autonomous Institution, Affiliated to Anna University, Chennai)

Rajiv Gandhi Salai (OMR), Kalavakkam – 603110

Curriculum and Syllabus

5-Year Integrated M.Tech.
Computer Science and Engineering

Regulations 2023

Choice Based Credit System (CBCS)

INTEGRATED M.TECH. (COMPUTER SCIENCE AND ENGINEERING)

VISION OF THE DEPARTMENT

To emerge as a world-class technology department through education, innovation, and collaborative research.

MISSION OF THE DEPARTMENT

- To impart quality education to students.
- To create and disseminate knowledge for the betterment of mankind.
- To establish a centre of excellence in collaboration with industries, research laboratories and other agencies to meet the changing needs of society.
- To provide individual attention and enable character building.
- To encourage entrepreneurship skills among students.

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CHOICE BASED CREDIT SYSTEM

5-year Integrated M.Tech. (Computer Science and Engineering)
CURRICULUM

Program Educational Objectives (PEOs)

PEO1: **Industry career**:

To enable graduates to be competitive in the field of computer science and Engineering and be well-versed in cutting-edge technologies as well as tools used in the industry to take up a challenging career.

PEO2: **Research Skills**:

To enable graduates to clearly formulate research problems and solve them effectively thus making them competent to pursue higher studies.

PEO3: Entrepreneurial skill:

To enable graduates to work on inter-disciplinary projects, exhibit leadership qualities and initiate business ventures that provide innovative solutions for problems of social relevance.

Program Outcomes (POs)

The graduates of the 5-year integrated M.Tech. degree program in Computer Science and Engineering will be able to

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. (K3)
2. 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. (K6)
3. 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. (K6)
4. 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. (K5)
5. 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. (K6)
6. 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.

7. Environment and sustainability: Understand the impact of professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
9. Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. 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.
11. 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.
12. 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 (PSOs)

1. Develop computational solutions to problems in diverse domains by applying principles and practices of computer science and Engineering (K3)
2. Conceptualize, construct and evaluate optimal solutions for practical problems by applying suitable computing techniques and tools. (K5)

MAPPING OF PROGRAM OUTCOMES/PROGRAM-SPECIFIC OUTCOMES TO PROGRAM EDUCATIONAL OBJECTIVES

1: Reasonable, 2: Significant, 3: Strong

	PEO1 Industry Career	PEO2 Research Skills	PEO3 Entrepreneurial skill
PO1 Engineering Knowledge	3	3	3
PO2 Problem analysis	3	3	2
PO3 Design	3	2	3
PO4 Complex problem	3	2	2
PO5 Modern tool	3	2	3
PO6 Engineer and Society	1	2	3
PO7 Sustainability	2	3	3
PO8 Ethics	3	3	3
PO9 Team work	3	2	2
PO10 Communication	3	2	3
PO11 Project management	3	2	3
PO12 Life long learning	3	3	3
PSO1 Develop computational solutions	3	2	2
PSO2 Evaluate optimal solutions	3	3	3

MAPPING OF COURSES TO PROGRAM OUTCOMES / PROGRAM SPECIFIC OUTCOMES

Sem		PO												PSO	
	COURSES	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
I	English Communication Skills									2	3		2		
	Matrices and Applications of Calculus	3	2										1		
	Problem Solving and Programming in C	3	2	3		2					2		2	3	2
	Principles of Digital System Design	3	2	3							2			3	2
	Unix and Shell Programming (TCP)	3	2	2		2					2		2	2	2
	Heritage of Tamils														
	Principles of Digital System Design Laboratory	3	2	3	3	3					2			3	2
	Problem Solving and Programming in C Laboratory	3	2	3	3	2					2		2	3	2
II	Probability and Statistical Techniques	3	2		1									1	
	Physics for Information Science	3													
	Fundamentals of Computer Organization and Architecture	3	2	3							2		2	3	2
	Software Development and Practice using Python (TCPL)	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Data Structures and Algorithms	3	3	3							2		2	3	2
	Tamils and Technology														
	Environmental Science						3	3							
	Data Structures and Algorithms Laboratory	3	3	3	3	3				2	2	2	2	3	2
III	Linear Algebra	3	3	2						1	1	1	3		
	Principles of Object-Oriented Programming	3	3	3		3	2	2	3	3	2	3	2	2	2
	Introduction to Data Science	3	3	3	3	3	2		3		2		3	2	2

	Fundamentals of Operating Systems	3	3	3							2			3	
	Universal Human Values - II: Understanding Harmony (TCP)						3		3	3	2		3		
	Data Science and Visualization Laboratory	3	3	3	3	3	2		3		2		3	2	2
	Java Programming Laboratory	3	3	3	3	3	2	2	3	3	3	3	2	2	2
	Operating System Practices Laboratory	3	3	3	3	2					3			3	
IV	Discrete Mathematical Structures	3	3	2						1	1	1	3		
	Algorithms Design and Analysis	3	2	2	2	2					2		2	2	2
	Database Systems	3	3	3		3	2			3	2	2		2	2
	Introduction to Artificial Intelligence	3	3	2	3	2			3	3	3		3	2	3
	Microprocessors and Microcontrollers	3	2	3							3		2	3	3
	Software Engineering Principles and Practices	3	3	3		3	2	2	3	3	3	2	2	3	2
	Indian Constitution						2		2	2	2		2		
	Database Systems Laboratory	3	3	3	3	3	2	2	2	3	2	3		2	2
	Algorithms Laboratory	3	2	2	2	2					2			2	2
	Microprocessors and Microcontrollers Laboratory	3	2	2	3	2					3			2	3
V	Applied Optimization Techniques	3	3	2						1	1	1	3		
	Introduction to Machine Learning	3	3	3		3	2		2		2		2	2	3
	Web Application Development	3	3	3		3	2	2		3	3		2	2	3
	Principles of Computer Networks	3	3	2							2		3	3	2
	Professional Elective I														
	Management Elective														

	Web Application Development Laboratory	3	3	3	3	3	2	2		3	3	3	3	2	3
	Machine Learning Algorithms Laboratory	3	3	3	3	3	2		2		2		2	2	3
	Computer Networks Laboratory	3	3	2	3	3					2		2	2	2
VI	Automata and Formal Languages	3	2	2							2		2	3	3
	Introduction to Internet of Things	3	2	2		2	2	3	2		2		2	2	3
	Distributed Systems Design	3	3	3							2		2	3	2
	Big Data Management	3	2	2		3	2				2		2	2	3
	Competitive Programming	3	2	2	3	3			2		2	2	3	2	3
	Professional Elective II														
	Open Elective I														
	IoT Design Laboratory	3	2	2	3	2	2	3	2	2	2		2	2	3
	Big Data Management Laboratory	3	2	2	3	3	2			2	2		2	2	3
VII	Design of Compilers	3	3	3								2	2	3	3
	Cryptography and Data Security	3	2	2		2	2	2	2		2		2	2	3
	Microservices and DevOps	3	3	3		2			2	2	2		2	2	3
	Professional Elective III														
	Open Elective II														
	Research Practices and Methodologies	3	3	3		2			2		3		2	3	2
	Security Laboratory	3	2	2	3	2	2	2	2		2		2	2	3
	Compilers Laboratory	3	3	3	3	3				3	2	3	2	3	3
	Product Development Project – Phase I	3	3	3	3	3	3	3	3	3	3	3	3	3	3
VIII	Modern Data Structures and Algorithms	3	3	3									2	3	2
	Parallel Architectures	3	2	3							2		2	2	3
	Professional Elective IV														
	Professional Elective V														

	Open Elective III														
	Modern Data Structures and Algorithms Laboratory	3	3	3	3	3					2		2	3	2
	Product Development Project – Phase II	3	3	3	3	3	3	3	3	3	3	3	3	3	3
IX	Professional Elective VI														
	Professional Elective VII														
	Professional Elective VIII														
	Internship and Seminar*	3	3	3	3	3	3	2	3	2	3	3	3	3	3
	Research Project– Phase I	3	3	3	3	3	3	3	3	3	3	3	3	3	3
X	Research Project– Phase II	3	3	3	3	3	3	3	3	3	3	3	3	3	3

PROFESSIONAL ELECTIVES (PE)

	Course Title	Programme Outcome (PO)												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2
PE1	Ethical Hacking	3	2	2		3	2		2		2		2	2	2
	Advanced Graph Theory	3	3	2						1	1	1	3		
	Image Processing and Analysis (TCP)	3	3	3	3	3					2		2	2	2
	User Experience Design (TCP)	3	2	2		2	2				2		2	2	2
	Programming Paradigms	3	3	3	3	2					2		2	2	3
	Soft Computing (TCP)	3	3	3	2	2					2			2	2
PE2	Wireless Sensor Networks & Protocols	3	2	2	3	2					2			2	2
	Natural Language Processing (TCP)	3	3	3	3	3					2		2	2	2
	Computer Vision	3	3	3	2	2					2		2	2	2
	Graphics and Multimedia Techniques (TCP)	3	2	2	2	2				2	2		2	2	2
	Statistical Methods in Data Analysis	3	2	2	2	2					2			2	2
	Agile Methodologies	3	3	3	2	2			2	2	2		2	2	2
PE3	Software Defined Networks	3	2	2		2					2		2	2	2
	Fundamentals of Fog and Edge Computing	3	3	3		3					2		2	2	3
	Business Intelligence	3	2	2		2					2		2	2	2
	GPU Computing	3	2	2	3	2								2	2
	Deep Learning Techniques (TCP)	3	3	3	3	3				3	2		2	2	2
	Speech Processing and Synthesis	3	3	3		2					2		2	2	2
PE4	Information Security	3	2	2		2	2		2		2		2	2	2
	Data Privacy	3	2	2		2	2		2		2		2	2	2
	Augmented Reality & Virtual Reality (TCP)	3	2	2	2	2				2	2		2	2	2
	Cognitive Computing	3	2	2							2			2	2
	Big Data Technologies (TCP)	3	2	3	3	3				3	3		2	2	2
	Embedded Software Development	3	3	3		3					2		2	2	3
	Edge Analytics	3	3	2		2					2		2	3	2
	Software Project Management	3	2	2		2				3	3	3	2	2	2

PE5	Principles of Blockchain Technology	3	2	2		2	2				2		2	2	2
	Penetration Testing and Vulnerability Analysis (TCP)	3	2	2		2	2				2		2	2	2
	Advanced AI (TCP)	3	3	2	3	2			3	3	3		3	2	2
	Robotics	3	2	3		2							2	2	2
	Information Retrieval Techniques	3	2	2	2	2			2		2		2	2	2
	Video Processing & Analytics	3	2	2	3	2				3	2		2	2	2
	Mobile Application Development (TCP)	3	2	3	3	2					3		2	2	2
PE6	Cyber Security	3	2	2	2	2	2				2		2	2	2
	Malware Analysis (TCP)	3	2	2	3	2	2				2		2	2	2
	Financial Data Analytics (TCP)	3	3	2	2	2					2		2	2	2
	Cloud Computing (TCP)	3	2	2		2				2	2		2	2	2
	Game Programming (TCP)	3	2	2	2	2				2	2		2	2	2
	Bioinformatics	3	2	2		2								2	2
	Realtime Systems	3	2	2							2			2	2
PE7	Network & Server Security	3	2											2	
	Privacy and Security in IoT	3	3	3		3	2				2		2	2	2
	Exploratory Data Analysis (TCP)	3	2	3	2	2					2		2	2	2
	Multivariate Statistical Analysis	3	2	2	2	2					2		2	2	2
	Principles of Reinforcement Learning	3	2	3	3	2					2		2	2	2
	3D Modeling and Animation (TCP)	3	2	2	3	2				3	2		2	2	2
	Software Verification & Validation (TCP)	3	2	2	2	2				2	2		2	2	2
PE8	Wearable Computing	3	2	2		2					2		2	2	2
	Application Development using AR, VR and MR	3	2	2		2					2		2	2	2
	Database Tuning	3	2	3							2		2	2	2
	Semantic Web	3	2	3							2		2	2	2
	Quantum Computing	3	2	2		2					2		2	2	2
	Social Networks Analysis	3	2	2	2	2			2		2		2	2	2

MANAGEMENT ELECTIVES

S. No	Course Title	Programme Outcome (PO)												PSO	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	Principles of Management					3	3	2	3	2	2	2	1		
2	Total Quality Management					3	3	2	3	2	2	2	1		
3	Work Ethics, Corporate Social Responsibility and Governance						3	2	3	1	1	2	2		

SUSTAINABLE DEVELOPMENT GOALS

SDG	Short Form	Full Form
1	No Poverty	End poverty in all its forms everywhere
2	Zero Hunger	End hunger, achieve food security and improved nutrition, and promote sustainable agriculture
3	Good health and well being	Ensure healthy lives and promote well-being for all at all ages
4	Quality education	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
5	Gender Equality	Achieve gender equality and empower all women and girls
6	Clean water and sanitation	Ensure availability and sustainable management of water and sanitation for all
7	Affordable and clean energy	Ensure access to affordable, reliable, sustainable, and modern energy for all
8	Decent work and Economic Growth	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
9	Industry, Innovation and Infrastructure	Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation
10	Reducing Inequality	Reduce income inequality within and among countries
11	Sustainable cities and communities	Make cities and human settlements inclusive, safe, resilient, and sustainable
12	Responsible consumption and production	Ensure sustainable consumption and production patterns
13	Climate action	Take urgent action to combat climate change and its impacts by regulating emissions and promoting developments in renewable energy
14	Life below water	Conserve and sustainably use the oceans, seas and marine resources for sustainable development
15	Life on Land	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
16	Peace, justice and string Institutions	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
17	Partnerships for the goals	Strengthen the means of implementation and revitalize the global partnership for sustainable development

MAPPING OF COURSES TO SUSTAINABLE DEVELOPMENT GOALS

Courses	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
English Communication Skills				1													
Matrices and Applications of Calculus				1													
Problem Solving and Programming in C				1													
Principles of Digital System Design				1													
Unix and Shell Programming (TCP)				1													
Heritage of Tamils				1													
Principles of Digital System Design Laboratory				1							1						
Problem Solving and Programming in C Laboratory				1													
Probability and Statistical Techniques				1													
Physics for Information Science				1													
Fundamentals of Computer Organization and Architecture				1													
Software Development and Practice using Python (TCP)				1				1	1								
Data Structures and Algorithms				1													
Tamils and Technology				1													
Environmental Science			1	1		1	1						1	1	1		
Data Structures and Algorithms Laboratory				1				1									
Linear Algebra				1													
Principles of Object-Oriented Programming				1													
Introduction to Data Science				1													
Fundamentals of Operating Systems				1													
Universal Human Values - II: Understanding Harmony (TCP)			1	1													
Data Science and Visualization Laboratory				1				1									
Java Programming Laboratory				1				1									
Operating System Practices Laboratory				1				1									
Discrete Mathematical Structures				1													

Algorithms Design and Analysis				1													
Database Systems				1													
Introduction to Artificial Intelligence				1													
Microprocessors and Microcontrollers				1													
Software Engineering Principles and Practices				1													
Indian Constitution				1													
Database Systems Laboratory				1				1									
Algorithms Laboratory				1				1									
Microprocessors and Microcontrollers Laboratory				1							1						
Applied Optimization Techniques				1													
Introduction to Machine Learning				1													
Web Application Development				1													
Principles of Computer Networks				1													
Professional Elective I																	
Management Elective																	
Web Application Development Laboratory			1	1				1			1						
Machine Learning Algorithms Laboratory			1	1				1			1						
Computer Networks Laboratory				1							1						
Automata and Formal Languages				1													
Introduction to Internet of Things				1													
Distributed Systems Design				1												1	
Big Data Management				1													
Competitive Programming				1													
Professional Elective II																	
Open Elective I																	
IoT Design Laboratory				1													
Big Data Management Laboratory				1													
Design of Compilers				1													
Cryptography and Data Security				1													
Microservices and DevOps				1													
Professional Elective III																	
Open Elective II																	

Research Practices and Methodologies																	
Security Laboratory				1													
Compilers Laboratory				1													
Product Development Project – Phase I			1	1				1	1								
Modern Data Structures and Algorithms				1													
Parallel Architectures				1													
Professional Elective IV																	
Professional Elective V																	
Open Elective III																	
Modern Data Structures and Algorithms Laboratory				1													
Product Development Project – Phase II			1	1				1	1								
Professional Elective VI																	
Professional Elective VII																	
Professional Elective VIII																	
Internship and Seminar*				1				1	1								1
Research Project– Phase I			1	1				1	1								
Research Project– Phase II			1	1				1	1								

Professional Electives

Courses	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Ethical Hacking				1				1	1								
Advanced Graph Theory				1													
Image Processing and Analysis (TCP)				1										1	1		
User Experience Design (TCP)				1				1									
Programming Paradigms				1													
Soft Computing (TCP)				1													
Wireless Sensor Networks & Protocols				1													
Natural Language Processing (TCP)				1					1								
Computer Vision				1										1	1		
Graphics and Multimedia Techniques (TCP)				1													
Statistical Methods in Data Analysis				1													
Agile Methodologies				1													
Software Defined Networks				1							1						

Fundamentals of Fog and Edge Computing				1													
Business Intelligence				1				1	1								
GPU Computing				1				1	1								
Deep Learning Techniques (TCP)				1				1	1								
Speech Processing and Synthesis				1				1	1								
Information Security				1				1	1								
Data Privacy				1					1								
Augmented Reality & Virtual Reality (TCP)				1					1								
Cognitive Computing				1					1								
Big Data Technologies (TCP)				1				1	1								
Embedded Software Development				1					1								
Software Project Management				1				1									
Edge Analytics				1					1								
Principles of Blockchain Technology				1				1	1								
Penetration Testing and Vulnerability Analysis (TCP)				1				1	1								
Advanced AI (TCP)				1				1	1								
Robotics				1					1								
Information Retrieval Techniques				1													
Video Processing & Analytics				1													
Mobile Application Development (TCP)				1													
Cyber Security				1													
Malware Analysis (TCP)				1													
Financial Data Analytics (TCP)				1													
Cloud Computing				1													
Game Programming				1					1								
Bioinformatics				1													
Realtime Systems				1													
Network & Server Security				1													
Privacy and Security in IoT				1					1								
Exploratory Data Analysis (TCP)				1					1								
Multivariate Statistics Analysis				1													

Principles of Reinforcement Learning				1					1								
3D Modeling and Animation (TCP)				1					1								
Software Verification & Validation (TCP)				1													
Wearable Computing				1					1								
Application Development using AR, VR and MR				1					1								
Database Tuning				1													
Semantic Web				1													
Quantum Computing				1					1								
Social Networks Analysis				1				1									
Principles of Management				1													
Total Quality Management				1													
Work Ethics, Corporate Social Responsibility and Governance	1	1	1	1	1			1		1							

CURRICULUM

SEMESTER I

No	Code	Course Title	Category	Periods	L	T	P	E	C
Theory									
1	IEN1176	English Communication Skills	HS	4	2	0	2	0	3
2	IMA1176	Matrices and Applications of Calculus	BS	4	3	1	0	0	4
3	ICS1101	Problem Solving and Programming in C	ES	2	2	0	0	0	2
4	ICS1102	Principles of Digital System Design	ES	3	3	0	0	0	3
5	ICS1161	Unix and Shell Programming (TCP)	ES	4	2	0	2	0	3
6	IGA2176	Heritage of Tamils	HS	1	1	0	0	0	1
Practical									
7	ICS1111	Principles of Digital System Design Laboratory	ES	4	0	0	4	0	2
8	ICS1112	Problem Solving and Programming in C Laboratory	ES	4	0	0	4	0	2
Total				**26**	**13**	**1**	**12**	**0**	**20**

SEMESTER II

No	Code	Course Title	Category	Periods	L	T	P	E	C
Theory									
1	IMA1276	Probability and Statistical Techniques	BS	4	3	1	0	0	4
2	IPH1276	Physics for Information Science	BS	3	3	0	0	0	3
3	ICS1201	Fundamentals of Computer Organization and Architecture	PC	3	3	0	0	0	3
4	ICS1261	Software Development and Practice using Python (TCP)	ES	8	1	0	4	3	4
5	ICS1202	Data Structures and Algorithms	PC	3	3	0	0	0	3
6	IGA1276	Tamils and Technology	HS	1	1	0	0	0	1
	ICY1276	Environmental Science	MC*	3	3	0	0	0	0
Practical									
7	ICS1211	Data Structures and Algorithms Laboratory	PC	4	0	0	4	0	2
			Total	**29**	**17**	**1**	**8**	**3**	**20**

*MC – Mandatory Course

SEMESTER III

No	Code	Course Title	Category	Periods	L	T	P	E	C
Theory									
1	IMA1351	Linear Algebra	BS	4	3	1	0	0	4
2	ICS1301	Principles of Object-Oriented Programming	PC	3	3	0	0	0	3
3	ICS1302	Introduction to Data Science	ES	3	3	0	0	0	3
4	ICS1303	Fundamentals of Operating Systems	PC	3	3	0	0	0	3
5	IHS1361	Universal Human Values 2: Understanding Harmony	HS	4	2	0	2	0	3
Practical									
6	ICS1311	Data Science and Visualization Laboratory	ES	3	0	0	3	0	1.5
7	ICS1312	Java Programming Laboratory	PC	4	0	0	4	0	2
8	ICS1313	Operating System Practices Laboratory	PC	3	0	0	3	0	1.5
			Total	**27**	**14**	**1**	**12**	**0**	**21**

SEMESTER IV

No	Code	Course Title	Category	Periods	L	T	P	E	C
Theory									
1	IMA1451	Discrete Mathematical Structures	BS	3	3	0	0	0	3
2	ICS1401	Algorithms Design and Analysis	PC	3	3	0	0	0	3
3	ICS1402	Database Systems	PC	3	3	0	0	0	3
4	ICS1403	Introduction to Artificial Intelligence	PC	4	3	1	0	0	4
5	ICS1404	Microprocessors and Microcontrollers	PC	3	3	0	0	0	3
6	ICS1405	Software Engineering Principles and Practices(TCP)	PC	3	2	0	2	0	3
7	IHS1476	Indian Constitution	MC*	3	3	0	0	0	0
Practical									
8	ICS1411	Database Systems Laboratory	PC	3	0	0	3	0	1.5
9	ICS1412	Algorithms Laboratory	PC	2	0	0	2	0	1
10	ICS1413	Microprocessors and Microcontrollers Laboratory	PC	3	0	0	3	0	1.5
			Total	**30**	**20**	**1**	**10**	**0**	**23**

SEMESTER V

No	Code	Course Title	Category	Periods	L	T	P	E	C
Theory									
1	ICS1501	Applied Optimization Techniques	BS	4	3	1	0	0	4
2	ICS1502	Introduction to Machine Learning	PC	3	3	0	0	0	3
3	ICS1503	Web Application Development	PC	3	3	0	0	0	3
4	ICS1504	Principles of Computer Networks	PC	3	3	0	0	0	3
5		Professional Elective I	PE	3	3	0	0	0	3
6		Management Elective	HS	3	3	0	0	0	3
Practical									
7	ICS1511	Web Application Development Laboratory	PC	3	0	0	3	0	1.5
8	ICS1512	Machine Learning Algorithms Laboratory	PC	4	0	0	4	0	2
9	ICS1513	Computer Networks Laboratory	PC	3	0	0	3	0	1.5
			Total	**29**	**18**	**1**	**10**	**0**	**24**

SEMESTER VI

No	Code	Course Title	Category	Periods	L	T	P	E	C
Theory									
1	ICS1601	Automata and Formal Languages	PC	3	3	0	0	0	3
2	ICS1602	Introduction to Internet of Things	PC	3	3	0	0	0	3
3	ICS1603	Distributed Systems Design	PC	3	3	0	0	0	3
4	ICS1604	Big Data Management	PC	3	3	0	0	0	3
5	ICS1661	Competitive Programming	PC	3	1	0	2	0	2
6		Professional Elective II	PE	3	3	0	0	0	3
7		Open Elective I	OE	3	3	0	0	0	3
Practical									
7	ICS1611	IoT Design Laboratory	PC	3	0	0	3	0	1.5
8	ICS1612	Big Data Management Laboratory	PC	3	0	0	3	0	1.5
			Total	**27**	**19**	**0**	**8**	**0**	**23**

SEMESTER VII

No	Code	Course Title	Category	Periods	L	T	P	E	C
Theory									
1	ICS1701	Design of Compilers	PC	3	3	0	0	0	3
2	ICS1702	Cryptography and Data Security	PC	3	3	0	0	0	3
3	ICS1761	Microservices	PC	4	2	0	2	0	3
4		Professional Elective III	PE	3	3	0	0	0	3
5		Open Elective II	OE	3	3	0	0	0	3
6	ICS1762	Research Practices and Methodologies	MLC*	3	1	0	2	0	2
Practical									
7	ICS1711	Security Laboratory	PC	4	0	0	4	0	2
8	ICS1712	Compilers Laboratory	PC	2	0	0	2	0	1
9	ICS1718	Product Development Project – Phase I	EEC	6	0	0	6	3	4
			Total	**31**	**15**	**0**	**16**	**3**	**24**

*MLC – Mandatory Learning Course

SEMESTER VIII

No	Code	Course Title	Category	Periods	L	T	P	E	C
Theory									
1	ICS1801	Modern Data Structures and Algorithms	PC	3	3	0	0	0	3
2	ICS1802	Parallel Architectures	PC	3	3	0	0	0	3
3		Professional Elective IV	PE	3	3	0	0	0	3
4		Professional Elective V	PE	3	3	0	0	0	3
5		Open Elective III	OE	3	3	0	0	0	3
Practical									
6	ICS1811	Modern Data Structures and Algorithms Laboratory	PC	2	0	0	2	0	1
7	ICS1818	Product Development Project – Phase II	EEC	10	0	0	10	6	7
			Total	**27**	**15**	**0**	**12**	**0**	**23**

SEMESTER XI

No	Code	Course Title	Category	Periods	L	T	P	E	C
Theory									
1		Professional Elective VI	PE	3	3	0	0	0	3
2		Professional Elective VII	PE	3	3	0	0	0	3
3		Professional Elective VIII	PE	3	3	0	0	0	3
Practical									
4	ICS1916	Internship and Seminar*	EEC	0	0	0	0	0	2
5	ICS1918	Research Project– Phase I	EEC	14	0	0	14	6	9
			Total	**23**	**9**	**0**	**14**	**6**	**20**

* The students will undergo 4 weeks Industrial training / Internship during the previous semester vacation

SEMESTER X

No	Code	Course Title	Category	Periods	L	T	P	E	C
Practical									
1	ICS1018	Research Project– Phase II	EEC	22	0	0	22	6	12
			Total	**22**	**0**	**0**	**22**	**6**	**12**

Total Credits : 210

L Lecture periods per week
T Tutorial periods per week
P Practical periods per week
E Experiential learning periods per week
C Credits
TCP Theory-cum Practical
MC Mandatory Course
MLC Mandatory Learning Course

MANAGEMENT ELECTIVES

No	Code	Course Title	Category	Periods	L	T	P	E	C
1	IBA1541	Principles of Management	HS	3	3	0	0	0	3
2	IBA1542	Total Quality Management	HS	3	3	0	0	0	3
3	IBA1543	Work Ethics, Corporate Social Responsibility and Governance	HS	3	3	0	0	0	3

PROFESSIONAL ELECTIVES

Professional Elective I [Semester 5]

No	Code	Course Title	Category	Periods	L	T	P	E	C
1	ICS1561	Ethical Hacking (TCP)	PE	4	2	0	2	0	3
2	ICS1521	Advanced Graph Theory	PE	3	3	0	0	0	3
3	ICS1562	Image Processing and Analysis (TCP)	PE	4	2	0	2	0	3
4	ICS1563	User Experience Design (TCP)	PE	4	2	0	2	0	3
5	ICS1522	Programming Paradigms	PE	3	3	0	0	0	3
6	ICS1564	Soft Computing (TCP)	PE	4	2	0	2	0	3

Professional Elective II [Semester 6]

No	Code	Course Title	Category	Periods	L	T	P	E	C
1	ICS1621	Wireless Sensor Networks & Protocols	PE	3	3	0	0	0	3
2	ICS1662	Natural Language Processing (TCP)	PE	4	2	0	2	0	3
3	ICS1622	Computer Vision	PE	3	3	0	0	0	3
4	ICS1663	Graphics and Multimedia Techniques (TCP)	PE	4	2	0	2	0	3
5	ICS1623	Statistical Methods in Data Analysis	PE	3	3	0	0	0	3
6	ICS1624	Agile Methodologies	PE	3	2	1	0	0	3

Professional Elective III [Semester 7]

No	Code	Course Title	Category	Periods	L	T	P	E	C
1	ICS1763	Software Defined Networks (TCP)	PE	4	2	0	2	0	3
2	ICS1721	Fundamentals of Fog and Edge Computing	PE	3	3	0	0	0	3
3	ICS1722	Business Intelligence	PE	3	3	0	0	0	3
4	ICS1723	GPU Computing	PE	3	3	0	0	0	3
5	ICS1764	Deep Learning Techniques (TCP)	PE	4	2	0	2	0	3
6	ICS1724	Speech Processing and Synthesis	PE	3	3	0	0	0	3

Professional Elective IV [Semester 8]

No	Code	Course Title	Category	Periods	L	T	P	E	C
1	ICS1821	Information Security	PE	3	3	0	0	0	3
2	ICS1822	Data Privacy	PE	3	3	0	0	0	3
3	ICS1861	Augmented Reality & Virtual Reality (TCP)	PE	4	2	0	2	0	3
4	ICS1823	Cognitive Computing	PE	3	3	0	0	0	3
5	ICS1862	Big Data Technologies (TCP)	PE	4	2	0	2	0	3
6	ICS1824	Embedded Software Development	PE	3	3	0	0	0	3
7	ICS1825	Software Project Management	PE	3	3	0	0	0	3
8	ICS1826	Edge Analytics	PE	3	3	0	0	0	3

Professional Elective V [Semester 8]

No	Code	Course Title	Category	Periods	L	T	P	E	C
1	ICS1827	Principles of Blockchain Technology	PE	3	3	0	0	0	3
2	ICS1863	Penetration Testing and Vulnerability Analysis (TCP)	PE	4	2	0	2	0	3
3	ICS1864	Advanced AI (TCP)	PE	4	2	0	2	0	3
4	ICS1828	Robotics	PE	3	3	0	0	0	3
5	ICS1829	Information Retrieval Techniques	PE	3	3	0	0	0	3
6	ICS1831	Video Processing & Analytics	PE	3	3	0	0	0	3
7	ICS1865	Mobile Application Development (TCP)	PE	4	2	0	2	0	3

Professional Elective VI [Semester 9]

No	Code	Course Title	Category	Periods	L	T	P	E	C
1	ICS1921	Cyber Security	PE	3	3	0	0	0	3
2	ICS1961	Malware Analysis (TCP)	PE	4	2	0	2	0	3
3	ICS1962	Financial Data Analytics (TCP)	PE	4	2	0	2	0	3
4	ICS1963	Cloud Computing (TCP)	PE	4	2	0	2	0	3
5	ICS1964	Game Programming (TCP)	PE	4	2	0	2	0	3
6	ICS1922	Bioinformatics	PE	3	3	0	0	0	3
7	ICS1923	Realtime Systems	PE	3	3	0	0	0	3

Professional Elective VII [Semester 9]

No	Code	Course Title	Category	Periods	L	T	P	E	C
1	ICS1924	Network & Server Security	PE	3	3	0	0	0	3
2	ICS1925	Privacy and Security in IoT	PE	3	3	0	0	0	3
3	ICS1965	Exploratory Data Analysis (TCP)	PE	4	2	0	2	0	3
4	ICS1926	Multivariate Statistical Analysis	PE	3	3	0	0	0	3
5	ICS1927	Principles of Reinforcement Learning	PE	3	3	0	0	0	3
6	ICS1967	3D Modeling and Animation (TCP)	PE	5	1	0	4	0	3
7	ICS1966	Software Verification & Validation (TCP)	PE	4	2	0	2	0	3

Professional Elective VIII [Semester 9]

No	Code	Course Title	Category	Periods	L	T	P	E	C
1	ICS1928	Wearable Computing	PE	4	2	0	2	0	3
2	ICS1929	Application Development using AR, VR and MR	PE	5	2	0	0	3	3
3	ICS1931	Database Tuning	PE	3	3	0	0	0	3
4	ICS1932	Semantic Web	PE	3	3	0	0	0	3
5	ICS1933	Quantum Computing	PE	3	3	0	0	0	3
6	ICS1934	Social Networks Analysis	PE	3	3	0	0	0	3

Grouping of Electives

Professional Elective	Semester	Networks & Security	Data Science	Multi Media Processing	Software Systems
PE1 -5S	5	Ethical Hacking (TCP)	Soft Computing (TCP), Advanced Graph Theory	Image Processing and Analysis (TCP)	User Experience Design (TCP), Programming Paradigms
PE2-6S	6	Wireless Sensor Networks & Protocols	Natural Language Processing (TCP), Computer Vision, Statistical Methods in Data Analysis	Graphics and Multimedia Techniques (TCP)	Agile Methodologies
PE3-7S	7	Software Defined Networks(TCP), Fundamentals of Fog and Edge Computing,	Deep Learning Techniques (TCP), Business Intelligence,	Speech Processing and Synthesis	GPU Computing,
PE4-8S	8	Information Security, Data Privacy	Cognitive Computing, Big Data Technologies (TCP) Edge Analytics	Augmented Reality & Virtual Reality (TCP)	Embedded Software Development, Software Project Management
PE5-8S	8	Penetration Testing and Vulnerability Analysis(TCP), Principles of Blockchain Technology	Information Retrieval Techniques, Advanced AI (TCP), Robotics	Video Processing & Analytics	Mobile Application Development (TCP)
PE6-9S	9	Malware Analysis (TCP) Cyber Security	Bioinformatics, Financial Data Analytics (TCP)	Game Programming (TCP)	Cloud Computing (TCP), Realtime Systems
PE7-9S	9	Network & Server Security, Privacy and Security in IoT	Principles of Reinforcement Learning Multivariate Statistical Analysis Exploratory Data Analysis (TCP)	3D Modeling and Animation (TCP)	Software Verification & Validation (TCP)
PE8-9S	9	Wearable Computing(TCP)	Social Networks Analysis, Quantum Computing	Application Development using AR, VR and MR(TCP)	Database Tuning, Semantic Web

DISTRIBUTION OF COURSES

Sem	HS	BS	ES	PC	PE	OE	EEC	MLC	MC	Total
I	4	4	12							**20**
II	1	7	4	8					0	**20**
III	3	4	4.5	9.5						**21**
IV		3		20					0	**23**
V	3	4		14	3					**24**
VI				17	3	3				**23**
VII				12	3	3	4	2		**24**
VIII				7	6	3	7			**23**
IX					9		11			**20**
X							12			**12**
Credits Total	11	22	20.5	87.5	24	9	34	2	0	**210**
Percentage	5.2	10.5	9.8	41.7	11.4	4.3	16.2	1	0	**100**

HUMANITIES AND SOCIAL SCIENCES (HS)

No	Code	Course	Periods	L	T	P	E	C
1	IEN1176	English Communication Skills	4	2	0	2	0	3
2	IGA2176	Heritage of Tamils	1	1	0	0	0	1
3	IGA1276	Tamils and Technology	1	1	0	0	0	1
4	IHS1361	Universal Human Values: Understanding Harmony	4	2	0	2	0	3
5		Management Elective	3	3	0	0	0	3
		Total	**13**	**9**	**0**	**4**	**0**	**11**

BASIC SCIENCES (BS)

No	Code	Course	Periods	L	T	P	E	C
1	IMA1176	Matrices and Applications of Calculus	4	3	1	0	0	4
2	IMA1276	Probability and Statistical Techniques	4	3	1	0	0	4
3	IPH1276	Physics for Information Science	3	3	0	0	0	3
4	IMA1351	Linear Algebra	4	3	1	0	0	4
5	IMA1451	Discrete Mathematical Structures	3	3	0	0	0	3
6	ICS1501	Applied Optimization Techniques	4	3	1	0	0	4
		Total	**22**	**18**	**4**	**0**	**0**	**22**

ENGINEERING SCIENCES (ES)

No	Code	Course	Periods	L	T	P	E	C
1	ICS1101	Problem Solving and Programming in C	2	2	0	0	0	2
2	ICS1102	Principles of Digital System Design	3	3	0	0	0	3
3	ICS1161	Unix and Shell Programming (TCP)	4	2	0	2	0	3
4	ICS1111	Principles of Digital System Design Laboratory	4	0	0	4	0	2
5	ICS1112	Problem Solving and Programming in C Laboratory	4	0	0	4	0	2
6	ICS1261	Software Development and Practice using Python (TCPL)	8	1	0	4	3	4
7	ICS1302	Introduction to Data Science	3	3	0	0	0	3
8	ICS1311	Data Science and Visualization Laboratory	3	0	0	3	0	1.5
		Total	**31**	**11**	**0**	**17**	**3**	**20.5**

PROFESSIONAL CORE (PC)

No	Code	Course	Periods	L	T	P	E	C
1	ICS1201	Fundamentals of Computer Organization and Architecture	3	3	0	0	0	3
2	ICS1202	Data Structures and Algorithms	3	3	0	0	0	3
3	ICS1211	Data Structures and Algorithms Laboratory	4	0	0	4	0	2
4	ICS1301	Principles of Object-Oriented Programming	3	3	0	0	0	3
5	ICS1303	Fundamentals of Operating Systems	3	3	0	0	0	3
6	ICS1312	Java Programming Laboratory	4	0	0	4	0	2
7	ICS1313	Operating System Practices Laboratory	3	0	0	3	0	1.5
8	ICS1401	Algorithms Design and Analysis	3	3	0	0	0	3
9	ICS1402	Database Systems	3	3	0	0	0	3
10	ICS1403	Introduction to Artificial Intelligence	4	3	1	0	0	4
11	ICS1404	Microprocessors and Microcontrollers	3	3	0	0	0	3
12	ICS1405	Software Engineering Principles and Practices(TCP)	3	2	0	2	0	3
13	ICS1411	Database Systems Laboratory	3	0	0	3	0	1.5
14	ICS1412	Algorithms Laboratory	2	0	0	2	0	1
15	ICS1413	Microprocessors and Microcontrollers Laboratory	3	0	0	3	0	1.5
16	ICS1502	Introduction to Machine Learning	3	3	0	0	0	3
17	ICS1503	Web Application Development	3	3	0	0	0	3
18	ICS1504	Principles of Computer Networks	3	3	0	0	0	3
19	ICS1511	Web Application Development Laboratory	3	0	0	3	0	1.5
20	ICS1512	Machine Learning Algorithms Laboratory	4	0	0	4	0	2
21	ICS1513	Computer Networks Laboratory	3	0	0	3	0	1.5
22	ICS1601	Automata and Formal Languages	3	3	0	0	0	3
23	ICS1602	Introduction to Internet of Things	3	3	0	0	0	3
24	ICS1603	Distributed Systems Design	3	3	0	0	0	3

25	ICS1604	Big Data Management	3	3	0	0	0	3
26	ICS1661	Competitive Programming	3	1	0	2	0	2
27	ICS1611	IoT Design Laboratory	3	0	0	3	0	1.5
28	ICS1612	Big Data Management Laboratory	3	0	0	3	0	1.5
29	ICS1701	Design of Compilers	3	3	0	0	0	3
30	ICS1702	Cryptography and Data Security	3	3	0	0	0	3
31	ICS1761	Microservices	4	2	0	2	0	3
32	ICS1711	Security Laboratory	4	0	0	4	0	2
33	ICS1712	Compilers Laboratory	2	0	0	2	0	1
34	ICS1801	Modern Data Structures and Algorithms	3	3	0	0	0	3
35	ICS1802	Parallel Architectures	3	3	0	0	0	3
36	ICS1811	Modern Data Structures and Algorithms Laboratory	2	0	0	2	0	1
		Total	**111**	**62**	**1**	**49**	**0**	**87.5**

PROFESSIONAL ELECTIVES (PE)

No	Code	Course	Periods	L	T	P	E	C
1		Professional Elective I	3	3	0	0	0	3
2		Professional Elective II	3	3	0	0	0	3
3		Professional Elective III	3	3	0	0	0	3
4		Professional Elective IV	3	3	0	0	0	3
5		Professional Elective V	3	3	0	0	0	3
6		Professional Elective VI	3	3	0	0	0	3
7		Professional Elective VII	3	3	0	0	0	3
8		Professional Elective VIII	3	3	0	0	0	3
			24	**24**	**0**	**0**	**0**	**24**

OPEN ELECTIVES (OE)

No	Code	Course	Periods	L	T	P	E	C
1		Open Elective I	3	3	0	0	0	3
2		Open Elective II	3	3	0	0	0	3
3		Open Elective II	3	3	0	0	0	3
Total			**9**	**9**	**0**	**0**	**0**	**9**

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

No	Code	Course	Periods	L	T	P	E	C
1	ICS1718	Product Development Project – Phase I	6	0	0	6	3	4
2	ICS1818	Product Development Project – Phase II	10	0	0	10	6	7
3	ICS1916	Internship and Seminar*	0	0	0	0	0	2
4	ICS1918	Research Project– Phase I	14	0	0	14	6	9
5	ICS1018	Research Project– Phase II	22	0	0	22	6	12
Total			**52**	**0**	**0**	**52**	**21**	**34**

MANDATORY COURSES (MC)*

No	Code	Course	Periods	L	T	P	E	C
1	ICY1276	Environmental Science	3	3	0	0	0	0
2	IHS1476	Indian Constitution	3	3	0	0	0	0

*Mandatory Course

MANDATORY LEARNING COURSES (MLC) *

No	Code	Course	Periods	L	T	P	E	C
1	ICS1762	Research Practices and Methodologies	3	1	0	2	0	2

*Mandatory Learning Course

COURSE CODE	COURSE TITLE	L	T	P	E	C
IEN1176	**ENGLISH COMMUNICATION SKILLS**	**2**	**0**	**2**	**0**	**3**

OBJECTIVES

- Improve conversation and networking skills in English
- Contribute effectively to meetings and group discussions
- Prepare well-organized presentations and participate in interviews
- Learn the language and strategies of successful negotiations
- Communicate effectively during conflict-resolving situations

UNIT I CONVERSATION AND NETWORKING SKILLS 6

Introducing yourself, peers and others. Conversation skills: starting a conversation; keeping the conversation going; closing the conversation; giving directions and instructions. Imparting the basic skills and techniques for telephonic conversations. Writing professional emails.

UNIT II COLLABORATION AND TEAM SKILLS 6

Setting up and holding meetings; organizing and conducting effective meetings; learning the language used to lead a meeting; practicing how to agree and disagree with people and to ideas politely; making notes, summarizing, and reporting in meetings. Group discussion skills: discussing to arrive at a consensus.

UNIT III PRESENTATIONS AND INTERVIEW SKILLS 6

Making effective presentations: structure of a presentation; referring to data; describing visuals; using persuasive language in presentations; non-verbal communication skills; examples of model presentations. Applying for jobs; writing resumes; and cover letters. Participating in job interviews and other interviews.

UNIT IV NEGOTIATING SKILLS AND ASSERTIVENESS 6

Negotiation strategies; negotiating effectively; exchanging and comparing information; building rapport with people; practicing the language used in negotiations; considering and respecting cultural differences while negotiating; making compromises. Communication styles: passive, aggressive and assertive styles.

UNIT V CONFLICT RESOLUTION AND DECISION-MAKING SKILLS 6

Resolving conflicts: listening actively to ideas; handling people smoothly; dealing with and attempting to solve conflicting problems. Making a decision: thinking about various possibilities before decision-making; communicating the pros and cons of a decision; presenting a mutually beneficial solution. Developing cross-cultural communication skills.

TOTAL PERIODS: 30
PRACTICAL : 30

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1 Develop conversation and networking skills in English
CO2 Communicate effectively in meetings and group discussions
CO3 Deliver engaging presentations and professional interviews
CO4 Speak and negotiate strategically in formal and informal settings
CO5 Presenting effectively during conflict-resolving situations

TEXTBOOKS

1 Herbert Hirsch. (2007). Essential Communication Strategies: For Scientists, Engineers, and Technology Professionals, 2nd edition. Wiley-IEEE Press.

2 Dwyer, J. (2012). *Communication for Business and the Professions: Strategies and Skills*. Pearson Higher Education AU.

REFERENCE BOOKS

1 Gill Hasson. (2012). Brilliant Communication Skills: What the Best Communicators Know, Do and Say. Ft Pr.

2 Jones, L., & Alexander, R. (2011). *New international business English updated edition student's book: Communication skills in English for business purposes* (Vol. 3). Cambridge university press.

3 Kerry Patterson, Joseph Grenny, Ron McMillan and Al Switzler. (2013). Crucial Conversations: Tools for Talking When Stakes Are High. Brilliance Audio.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1									2	3		2
CO2									2	3		2
CO3									2	3		2
CO4									2	3		2
CO5									2	3		2
Total									10	15		10
Score									2	3		2

COURSE CODE	COURSE TITLE	L	T	P	E	C
IMA1176	MATRICES AND APPLICATIONS OF CALCULUS	3	1	0	0	4

OBJECTIVES

1. To reduce quadratic form to canonical form of a matrix and identify its nature
2. To solve second and higher order ordinary differential equations
3. To study the concept of evolute and envelope
4. To find the extreme values for a function of two variables
5. To compute area of closed surface and volume of solids using multiple integral

UNIT I MATRICES 12

Characteristic equation - Eigenvalues and Eigenvectors of a real matrix – Properties of eigenvalues and eigenvectors, Cayley-Hamilton Theorem – statement and applications, Diagonalization of matrices – Similarity transformation - Quadratic form - Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

UNIT II ORDINARY DIFFERENTIAL EQUATIONS 12

Solution of second and higher order linear differential equation with constant coefficients ($f(x)=e^{mx}$, sinmx, cosmx, x^n, $f(x)e^{mx}$, f(x)sinmx) - Method of variation of parameters - Simultaneous linear equations with constant coefficients of first order - Solution to second order differential equations with variable coefficients: Legendre equations.

UNIT III APPLICATIONS OF DIFFERENTIAL CALCULUS 12

Curvature, radius of curvature - Cartesian and parametric co-ordinates – Centre of curvature – Circle of curvature in Cartesian form – Evolutes -Envelopes (including two parameter family), Evolute as envelope of normals.

UNIT IV FUNCTIONS OF SEVERAL VARIABLES 12

Partial derivatives – Total derivative – Differentiation of implicit functions – Jacobian and its properties – Taylor's series for functions of two variables – Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers.

UNIT V MULTIPLE TEGRALS 12

Double integrals in Cartesian and polar coordinates – Change of order of integration, Area enclosed by plane curves – Change of variables in double integrals, Triple integrals.

TOTAL PERIODS: 60

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1 Reduced quadratic form to canonical form by orthogonal transformation and identify the nature of the quadratic form (K3)
CO2 Solve second and higher order ordinary differential equations(K3)
CO3 Find evolute of a given curve and envelope of family of curves(K3)
CO4 Find the extrema of function of two variables (K4)
CO5 Evaluate the double and triple integral (K3)

TEXTBOOKS

1. Grewal B.S, Higher Engineering Mathematics, Khanna Publishers, 44th Edition, 2018
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, Inc., 10th Edition, 2016.

REFERENCE BOOKS

1. Bali N. P and Manish Goyal, "A Text book of Engineering Mathematics", Ninth Edition, Laxmi Publications Pvt Ltd., 2016.
2. James Stewart, Calculus: Early Transcendental, Cengage Learning, New Delhi, 7th Edition, 2013.
3. Dass, H.K., and Er. Rajnish Verma," Higher Engineering Mathematics", S. Chand Private Ltd., 2011.
4. Srimanta Pal and Subodh C. Bhunia, Engineering Mathematics, Oxford University Press, 2015.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										
CO2	3	2										
CO3	3	2										
CO4	3	2										1
CO5	3	2										
Total	15	10										1
Score	3	2										1

COURSE CODE	COURSE TITLE	L	T	P	E	C
ICS1101	PROBLEM SOLVING AND PROGRAMMING IN C	2	0	0	0	2

OBJECTIVES

- To learn algorithmic problem-solving techniques.
- To learn the fundamentals of C programming.
- To develop applications in C using conditions, iterations and decompose a problem into functions.
- To construct programs in C using user-defined data types.

UNIT I LOGICAL AND ALGORITHMIC THINKING 6

Logical thinking, Algorithmic thinking; Problem solving and decomposition: Defining the problem, devising the solution, decomposition; Effective building blocks - Basic algorithmic constructs - Algorithm, Flowchart, Pseudocode; Incremental design; Self documentation - Test case design.

UNIT II BASICS OF C PROGRAMMING 6

C Fundamentals, Operators and Expressions, Data Input and Output, Control Statements.

UNIT III FUNCTIONS 5

Defining a function, accessing a function, Function prototypes, Passing arguments to a function; Recursion; Standard library functions; Command line arguments.

UNIT IV ARRAYS AND STRINGS 7

Defining an array, Processing an array, Passing arrays to functions, Multidimensional arrays, Arrays and Strings; String library functions; Pointers and one-dimensional arrays, Dynamic memory allocation.

UNIT V STRUCTURES AND FILES 6

Defining a structure, Processing a structure, Typedef, Structures and pointers, Passing structures to functions; Files: Opening and closing a data file, creating and processing a data file, unformatted data files.

LECTURE PERIODS: 30

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1 Solve programming problems and express solutions using algorithmic constructs.(K3)
CO2 Examine the problem and choose suitable control constructs to solve the problem.(K4)
CO3 Analyze the given problem and develop user-defined functions by selecting the required arguments.(K4)
CO4 Develop simple applications using arrays and strings.(K3)
CO5 Develop programming solutions using structures and files.(K3)

TEXTBOOKS

1 Karl Beecher, “Computational Thinking – A beginner’s Guide to Problem Solving and Programming”, British Computer Society (BCS), 2017.
2 Byron S Gottfried, “Programming with C” (Schaum’s Outlines Series), McGraw-Hill Education, 2nd Edition, 2022.

REFERENCE BOOKS

1 Herbert Schildt, “C: The Complete Reference”, McGraw-Hill Education, 4th Edition, 2017.
2 Yashavant Kanetkar, “Let Us C: Authentic guide to C programming language”, BPB Publications,19th Edition, 2022.
3 Peter Prinz, “C in a Nutshell”, O′Reilly, 2nd edition, 2016.
4 David Griffiths, Dawn Griffiths, “Head First C: A Brain-Friendly Guide”, O'Reilly; 1st edition, 2012
5 Greg Perry, Dean Miller, “C Programming (Absolute Beginner's Guide)”, Que Publishing, 3rd edition, 2013

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2											2	
CO2	3	3	3										2	2
CO3	3	3	3										2	2
CO4	3	2	2									2	2	
CO5	3	2	2										2	
Total	15	12	10									2	10	4
Score	3	3	3									2	2	2

COURSE CODE	COURSE TITLE	L	T	P	E	C
ICS1102	PRINCIPLES OF DIGITAL SYSTEM DESIGN	3	0	0	0	3

OBJECTIVES

- To design digital circuits using simplified Boolean functions
- To analyze and design combinational circuits
- To analyze and design synchronous and asynchronous sequential circuits
- To understand Programmable Logic Devices
- To write HDL code for combinational and sequential circuits

UNIT I BOOLEAN ALGEBRA AND LOGIC GATES 9

Number Systems – Arithmetic Operations – Binary Codes– Boolean Algebra and Logic Gates – Theorems and Properties of Boolean Algebra – Boolean Functions – Canonical and Standard Forms – Simplification of Boolean Functions using Karnaugh Map – Quine-McCluskey method - Logic Gates – NAND and NOR Implementations.

UNIT II COMBINATIONAL LOGIC 9

Combinational Circuits – Analysis and Design Procedures – Binary Adder–Subtractor – Fast Adder – Decimal Adder – Binary Multiplier – Binary Divider – Magnitude Comparator – Decoders – Encoders – Multiplexers – Introduction to HDL – HDL Models of Combinational circuits

UNIT III SYNCHRONOUS SEQUENTIAL LOGIC 9

Sequential Circuits – Storage Elements: Latches, Flip–Flops, Realization of one Filp-Flop using another Flip-Flop; Analysis of Clocked Sequential Circuits – State Reduction and Assignment – Design Procedure – Registers and Counters – HDL Models of Sequential Circuits.

UNIT IV ASYNCHRONOUS SEQUENTIAL LOGIC 9

Analysis and Design of Asynchronous Sequential Circuits – Reduction of State and Flow Tables – Race-free State Assignment – Hazards.

UNIT V MEMORY AND PROGRAMMABLE LOGIC 9

RAM – Memory Decoding – Error Detection and Correction – ROM – Programmable Logic Array – Programmable Array Logic – Sequential Programmable Devices.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1 Solve Boolean functions using K-Map.(K3)
CO2 Analyze and construct Combinational Circuits.(K3)
CO3 Choose appropriate logic circuit to construct Synchronous Sequential Circuits.(K4)
CO4 Analyze and construct Asynchronous Sequential Circuits.(K4)
CO5 Construct various memories and Boolean functions using Programmable Logic Devices.(K3)

TEXTBOOKS

1 Morris R Mano, Michael D Ciletti, “Digital Design: With an Introduction to the Verilog HDL, VHDL, and SystemVerilog”, 6th Edition, Pearson Education, 2017

2 S Salivahanan, S Arivazhagan, “Digital Circuits and Design”, 5th edition, Oxford University Press, 2018

REFERENCE BOOKS

1 G K Kharate, “Digital Electronics”, Oxford University Press, 2010.

2 John F Wakerly, “Digital Design Principles and Practices”, 5th Edition, Pearson Education, 2017.

3 Charles H Roth Jr, Larry L Kinney, “Fundamentals of Logic Design”, 6th Edition, Cengage Learning, 2013.

4 Donald D Givone,“Digital Principles and Design”, Tata Mc Graw Hill, 2003.

5 Thomas L Floyd, “Digital Fundamentals”, 11th edition, Pearson Education, 2017.

6. Ronald J. Tocci, Neal S. Widmer and Gregory L. Moss 2018, Digital Systems: Principles and Applications, 12th edition, Pearson Higher Education, USA.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2											2	
CO2	3	2	3							3			2	2
CO3	3	2	3							3			2	2
CO4	3	2	3										2	
CO5	3	2	2										2	2
Total	15	10	11							6			10	6
Score	3	2	3							3			2	2

COURSE CODE	COURSE TITLE	L	T	P	E	C
ICS1161	UNIX AND SHELL PROGRAMMING	2	0	2	0	3

OBJECTIVES

- To understand the basics of UNIX operating system
- To learn basic UNIX commands and scripts
- To understand the principles of Unix File system
- To learn Shell Programming.

UNIT I UNIX BASICS 6

Unix Organization and structure –Introduction to flavours of Unix - Unix environment - Types of Shell – Types of Editors: nano and vi - Processes and threads - Basic file and directory commands

UNIT II UNIX FILE SYSTEM AND DATA STRUCTURES 6

File Systems - File and Permissions – Users and groups – System calls – Inode and Storage of files – File system data structures

UNIT III UNIX COMMANDS 6

Regular Expressions - sed: Addresses, Commands; awk: Patterns, Actions, Associative Arrays

UNIT IV BASIC SHELL PROGRAMMING 6

Shell scripts - Variables – Special Variables – Operators – Conditional constructs – Substitution and Loops – Pipes and Filters

UNIT V INPUT OUTPUT AND SIGNAL HANDLING 6

Arrays and File operations - Redirection operators – Command line processing - Processes and Cron Jobs – Trapping Signals – Executing multiple scripts

TOTAL PERIODS(THEORY): 30

LIST OF EXPERIMENTS

1. Experiment with basic Unix commands.
2. Make use of Unix commands for file and directory handling.
3. Experiment with security and file permissions.
4. Make use of pipes, quotes, aliases and variables.
5. Make use of filters.
6. Experiment with sed, awk
7. Develop Bash shell scripts to search for a pattern in a file
8. Develop Bash shell script to reverse and print the digits of a number.
9. Develop scripts using signals and cron jobs

TOTAL PERIODS(PRACTICAL): 15

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1 Explain the structure and functionalities of Unix operating System.(K2)
CO2 Apply in-memory file data structures to manipulate Unix file system.(K3)
CO3 Demonstrate the working of basic Unix commands.(K3)
CO4 Develop basic shell scripts to manipulate variables, file and directories.(K3)
CO5 Develop shell scripts to use cron jobs to schedule tasks.(K3)

TEXTBOOKS

1 Behrouz Forouzan, Richard Gilberg "UNIX and Shell Programming: A Textbook", Thomson Learning, 2005 (Units I & II).
2 Cameron Newham, Bill Rosenblatt "Learning the Bash Shell", Third Edition, O'Reilly, 2005 (Units III, IV & V).

REFERENCE BOOKS

1 Mike Loukides, Tim O'Reilly, Jerry Peek, Shelley Powers, "Unix Power Tools", 3rd Edition, O'Reilly, 2009.
2 Sumitabha Das, "Unix: Concepts and Applications", Tata McGraw Hill,2017.
3 Richard Blum, Christine Bresnahan, "Linux Command Line and Shell Scripting Bible", Wiley, 2015.
4 Stephen Kochan, Patrick Wood, "Shell Programming in UNIX, Linux and OSX", Addison Wesley, 2016.
5 Randal K Michael, "Mastering Unix Shell Scripting", 2nd Edition, Wiley, 2008.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO1 2**	**PSO 1**	**PSO 2**
CO1	3	2											2	
CO2	3	2											2	
CO3	3	3	3	3						3			2	2
CO4	3	3	3	3						3			2	2
CO5	3	3	3	3						3			2	2
Total	15	13	9	9						9			10	
Score	3	3	3	3						3			2	2

COURSE CODE	COURSE TITLE	L	T	P	E	C
IGA2176	HERITAGE OF TAMILS	1	0	0	0	1

UNIT I LANGUAGE AND LITERATURE 3

Language Families in India - Dravidian Languages – Tamil as a Classical Language – Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE3

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

UNIT III FOLK AND MARTIAL ARTS 3

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV THINAI CONCEPT OF TAMILS 3

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

UNIT V CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE 3

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

TOTAL PERIODS: 15

TEXTBOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr. K.K. Pillay) A joint publication of TNTB & ESC and RMRL (in print)
6. Social Life of the Tamils - The Classical Period (Dr. S. Singaravelu) (Published by:

International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr. S.V. Subaramanian, Dr. K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr. M. Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr. K.K. Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R. Balakrishnan) (Published by: RMRL) – Reference Book.

COURSE CODE	COURSE TITLE	L	T	P	E	C
ICS1111	**PRINCIPLES OF DIGITAL SYSTEM DESIGN LABORATORY**	**0**	**0**	**4**	**0**	**2**

OBJECTIVES

- To understand the various basic logic gates.
- To design and implement the various combinational circuits.
- To design and implement combinational circuits using MSI devices.
- To design and implement sequential circuits.
- To understand and code with HDL programming.

SUGGESTED EXERCIES

1. Verification of Boolean Theorems using basic gates.
2. Design and implementation of combinational circuits using basic gates for arbitrary functions, code converters.
3. Design and implement half/full adder and subtractor.
4. Design and implement a 2-bit ripple carry adder, 2-bit multiplier and 2-bit magnitude comparator using basic gates.
5. Design and implement combinational circuits using MSI devices:
   - 4-bit binary adder/subtractor
   - Parity generator/checker
   - Magnitude Comparator
   - Application using multiplexers
6. Design and implement shift-registers.
7. Design and implement synchronous counters.
8. Design and implement asynchronous counters.
9. Coding combinational circuits using HDL.
10. Coding sequential circuits using HDL.
11. Design and implementation of a simple digital system (Mini Project).

TOTAL PERIODS: 60

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1 Use Boolean simplification techniques to design a combinational circuit using logic gates and MSI devices.(**K3)**

CO2 Build different functional units for a digital computer system and model using VHDL/ Verilog HDL.(**K3)**

CO3 Choose the required functional units, construct the sequential circuits, and create a model using VHDL or Verilog HDL.(**K5)**

LABORATORY REQUIREMENT

Hardware:

1. Digital trainer kits - 25
2. Digital ICs required for the experiments in sufficient numbers

Software:

1. HDL simulator.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2		3					3	3			2	2
CO2	3	2	2	3					3	3			2	2
CO3	3	2	2	3					3	3			2	2
Total	9	6	4	9					9	9			6	6
Score	3	2	2	3					3	3			2	2

COURSE CODE	COURSE TITLE	L	T	P	E	C
ICS1112	PROBLEM SOLVING AND PROGRAMMING IN C LABORATORY	0	0	4	0	2

OBJECTIVES

- To write, test and debug simple C programs.
- To apply conditions and loops to solve problems using C.
- To achieve modular programming using functions.
- To develop program solutions using arrays, strings and structures.

SUGGESTED EXERCIES

Construct algorithm for the following problems by decomposing the problem into modules. Apply best practices such that the programming solution is self-documented. Test the algorithm / program with various test cases and adapt incremental design and implementation wherever required.

1. Programs using sequential construct (e.g., Sharon is traveling from city P to city Q. The distance between the two cities is a variable because she would like to use the equation for other cities also. She knows that she will be travelling half the distance at a speed of 40 miles per hour, and that the remaining half will be travelled at 55 miles per hour. Calculate the time that it will take to travel from one city to the next.)
2. Programs using conditional constructs (e.g., Calculate the water bill given the cubic feet of water used for Eureka Water Company, which charges the owner one of the following: (a) A flat rate of Rs. 750/- for usage up to and including 1000 cubic feet, (b) Rs. 5/- per cubic foot for usage over 1000 cubic feet and up to and including 2000 cubic feet, (c) Rs. 10/- per cubic foot for usage over 2000 cubic feet and up to and including 3000 cubic feet, (d) A flat rate of Rs.4500/- for usage over 3000 cubic feet.)
3. Programs using looping constructs (e.g., Find the maximum and minimum of the values entered by the user. The number of inputs might change and can be assumed to be stored as a value before each run. Use a trip value to stop the processing of the loop.)
4. Modular programming using functions (e.g., Generating marksheet for a student provided with 3 subject marks. Define user-defined functions to input student details, compute total, average, grade of a subject, GPA)
5. Solving mathematical formulas using recursive functions. (e.g., Calculate $y = 1 – x + x^2/2 -x^3/6 +x^4/24 + . . . + (-l)^n x^n/n!$)
6. Programs using arrays and functions (e.g., John has a weather station in his house. He has been keeping track of the fastest wind speed for each day for two weeks. He would like to know the average wind speed over the two weeks, the days on which the highest wind speed and the lowest wind speed were recorded, and the difference between the highest wind speed recorded and each day’s average wind speed.)
7. Programs using strings (e.g., Spam message detection based upon pattern matching)
8. Programs using structures and functions (e.g., Accept the following information for each team in baseball: Team name, Number of wins, Number of losses, Number of hits, Number of runs, Number of warnings. Reorder and print the list of teams according to their win-lose records, insert and remove teams from the list.)
9. Programs using files (e.g., Writing and reading records from a file and modifying them)

TOTAL PERIODS: 60

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1 Analyze the given problem and choose suitable control constructs to develop programming solutions.(**K5)**

CO2 Solve problems using arrays, strings and implement modular programming.(**K3)**

CO3 Develop applications using pointers, structures and files.(**K3)**

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	3					1				2	2
CO2	3	2	2	3									2	2
CO3	3	2	2	3									2	2
Total	9	7	7	9									6	6
Score	3	3	3	3					1				2	2

COURSE CODE	COURSE TITLE	L	T	P	E	C
IMA1276	**PROBABILITY AND STATISTICAL TECHNIQUES**	**3**	**1**	**0**	**0**	**4**

OBJECTIVES

- To identify the standard distributions and apply them in solving problems.
- To understand the concept of two-dimensional random variables and solve problems in finding the joint probabilities and correlation between them.
- To understand estimation theory and apply the principle of least squares.
- To use testing of hypothesis for parameter estimation.
- To understand and perform various non-parametric tests

UNIT I ONE DIMENSIONAL RANDOM VARIABLES 12

Discrete and continuous random variables – Moments – Moment generating function –Binomial, Poisson, Geometric, Uniform, Exponential, and Normal distributions - Functions of random variable

UNIT II TWO DIMENSIONAL RANDOM VARIABLES 12

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and Linear regression – Transformation of random variables – Applications of Central Limit Theorem.

UNIT III ESTIMATION THEORY 12

Estimation: Point Estimation, Interval Estimation - Unbiased estimators – Maximum likelihood estimation – Curve fitting by principle of least squares – Regression Curves – Applications in data science

UNIT IV TESTING OF HYPOTHESIS 12

Sampling Distributions - Type I and Type II errors - Large sample test : Test based on Normal distribution (Single, difference of mean and proportions) – Small Sample Test : Test based on t - distribution for testing of single mean and difference of means – F-test for variance - χ^2 $\chi 2$ -test: Independence of attributes and goodness of fit.

UNIT V NON-PARAMETRIC TESTS 12

Introduction to Non- parametric test - Sign test - Wilcoxon signed rank test - Mann-Whitney test - Run test - Kolmogorov-Smirnov test - Spearman's and Kendall's test.

TOTAL PERIODS (THEORY): 60

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1: Identify standard distributions and apply them.
CO2: Solve problems in two-dimension random variables and find the correlation between them.
CO3: Evaluate the unbiasedness of estimators and apply for problems in data science
CO4: Identify and apply the suitable testing of hypothesis under normal, t , F and χ^2 $\chi 2$ - tests.
CO5: Use the concepts of Non-Parametric Testing in solving problems

Textbooks:

1. Veerarajan T, Probability and Statistics, Random Processes and Queueing Theory, First edition, McGrawHill,2018.
2. I.R. Miller, J.E. Freund and R. Johnson, Probability and Statistics for Engineers, 8th Edition, 2015.
3. Gupta S. C., Kapoor V. K., Fundamentals of Mathematical Statistics, Sultan and Sons, New Delhi, 2001.

Reference Books:

1. Trivedi.K.S., Probability and Statistics with Reliability, Queueing and Computer Science Applications, John Wiley and Sons, 2nd Edition, 2002.
2. Hwei Hsu, Schaum's Outline of Theory and Problems of Probability, Random Variables and Random Processes, Tata McGraw Hill Edition, New Delhi, 2004.
3. Yates. R.D. and Goodman. D. J., Probability and Stochastic Processes, Wiley India Pvt. Ltd.,Bangalore, 2nd Edition, 2012.
4. 1. Ibe. O.C., Fundamentals of Applied Probability and Random Processes, Elsevier, 1st Indian Reprint, 2007.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										
CO2	3	2										
CO3	3	2										1
CO4	3	2										1
CO5	3	2										1
Total	15	10										3
Score	3	2										1

COURSE CODE	COURSE TITLE	L	T	P	E	C
IPH1276	PHYSICS FOR INFORMATION SCIENCE	3	0	0	0	3

OBJECTIVES

- Develop an understanding of quantum mechanical phenomena and the associated theory.
- Gain knowledge on the physics of semiconductors.
- Understand the origin of magnetism and data storage principles.
- Study the fundamentals of optical materials and their applications to display devices.
- Develop an overview of nanomaterials and their applications to nano devices.

UNIT I QUANTUM PHYSICS **9**

Black body radiation – Planck's theory (derivation) – Deduction of Wien's displacement law and Rayleigh-Jeans law from Planck's theory – Properties of Matter waves – wave particle duality – Schrödinger's wave equation – Time independent and time dependent equations – Physical significance of wave function – Particle in a one dimensional box and extension to three dimensional box – Degeneracy of electron energy states – Quantum free electron theory – Density of states – Fermi-Dirac statistics– Free electron concentration in metals (no derivation).

UNIT II SEMICONDUCTORS **9**

Concept of Band theory – Classification of semiconductors based on doping and band gap – Intrinsic semiconductor – Concept of hole – carrier concentration derivation – Fermi level and its variation with temperature – electrical conductivity – band gap determination – Extrinsic semiconductors – Carrier concentration derivation in n-type semiconductors – Variation of Fermi level with temperature and impurity concentration.

UNIT III MAGNETISM AND DATA STORAGE PRINCIPLES **9**

Origin of magnetic moment – Bohr magneton , atomic magnetic moments-magnetic permeability and susceptibility – Microscopic and macroscopic classification of magnetic materials – comparison of Dia and Para magnetism and Ferro magnetism – Ferromagnetism : origin and exchange interaction-saturation magnetization and Curie temperature - Domain theory – Hysteresis (based on domain theory) – soft and hard magnetic materials – Magnetic principles in computer data storage – Magnetic hard disc – GMR Sensor- Principle of GMR- Parts of a magnetic hard disc - CD-ROM-WORM-Magneto-optical storage, recording and reading systems - Holographic optical data storage.

UNIT IV OPTICAL MATERIALS AND DISPLAY DEVICES **9**

Absorption emission and scattering of light in metals, insulators and semiconductors (concepts only)-Carrier generation and recombination in semiconductors –- LED – OLED- Semiconductor Laser diodes (Homo and double hetero junction) –Photo detectors – Photodiodes and Photoconductors (concepts only) – Solar cell – Liquid crystal display - Charged Coupled Devices.

UNIT V NANO DEVICES **9**

Nano materials – Properties, Applications, Size effect-Density of states in quantum well, quantum wire and quantum dot structures- Quantum confinement- Quantum well and Quantum dot lasers-Franz-Keldysh effect-Quantum Confined Stark effect–Quantum Well Electro Absorption modulators-Magnetic semiconductors – Spintronics.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1 Explain the basic quantum mechanical concepts to correlate with experimental results. (**K2)**

CO2 Explain the basics of semiconductor physics to be applicable in semiconductor devices. (**K2)**

CO3 Illustrate magnetic properties of materials and their applications to data storage.(**K2)**

CO4 Relate the use of optical materials to display devices.(**K2)**

CO5 Explain quantum mechanics of nanostructures and their application to Nano electronics and Spintronics.(**K2)**

TEXTBOOKS

1 S. Singaravadivelu, "Physics for Information Science and Technology", Veda Publications, 2023.

REFERENCE BOOKS

1 Kasap, S.O., Principles of Electronic Materials and Devices, (Special Indian Edition, McGraw-Hill Education, 3rd Edition, 2017.

2 Kittle Charles, "Introduction to Solid State Physics", Wiley, 2004

3 Serway, R.A. & Jewett, J.W. — Physics for Scientists and Engineers. Cengage Learning, 2010.

4 Tipler, P.A. & Mosca, G. — Physics for Scientists and Engineers with Modern Physics', W. H. Freeman, 2007.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
Total												
Score												

COURSE CODE	COURSE TITLE	L	T	P	E	C
ICS1201	FUNDAMENTALS OF COMPUTER ORGANIZATION AND ARCHITECTURE	3	0	0	0	3

OBJECTIVES

- To learn the basic structure and operations of a computer
- To understand and develop proficiency in the design and implementation of Arithmetic and Logic Unit (ALU), fixed-point and floating-point arithmetic units
- To design and implement a MIPS processor with a pipelined datapath and control implementation
- To gain a comprehensive understanding of memory hierarchies, cache systems, virtual memories, and effective communication with input/output (I/O) devices in computer systems.
- To understand parallelism and multi-core processors.

UNIT I COMPUTER ARCHITECTURE: HISTORY, TRENDS, PERFORMANCE 9

Introduction; Historical Perspective of Computers; Defining Computer Architecture; Trends in Technology; Trends in Power and Energy in Integrated Circuits; Dependability; Functional Units – Basic Operational Concepts – Performance; MIPS Instructions: Operations, Operands –Instruction representation – Logical operations – Decision making; Addressing modes; Parallelism and Instructions: Synchronization

UNIT II COMPUTER ARITHMETIC 9

Addition and subtraction; Multiplication; Division; Floating Point Representation: Floating point Operations, Parallelism and Computer Arithmetic: Subword Parallelism

UNIT III PIPELINING AND CONTROL UNIT 9

Processor: MIPS implementation - Building a datapath; Control implementation scheme; Pipelining: Pipelined datapath and control – Handling data hazards & Control hazards – Static Branch Prediction, Dynamic Branch Prediction,– Exceptions; Instruction-Level Parallelism: Concepts and Challenges; Reducing Branch Costs with Advanced Branch Prediction

UNIT IV MEMORY & I/O SYSTEMS 9

Memory Hierarchy; Memory technologies; Cache Memory: Basics and cache mapping techniques; Measuring and improving cache performance; Virtual Memory: TLBs; Parallelism and Memory Hierarchy: Redundant Arrays of Inexpensive Disks; Accessing I/O devices – Interrupts; Direct memory access; Bus structure – Bus operation – Arbitration; Interface circuits; USB.

UNIT V PARALLEL ARCHITECTURES 9

Parallel processing challenges; Flynn's classification: SISD – MIMD – SIMD – SPMD and Vector Architectures; Hardware multithreading; Multi-core processors and other shared memory; Multiprocessors, Clusters, Warehouse Scale Computers, and Other Message-Passing Multiprocessors, Introduction to Graphics Processing Units

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1 Explain the basics structure of computers, operations and instructions and measure their performance with suitable metrics.(K3)

CO2 Construct arithmetic and logic unit.(K3)
CO3 Analyse and compare pipelined vs. unpipelined execution unit performance.(K4)
CO4 Analyse various memory systems and understand I/O communication(K4)
CO5 Explain parallel processing architectures.(K2)

TEXTBOOKS

1 David A Patterson, John L Hennessy, "Computer Organization and Design: The Hardware/Software Interface", 5th Edition, Morgan Kaufmann / Elsevier, 2014.

2 Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Naraig Manjikian, "Computer Organization and Embedded Systems", 6th Edition, Tata McGraw Hill, 2022.

REFERENCE BOOKS

1 John L Hennessey, David A Patterson, "Architecture – A Quantitative Approach", 5th edition, Morgan Kaufmann, Elsevier, 2012 (Units I, III)

2 John P Hayes, "Computer Architecture and Organization", 3rd Edition, Tata McGraw Hill, 2012

3 Morris Mano M, "Computer System Architecture", Revised 3rd Edition, Pearson Publication, 2017

4 Chakraborty P, "Computer Architecture and Organization", JAICO Publishing House, 2010

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO1 1**	**PO12**	**PSO 1**	**PSO2**
CO1	3	2												
CO2	3	2	3							2			3	2
CO3	3	2	3										3	2
CO4	3	2	3							2		2	3	2
CO5	3	2								2		2		
Total	15	10	9							6		4	9	6
Score	3	2	3							2		2	3	2

COURSE CODE	COURSE TITLE	L	T	P	E	C
ICS1261	SOFTWARE DEVELOPMENT AND PRACTICE USING PYTHON	1	0	4	3	4

OBJECTIVES

- To solve problems using Python programming constructs such as lists, dictionaries, tuples and files.
- To progress from fundamental principles to larger engineering systems.
- To develop software projects by applying computing fundamentals.
- To validate the correctness of the system using various test cases.
- To motivate independent learning, exploration and teamwork.

Course Structure: Project + Theory + Lab = 30 + 15 + 30 = 75 Periods

PROJECT DEVELOPMENT

Students will be divided into teams. Each team will be given problem specifications to develop a project. Teams will be mentored to follow the best software engineering practices to develop simple software projects. A sample problem specification is as follows:

Sample Project:

Title: A mediating Platform for Job seekers and Talent acquisition Managers

Problem Statement / Objective:

To create a mediating platform through which,

i. Job seekers can explore open positions which match their profiles.
ii. Talent acquisition managers can search for deserving applicants who could qualify for their job requirements.

Domain Specification:

Let *S* be the set of Job-seekers, $S = \{S_1, S_2, \ldots\}$, where S_1, S_2, and so on are members of *S*
A member of *S* can be defined as a tuple with fields containing personal, educational, experience, skills, and certifications kind of details.

Let *A* be the set of Available jobs posted by the talent acquisition team, $A = \{A_1, A_2, \ldots\}$, *where* A_1, A_2, and so on are members of *A*

A member of *A* can be defined as a tuple with fields containing details related to the job profile, like the experience expected, qualifications, certifications, etc.

Starting point: Identify the fields of *S* and *A* and redefine them.

Input: Input sets of Job-seekers and Available jobs by specifying the data for the identified fields

Output: Every member of *S* should be recommended with members of *A* matching their profiles. Every member of *A* should be recommended with members of *S* matching their requirements.

Problem Formulation: Frame constraints that involve the fields of *S* and *A*, and their relationships. Recommendation (in percentage) should be computed based on the degree of satisfiability of the constraints framed.

Constraints: *For example*, a member of *A* can specify "Cisco Certification in Networking" as a compulsory constraint and "Experience > 7 years" as a desirable constraint. A member of *S* can specify that "Salary > 5 Lakh per annum" is a compulsory constraint and "No night shifts" is a desirable constraint. Understand these constraints as given as input to appropriate fields of *S* and *A*. Weightage can be given to constraints based on whether it is compulsory or desirable. Each satisfying constraint should be given a score multiplied by its weightage. Recommendation percentage is the

ratio of accumulation of weighted scores of all the satisfying constraints to the weighted scores of all the available constraints multiplied by 100.

Rubrics for evaluating the project:

Assessment tool	Project Execution	Viva-Voce	Presentation	Project Report
Review 1	--	10%	60% Problem formulation, scope, literature survey, limitations.	30% A report on design of various modules, detailed plan and tools.
Review 2	90% for Implementation & Demo	10%	--	--
End semester Evaluation	50% (Exploration, solution, quality of implementation)	10%	20%	20% Design, implementation, testing and results.

STUDIO PERIODS: 30

THEORY

UNIT I SOFTWARE DESIGN AND DEVELOPMENT BASICS **3**

Analyzing the Problem, Software Engineering Fundamentals: Project management, feasibility study. Software Development Life Cycle; Introduction to Unified Modeling Language: Use Case Diagrams, Sequence Diagrams, Activity Diagrams. Software Design: Structure Chart; Test case design

UNIT II BASIC CONSTRUCTS OF PYTHON **3**

Identifiers, Keywords, Variables, Operators, Data types, Reading and Printing, Control Flow Statements: conditionals, while loop, for loop, break, continue, pass.

UNIT III FUNCTIONS AND STRINGS **3**

Functions: Built-in function, definition, function call, scope of variables, parameters and arguments; Recursion; Strings: String operations, string slicing and joining, string methods and formatting strings.

UNIT IV LISTS AND TUPLES **3**

Lists: Traversing a list, mutability, list operations, list slices, list methods, aliasing, list arguments; Tuples: immutability, tuple assignment, tuple as return values, tuple operations.

UNIT V DICTIONARIES AND FILES **3**

Dictionaries: Methods, looping and dictionaries, reverse lookup, dictionary with lists and tuples; Files: reading and writing files.

LECTURE PERIODS: 15

LAB ASSIGNMENTS

1.Programs using conditions and looping constructs (e.g., printing patterns, sum of digits, finding prime numbers)

2.Programs using functions and recursive functions (e.g., sum of all the digits of a number, Fibonacci series)

3. Programs using strings (e.g., Implementing concatenation, substring, spilt without using string library functions)

4. Programs using lists and tuples (e.g., sorting, searching, matrix addition, multiplication)

5. Programs using dictionaries (e.g., Creating histogram from the given text)

6. Programs using files (e.g., Counting number of words and lines in a file)

LAB PERIODS: 30

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1 Formulate the problem elaborating the requirements and identifying the scope and boundaries. (**K6)**

CO2 Apply engineering fundamentals in computer science for problem solving.(**K3)**

CO3 Design and develop solutions adapting novel technologies, tools, and techniques.(**K6)**

CO4 Communicate effectively through reflections, reports, and presentations.

CO5 Work in teams to develop modules and integrate them.

CO6 Analyze the impact on health, safety, society, environment as well as underlying legal and ethical considerations whichever are applicable.

CO7 Solve programming problems using basic constructs in Python programming language.(**K3)**

TEXTBOOKS

1 Maureen Sprankle, Jim Hubbard, “Problem Solving & Programming Concepts”, Pearson Education, 9th edition, 2011.

2 Sridhar, Indumathi, Hariharan, "Python Programming", Pearson, 2023.

REFERENCE BOOKS

1 Allen B. Downey, “Think Python: How to Think Like a Computer Scientist”, 2nd edition, Green Tea Press, Shroff/O’Reilly Publishers, 2016

2 Gowrishankar S, Veena A, “Introduction to Python Programming”, CRC Press / BSP Books, 2019.

3 Ashok Namdev Kamthane, Amit Ashok Kamthane, "Programming and Problem Solving with Python", 2nd edition, McGraw Hill Education (India) Private Limited, 2020.

4 John V Guttag, “Introduction to Computation and Programming Using Python”, MIT Press, 2016.

5 Timothy A. Budd, “Exploring Python”, Mc-Graw Hill Education (India) Private Ltd., 2011.

6 Kenneth A. Lambert, “Fundamentals of Python: First Programs with MindTap”, 2nd Edition, Cengage Learning, 2019.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO1 1**	**PO12**	**PSO 1**	**PSO2**
CO1	3	3	3	3									3	3
CO2	3												2	
CO3			3	3	3			3					3	3
CO4										3		3		
CO5									3		3			
CO6						3	3							
CO7	2	3	3	3	2								3	3
Total	8	6	9	9	5	3	3	3	3	3	3	3	11	9
Score	3	3	3	3	3	3	3	3	3	3	3	3	3	3

COURSE CODE	COURSE TITLE	L	T	P	E	C
ICS1202	DATA STRUCTURES AND ALGORITHMS	3	0	0	0	3

OBJECTIVES

- To comprehend the notion of linear and non-linear data structures.
- To apply the linear and non-linear data structures to various problems.
- To choose suitable data structure to solve the given problem.

UNIT I Introduction to Data Structures 8

Abstract Data Type (ADT); List ADT: Array based and Linked List based Implementations; Doubly Linked List; Circular Linked List; Applications of List: Polynomial Manipulation; Asymptotic Notations: big-Oh; Efficiency of algorithms: Notion of time and space complexity; Analysis of non-recursive and recursive algorithms.

UNIT II Linear Data Structures 9

Stack ADT: Implementation of Stack; Applications of Stack: Balanced Symbols, Conversion of Infix to Postfix, Expression Evaluation; Queue ADT: Array Implementation of Queue.

UNIT III Non-Linear Data Structure - Trees 9

Tree Preliminaries; Binary Tree: Traversal on Trees, Expression Tree; Threaded Binary Tree; Binary Search Tree ADT; AVL Tree operations and implementation; Priority queues using Binary Heap, Binomial heap, and Fibonacci heap.

UNIT IV Non-Linear Data Structure - Graphs 10

Graphs: Basic definition and Representation of Graphs; Graph Traversals: Breadth First Search and Depth First Search; Topological Sort; Shortest Path: Dijkstra's Algorithm, Floyd Warshall Algorithm; Combinatorial problems in Graphs: Clique; Matching; Graph Coloring;

UNIT V Hashing and Disjoint Set Data Structure 9

Hash ADT: Hash function, Separate chaining, Open addressing, Rehashing, Extendible hashing, Cuckoo Hashing; Applications of Hashing technique; Sorting algorithms: Insertion sort, Merge sort and Shell sort; Algorithms for Disjoint Set operations.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1 Develop programs using arrays, linked lists for various applications and analyse their time complexity.(K4)
CO2 Apply the operations of Stack and Queue to develop solutions for various problems.(K3)
CO3 Develop programs for various operations of tree. (K3)
CO4 Solve problems using graph data structure. (K3)
CO5 Apply hashing and disjoint set to solve various computing problems.(K3)
CO6 Choose appropriate data structure to solve the given problem.(K5)

TEXTBOOKS

1. M A Weiss, “Data Structures and Algorithm Analysis in C”, 2nd Edition, Pearson Education, 2002.
2. Richard F Gilberg, Behrouz A Forouzan, “Data Structures: A Pseudocode Approach with C”, 2nd Edition, Cengage India, 2007.

REFERENCE BOOKS

1. Thomas H Cormen, Charles E Leiserson, Ronald L Rivest, Clifford Stein, “Introduction to Algorithms”, 3rd Edition, PHI Learning Private Limited, April 2022
2. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekar, “Fundamentals of Computer Algorithms”, 2nd Edition, University Press, 2017.
3. S Sridhar, “Design and Analysis of Algorithms”, 1st Edition, Oxford University Press, 2015.
4. Byron Gottfried, “Schaum's Outline of Programming with C”, 4th edition, 2019, McGraw Hill Education (India)
5. A V Aho, J E Hopcroft, J D Ullman, “Data Structures and Algorithms”, Pearson Education, 1st Edition Reprint, 2003.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3											
CO2	3	3	3											
CO3	3	3	3									2		
CO4	3	3	3									2	3	
CO5	3	3	3										3	
CO6	3	3	3							2		2	3	2
Total	18	18	18							2		6	9	2
Score	3	3	3							2		2	3	2

COURSE CODE	COURSE TITLE	L	T	P	E	C
IGA1276	TAMILS AND TECHNOLOGY	1	0	0	0	1

UNIT I WEAVING AND CERAMIC TECHNOLOGY 3

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY 3

Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

UNIT III MANUFACTURING TECHNOLOGY 3

Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold - Coins as source of history - Minting of Coins – Beads making-industries Stone beads - Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.

UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY 3

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING 3

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

TOTAL PERIODS: 15

TEXT – CUM – REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr. K.K. Pillay) A joint publication of TNTB & ESC and RMRL – (in print)

6. Social Life of the Tamils - The Classical Period (Dr. S. Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr. S.V. Subaramanian, Dr. K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr. M. Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr. K.K. Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R. Balakrishnan) (Published by: RMRL) – Reference Book.

COURSE CODE	COURSE TITLE	L	T	P	E	C
ICY1276	**ENVIRONMENTAL SCIENCE**	**3**	**0**	**0**	**0**	**0**

OBJECTIVES

- To better understand human relationships, perceptions and policies towards the environment
- To focus on design and technology for improving environmental quality

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 9

Definition, scope and importance of environment – concept, structure and function of an ecosystem – energy flow- food chains, food webs and ecological pyramids – ecological succession Introduction to biodiversity definition and types– values of biodiversity- India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity-endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

UNIT II NATURAL RESOURCES 9

Uses, over-exploitation of natural resources: Forest, Water, Mineral, Food, Energy and Land. Case studies on over exploitation of natural resources – Role of an individual in conservation of natural resources- Equitable use of resources for sustainable lifestyles.

UNIT III CURRENT ENVIRONMENTAL ISSUES 9

Environmental issues – causes, effects and control measures of Pollution of (a) Air (Smog, acid rain, climate change and global warming, ozone layer depletion) (b) Water (rainwater harvesting, watershed management and wastewater treatment) (c) Soil (solid waste management, wasteland reclamation) (d)Electronic waste. Population explosion, Resettlement and rehabilitation of people and Disaster management

UNIT IV ENGINEERING INTERVENTIONS TO REDUCE ENVRIONNMENTAL STRESSES 9

Role of information technology in environment – Remote Sensing – satellites and sensors – Geographical Information Systems(GIS) – Applications. Environment data base management system. Green chemistry – Principles – Green buildings – Advantages of green buildings over conventional buildings – Electric and Hybrid Electric Vehicles (HEV)

UNIT V ENVIRONMENTAL REGULATIONS 9

Environmental Ethics for sustainable development – Human rights – Environmental Impact Assessment – Ecomark – role of NGO- Central and state pollution control boards – Air (Prevention and Control of Pollution) act 1981 – Water (Prevention and control of Pollution) act 1974 – Wildlife protection act 1972 – Forest conservation act 1980 – The National Green Tribunal Act 2010

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1 Explain the structure and functions of the ecosystems and diversity among life forms within an ecosystem.(K2)

CO2 Explain the importance of various natural resources and its sustainable use.(K2)

CO3 Explain the various environmental issues such as pollution, population explosion etc and suggest remedial measures.(K2)
CO4 Illustrate the role of engineering techniques to minimize environmental stress.(K2)
CO5 Explain the role of various environmental machineries and to ensure proper environmental regulation.(K2)

TEXTBOOKS

1 Anubha Kaushik, C P Kaushik, "Environmental Science and Engineering", New Age International Publishers, 14thEdition, 2014.
2 Benny Joseph, "Environmental Science and Engineering", Tata McGraw-Hill, New Delhi, 2006.

REFERENCE BOOKS

1 Gilbert M Masters, "Introduction to Environmental Engineering and Science", 2nd edition, Pearson Education, 2004
2 G Tyler Miller, Scott E Spoolman, "Environmental Science", Cengage Learning India PVT Ltd, New Delhi, 2014.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1						3	3							
CO2						3	3							
CO3						3	3							
CO4						3	3							
CO5						3	3							
Course						3	3							

COURSE CODE	COURSE TITLE	L	T	P	E	C
ICS1211	DATA STRUCTURES AND ALGORTIHMS LABORATORY	0	0	4	0	2

OBJECTIVES

- Develop program solutions for various problems.
- Apply suitable linear and nonlinear data structures for a given problem statement
- Design the data structure for the given problem and implement the solution.

SUGGESTED EXERCIES

1. Applications of Array
2. Applications of Linked List
3. Applications of Doubly Linked List
4. Applications of Stack
5. Applications of Queue
6. Implementation of Expression Tree
7. Applications of Binary Search Tree
8. Applications of Graph Traversal Techniques
9. Implementation of Shortest path algorithms
10. Solving Clique, Matching and Coloring problems for small graphs
11. Implementation of Hash Table
12. Applications of Disjoint Set
13. Applications of Sorting algorithms
14. Mini Project

TOTAL PERIODS: 60

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1 Solve the applications using array, list, stack and queue data structures.(K3)

CO2 Apply tree, graph, hashing and disjoint set data structures to solve real-world applications. (K3)

CO3 Select real-world problem in team by applying suitable data structure with best practices and document its methodology.(K5)

Laboratory Requirement for Batch of 25 Students

Hardware

PC - 25 Nos

Software

GCC compiler

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3							2		
CO2	3	3	3	3	3							2	3	
CO3	3	3	3	3	3				2	2	2	2	3	
Total	9	9	9	9	9				2	2	2	6	6	2
Score	3	3	3	3	3				2	2	2	2	3	2

COURSE CODE	COURSE TITLE	L	T	P	E	C
IMA1351	LINEAR ALGEBRA	3	1	0	0	4

OBJECTIVES

- To study the concept of vector spaces, basis and dimension.
- To understand the linear transformation between vector spaces and dimension theorem.
- To study inner product spaces and find pseudo inverse of non-square matrices.
- To obtain various types of matrix decompositions.
- To apply the concept of matrices in linear coding theory

UNIT I VECTOR SPACES 12

Vector spaces – Subspaces – Linear combinations and system of Linear equations – Linear independence and Linear dependence – Bases and Dimensions.

UNIT II LINEARTRANSFORMATION 12

Linear Transformation – Matrix representation of Linear Transformation – Null space, Range space and dimension theorem.

UNIT III INNER PRODUCT SPACE 12

Inner product and norms – Gram Schmidt orthonormalization process – Pseudo Inverse – Method of least squares.

UNIT IV MATRIX DECOMPOSITION 12

Positive definite matrices - Cholesky decomposition - LU decomposition - QR decomposition- Singular value decomposition.

UNIT V LINEAR CODING THEORY 12

The notion of a code - Linear codes defined by generating matrices - Error correcting codes – Hamming distance – Hadamard codes – Perfect linear codes – perfect codes and cosets.

TOTAL PERIODS: 60

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Apply the concepts of basis and dimension of vector spaces in solving problems	**K3**
CO2	Use concepts of linear transformation in verifying dimension theorem	**K3**
CO3	Construct orthonormal basis using inner products and find pseudo inverses	**K3**
CO4	Analyze the matrices using decomposition techniques	**K4**
CO5	Apply the concepts of coding techniques for the design of systems	**K3**

TEXTBOOKS:

1. Friedberg A.H, Insel A.J. and Spence L, Linear Algebra, Pearson Education, 5th Edition, 2019.
2. Bernard Kolman, David R. Hill, Introductory Linear Algebra, Pearson Educations, New Delhi, 8th Edition, 2009.
3. S. Kumaresan, Linear algebra - A Geometric approach, Prentice Hall of India (2000).

REFERENCES BOOKS:

1. Richard Branson, Matrix Operations, Schaum's outline series, 1989.
2. Strang G, Linear Algebra and its applications, Thomson (Brooks / Cole) New Delhi, 4th Edition, 2005.
3. James Carrell, Fundamentals of Linear algebra, 2005.
4. S. Lang, Introduction to Linear Algebra, 2nd Edition, Springer, 2012.
5. K. Hoffman and R. Kunze, Linear Algebra,2nd Edition, Pearson, 2015.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										
CO2	3	2										
CO3	3	2										1
CO4	3	2										1
CO5	3	2										1
Total	15	10										3
Score	3	2										1

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1301	PRINCIPLES OF OBJECT-ORIENTED PROGRAMMING	3	0	0	3

OBJECTIVES

- To learn the basics of Object-Oriented Programming
- To know the principles of inheritance and polymorphism
- To learn the concepts of exception handling and packages.
- To learn the concepts of generic methods and generic collections.
- To demonstrate multitasking through multithreading

UNIT I OOPS CONCEPTS AND JAVA PROGRMMING 9

Principles of OOP: Classes - Objects - Data hiding - Data encapsulation - Inheritance - Polymorphism; Definition of Classes: Objects - Methods - Access specifiers - Static and final classes and members; Object Construction and Destruction - Fundamental programming structures in Java; Streams: Input-Output - this reference- overloading methods and constructors - garbage collection, exploring string class - Examples in Java.

UNIT II INHERITANCE AND POLYMORPHISM 9

Inheritance: Definition - Types of inheritance: Single - Multilevel - Multiple - Hierarchical; Subclass constructors; Polymorphism: dynamic binding - method overriding - abstract classes and methods; Interfaces in Java: Definition - Interfaces VS Abstract classes - Implementation - Extending interfaces - Inheritance versus delegation - Inheritance rules - Inner classes - Examples in Java.

UNIT III EXCEPTION HANDLING AND PACKAGES 9

Exception Handling: Benefits of exception handling - Classification of exceptions - Exception hierarchy - Checked exceptions and unchecked exceptions - Usage of try, catch, throw, throws and finally, rethrowing exceptions - Built in exceptions - Creating own exception sub classes; Packages: Defining, creating and accessing a package - Importing packages - Examples in Java.

UNIT IV GENERIC CLASS AND COLLECTIONS 9

Definition and concepts: Generic classes and generic methods - Generic types - Restrictions and limitations - Inheritance rules for generic types; Introduction to collections - Collection Classes and Interfaces: Array list - Linked list - Queue - Set - Trees; Iterators for collections - Map class - Examples in Java.

UNIT V FILES AND FEATURES 9

Files: streams - Byte streams - Character stream - text input/output - binary input/output - Random access file operations – Sealed Classes - Pattern Matching - Sequenced Collections - Vector API - Lambda expressions, - var-args - methods references – default methods - functional interface - Examples in Java.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Use classes and objects for problem solving	**K3**
CO2	Develop programs using inheritance and interfaces	**K3**
CO3	Apply the concepts of packages and exception handling	**K3**
CO4	Choose suitable collection framework to develop the given application	**K5**
CO5	Develop applications using files and advanced features	**K3**

TEXTBOOKS

1. Herbert Schildt, "Java: The Complete Reference", 12th Edition, McGraw Hill Education, 2022.
2. Danny Poo, Derek Kiong, Swarnalatha Ashok, "Object-Oriented Programming and Java",2nd Edition, Springer Publication, 2008.

REFERENCE BOOKS

1. Timothy Budd, "Understanding Object-oriented programming with Java", Updated Edition, Pearson Education, 2000
2. C Thomas Wu, "An introduction to Object-oriented programming with Java", 5th Edition, Tata McGraw-Hill Publishing company Ltd., 2009.
3. CayS Horstmann, Gary Cornell, "CoreJava Volume – I Fundamentals", 10th Edition, Prentice Hall, 2016.
4. Dr. Edward Lavieri, "Mastering Java 11" - Second Edition, Packt Publishing, 2018.
5. Steven Holzner, "Java 2 Black book", Dreamtech press, 2018.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	3	3											2	
CO2	3	3	3										2	
CO3	3	3	2		3								2	
CO4	3	3	3		3	2	2	3	3	2	3	2	2	2
CO5	3	3	3										2	
Total	15	10	11		6	2	2	3	3	2	3	2	10	2
Score	3	3	3		3	2	2	3	3	2	3	2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1302	INTRODUCTION TO DATA SCIENCE	3	0	0	3

OBJECTIVES

- To learn fundamentals of Data Science using Python.
- To develop Python program for analysis of data using Python libraries.
- To understand probability distributions.
- To understand statistical Inferences.
- To be familiar with supervised and unsupervised methods in machine learning.

UNIT I INTRODUCTION TO DATA SCIENCE 9

Introduction: Need for data science – Benefits and uses – Facets of data – Big data ecosystem - Data science process: Defining Research goals- Retrieving data- Cleansing, integrating and transforming data – Data analysis – Build the models – Presenting findings and building applications.

UNIT II DATA PREPROCESSING 9

Data manipulation: Reading and selection – Filtering missing data – Sorting – Grouping – Ranking and plotting; Data Manipulation with Pandas; Sample programs to pre-process – Data visualization using Matplotlib.

UNIT III DESCRIPTIVE STATISTICS 9

Introduction – Data Preparation – Exploratory Data Analysis: Data summarization – Data distribution Measuring asymmetry – Continuous Distribution: Normal Distribution – Exponential Distribution - Central limits theorem; Estimation: Mean – Variance - Sampling – Covariance – Correlation.

UNIT IV STATISTICAL INFERENCE 9

Introduction – Measuring the Variability in Estimates: Point estimates – Confidence intervals; Significance Testing: Hypothesis Testing using confidence intervals – Testing Using p-values – ANOVA.

UNIT V MACHINE LEARNING 9

Supervised Learning: Introduction – kNN classifier; Regression analysis: Linear regression – Logistic regression; Unsupervised Learning: Introduction – Clustering – Kmeans; Evaluation metrics.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Demonstrate the need for Data Science and Data science process	**K2**
CO2	Develop Python programs for data manipulation and data visualization	**K3**
CO3	Apply statistical techniques to explain and analyze the data	**K3**
CO4	Examine a population and make inferences using statistical inference	**K4**
CO5	Design a machine learning based solution to solve a real-world problem	**K6**

TEXTBOOKS

1 Davy Cielen, Arno D B Meysman, Mohamed Ali, “Introducing Data Science – Big data, Machine Learning, and more using Python tools”, Manning Publications Co, 2016.

2 Laura Igual, Santi Segua, “Introduction to Data Science – A Python Approach to Concepts, Techniques and Applications'”, Springer Nature, 2017

REFERENCE BOOKS

1 Jake VanderPlas, ``Python Data Science Handbook: Essential Tools for Working with Data", O'Reilly Media, 2016

2 Foster Provost, Tom Fawcett, ``Data Science for Business", O'Reilly Media, 2013

3 Rachel Schutt, Cathy O'Neil, ``Doing Data Science", O'Reilly Media, 2016

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2				2							2	
CO2	3	2		2	3								2	
CO3	3	2		3									2	
CO4	3	2											2	
CO5	3	3	3	3	3			3		2		3	2	
Total	15	11	3	8	6	2		3		2		3	10	2
Score	3	3	3	3	3	2		3		2		3	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1303	FUNDAMENTALS OF OPERATING SYSTEMS	3	0	0	3

OBJECTIVES

- To understand the structure and functions of OS
- To learn about Processes, Threads and Scheduling algorithms
- To understand the principles of concurrency and Deadlocks
- To learn various memory management schemes
- To study disk management and File systems, virtual machines.

UNIT I INTRODUCTION 9

Operating Systems Overview: Software, system software, operating system operations, operating systems generations, process management, memory management, storage management, protection and security, distributed systems. Operating Systems Structures: Operating system services, system calls, system programs, operating system structure.

UNIT II PROCESS MANAGEMENT AND IPC 9

Process Management: Process concepts, process state, process control block, operations on processes, scheduling queues, schedulers, dispatcher, CPU Scheduling: Scheduling Criteria, Scheduling Algorithms, Real-Time CPU Scheduling, Threads: Multithreading Model, Thread Libraries, Threading Issues, Multithreading. Inter Process Communication: Cooperating process, independent process, Communications using Shared memory, Pipe and Message passing, Case study – Process management and IPC in Linux and Windows.

UNIT III SYNCHRONIZATION AND DEADLOCKS 9

Concurrency And Synchronization: Process synchronization, critical section problem, Peterson's solution, synchronization hardware, semaphores, classic problems of synchronization: producer and consumer problem, reader and writers problem. Deadlocks: System model, deadlock characterization, deadlock prevention, avoidance, detection and recovery, Case study – Synchronization and Deadlocks in Linux and Windows.

UNIT IV MEMORY MANAGEMENT 9

Main Memory Management: Swapping, contiguous memory allocation, fragmentation, compaction, paging, page table structures, implementation of page table, segmentation, Virtual Memory: demand paging, page-replacement algorithms, allocation of frames, thrashing, Case study – Memory management in Linux and Windows.

UNIT V FILE SYSTEM AND I/O SYSTEM MANAGEMENT 9

File System: Concept of a file, access methods, directory structure, file system mounting, file sharing, protection, File System Implementation: file system structure, file system implementation, directory implementation, allocation methods, free-space management, I/O System: Mass storage structure - disk structure, disk scheduling algorithms – Virtual Machines – Hypervisor – Network OS – Storage OS

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Outline the basic services and functionalities of operating systems	**K2**
CO2	Compare various scheduling algorithms and inter process communication methods.	**K5**
CO3	Apply process synchronization, deadlock prevention and avoidance schemes	**K3**
CO4	Analyze different memory management schemes.	**K4**
CO5	Apply various disk management schemes and illustrate the functionalities of file systems, virtual machines.	**K3**

TEXTBOOKS

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, "Operating System Concepts", 10th Edition, John Wiley and Sons Inc, 2021
2. Andrew S. Tanenbaum, Herbert Bos, "Modern Operating Systems", 5th edition, Pearson Education, India, 2023.

REFERENCE BOOKS

1. William Stallings, "Operating Systems, Internals and Design Principles", 9th edition, Pearson Education, India, 2018.
2. Harvey M. Deitel, David R. Choffnes and Paul J. Deitel, "Operating systems", 3rd edition, Pearson Education, India, 2008.
3. Sunil K Joseph, Surabhi Kurian, "Mastering Linux: A Comprehensive Guide to the Operating System", Notion Press, 2023

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2											2		
CO2	3	3	3							2			3		
CO3	3	3											2		
CO4	3	3	3										2		
CO5	3	3											3		
Total	15	14	6										12		
Score	3	3	3							2			3		

COURSE CODE	COURSE TITLE	L	T	P	E	C
IHS1361	UNIVERSAL HUMAN VALUES 2: UNDERSTANDING HARMONY(TCP)	2	0	2	0	3

OBJECTIVES

- To help students distinguish between values and skills, and understand the need, basic guidelines, content, and process of value education.
- To help students initiate a process of dialogue within themselves to know what they want to be in their life and profession.
- To help students understand the meaning of happiness and prosperity for a human being.
- To facilitate the students to understand harmony at all the levels of human living and live accordingly.
- To facilitate the students in applying the understanding of harmony in existence in their profession and lead an ethical life Course.

UNIT I INTRODUCTION TO VALUE EDUCATION 9

Value Education – Need, Basic Guidelines, Content and Process, Self-Exploration – meaning, importance and process, Continuous Happiness and Prosperity – A look at basic Human Aspirations, Right understanding, Relationship and Physical Facilities – The basic requirements, Understanding Happiness and Prosperity – A critical appraisal of the current scenario, Method to fulfil the above human aspirations – UNDERSTANDING and living in harmony at various levels.

UNIT II HARMONY IN THE HUMAN BEING 9

An understanding human being as a co-existence of the sentient 'I' and the material 'Body', Understanding the needs of Self ('I') and 'Body' – Sukh and Suvidha, Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer), Understanding the characteristics and activities of 'I' and harmony in 'I', Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs, the meaning of Prosperity in detail, Pro- grams to ensure Sanyam and Swasthya.

UNIT III HARMONY IN THE FAMILY AND SOCIETY 9

Understanding harmony in the family – The basic unit of human interaction, understanding values in a human-to-human relationship; Understanding Trust – The foundational value in relationship, Difference between intention and competence, Understanding Respect – as the right evaluation, Difference between respect and differentiation; the other salient values in a relationship, Understanding the harmony in the society – comprehensive Human Goals, Visualizing a universal harmonious order in society– Undivided Society, Universal Order – From family to world family!

UNIT IV HARMONY IN NATURE AND EXISTENCE 9

Understanding the harmony in Nature, Interconnectedness, self-regulation and mutual fulfilment among the four orders of nature – recyclability, Understanding Existence as Coexistence of mutually interacting units in all-pervasive space, Holistic perception of harmony at all levels of existence.

UNIT V IMPLICATIONS OF THE ABOVE HOLISTIC UNDERSTANDING OF HARMONY ON PROFESSIONAL ETHICS 9

Natural acceptance of human values, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in Professional Ethics – augmenting universal human order, the scope and characteristics of people-friendly and eco-friendly, Holistic Technologies, production systems and management models – Case studies, Strategy for the transition from the present state to Universal Human Order – At the level of individual: as socially and ecologically responsible engineers, technologists and managers, At the level of society: as mutually enriching institutions and organizations.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1 Understand the significance of value inputs in a classroom, distinguish between values and skills, understand the need, basic guidelines, content, and process of value education, explore the meaning of happiness and prosperity and do a correct appraisal of the current scenario in the society.

CO2 Distinguish between the Self and the Body, understand the meaning of Harmony in the Self the Co-existence of Self and Body.

CO3 Understand the value of harmonious relationships based on trust, respect and other naturally acceptable feelings in human-human relationships and explore their role in ensuring a harmonious society.

CO4 Understand the harmony in nature and existence and work out their mutually fulfilling participation in nature.

CO5 Distinguish between ethical and unethical practices and start working out the strategy to actualize a harmonious environment wherever they work.

TEXTBOOKS

1	R R Gaur, R Sangal, G P Bagaria, “A Foundation Course in Human Values and Professional Ethics”, Excel Books, New Delhi, 2nd Revised Edition, 2019.

REFERENCE BOOKS

1	A Nagaraj, “Jeevan Vidya: Ek Parichaya”, Jeevan Vidya Prakashan, Amarkantak, 1999.
2	A N Tripathi, “Human Values”, New Age Intl Publishers, New Delhi, 2004.
3	“The Story of Stuff” (Book).
4	Mohandas Karamchand Gandhi, “The Story of My Experiments with Truth”.
5	E F Schumacher, “Small is Beautiful”
6	Cecile Andrews, “Slow is Beautiful”
7	J C Kumarappa, “The Economy of Permanence”
8	Pandit Sunderlal, “Bharat Mein Angreji Raj”
9	Dharampal, “Rediscovering India”
10	Mohandas K Gandhi, “Hind Swaraj or Indian Home Rule”
11	Maulana Abdul Kalam Azad, “India Wins Freedom”
12	Romain Rolland, “Vivekananda” (English)
13	Romain Rolland, “Gandhi” (English)

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1						3		3	3	2		3		
CO2						3		3	3	2		3		
CO3						3		3	3	2		3		
CO4						3		3	3	2		3		
CO5						3		3	3	2		3		
Total						15		15	15	10		15		
Score						3		3	3	2		3		

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1311	DATA SCIENCE AND VISUALIZATION LABORATORY	0	0	3	1.5

OBJECTIVES

- To get familiar with the python programming for data science
- To develop python programs for data preparation and manipulation using NumPy and Pandas
- To construct python programs for data visualization
- To make use of python packages for statistical analysis
- To apply business analytics on real world applications

SUGGESTED EXPERIMENTS

1. Creating a Data Frame with default index and user-defined index for data available as dictionary using Pandas.
2. Data Frame creation with different file formats using Pandas.
3. Perform basic computations and manipulation on arrays using the NumPy package.
4. Perform manipulations on the CSV files and images using NumPy package.
5. Perform data manipulation on the input CSV file using Pandas Package.
6. Perform data preparation and visualization on the input CSV file using Pandas, matplotlib packages and Tableau.
7. Perform Exploratory Data Analysis on a CSV file. Import any CSV file and perform Exploratory Data Analysis by plotting histogram based on frequency count and probability.
8. Develop python program to compute estimators using Pandas and Numpy.
9. Develop python code to prove central limits theorem.
10. Demonstrate the different sampling techniques using Pandas and Numpy.
11. Develop python code to examine a population and make inferences using statistical inference.
12. Download data from UCI Machine Learning Repository or Kaggle and build a model using supervised learning approach. Also evaluate its performance using appropriate evaluation metrics.
13. Download data from UCI Machine Learning Repository or Kaggle and build a model using an unsupervised learning approach. Also evaluate its performance using appropriate evaluation metrics.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Construct a Data Frame and perform data cleaning, integration, and transformation	**K3**
CO2	Estimate the values of the population parameters and make inferences using statistical inference.	**K5**
CO3	Design a system using machine learning to solve real world problems with Python packages	**K6**

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO 1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
CO1	3	2		2	3								2	
CO3	3	2		3									2	
CO3	3	3	3	3	3	2		3		2		3	2	
Total	9	7	3	8	6	2		3		2		3	6	2
Score	3	3	3	3	3	2		3		2		3	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1312	JAVA PROGRAMMING LABORATORY	0	0	4	2

OBJECTIVES

- To build software development skills using object-oriented programming for real world applications
- To develop applications using inheritance and polymorphism
- To build applications using exception handling
- To develop applications using generic methods and generic collections.
- To demonstrate multitasking through multithreading

SUGGESTED EXPERIMENTS

1. Build an application using classes and objects.
2. Develop an application using Inheritance.
3. Design a Java interface for ADTs.
4. Develop application using user defined exception.
5. Program to implement packages.
6. Program to implement generic classes, methods.
7. Develop applications using suitable collection framework.
8. Use multithreading concepts to develop inter process communication.
9. Program to manipulate files, lambda expressions and functional interfaces.
10. Develop a mini project for any application using object-oriented programming concepts with Java.

TOTAL PERIODS: 60

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Develop applications using object-oriented concepts like classes, objects, inheritance, interfaces and exception.	**K3**
CO2	Develop applications using packages, generics, collection frameworks and multithreading	**K3**
CO3	Select real-world problem in team and solve it by applying the appropriate features of object-oriented programming paradigm with best practices and document its methodology	**K5**

LABORATORY REQUIREMENT FOR BATCH OF 25 STUDENTS

Hardware: Desktops with Linux OS - 25 Nos
Software: JDK package

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3										2	
CO2	3	3	3										2	
CO3	3	3	3	3	3	2	2	3	3	3	3	2	2	2
Total	9	9	9	3	3	2	2	3	3	3	3	2	6	2
Score	3	3	3	3	3	2	2	3	3	3	3	2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1313	OPERATING SYSTEM PRACTICES LABORATORY	0	0	3	1.5

OBJECTIVES

- To learn and implement basic Unix commands using system calls
- To implement various CPU Scheduling Algorithms·
- To implement Process Creation and Inter Process Communication
- To implement Deadlock Avoidance algorithms
- To implement Page Replacement Algorithms
- To implement File Allocation and Disk Scheduling Strategies

SUGGESTED EXPERIMENTS

1. Study and Implement a few UNIX commands using system calls.
2. Implement the CPU Scheduling Algorithm (Round Robin, Non-preemptive Priority)
3. Implement Shared memory and IPC.
4. Implement Process Synchronization Semaphores
5. Implement Bankers Algorithm for Deadlock Avoidance
6. Develop applications using threads.
7. Implement the Page Replacement Algorithms (LRU, Optimal)
8. Implement the File Allocation Strategies (Sequential, Linked)
9. Implement the Disk Scheduling Algorithm (SSTF, CSCAN)
10. Install and explore different operating systems on a physical or logical (virtual) machine. (Linux Installation on Windows, Embedded system OS).
11. Develop a basic kernel module for a Linux-based / real time operating system to perform a straightforward task, such as printing a message to the kernel log or manipulating a system resource.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Compare the performance of various CPU and Disk scheduling algorithms.	**K5**
CO2	Develop programs to implement system commands, deadlock avoidance, semaphores and IPC.	**K3**
CO3	Develop programs to implement various page replacement algorithms, file allocation strategies.	**K3**

LABORATORY REQUIREMENT FOR BATCH OF 38 STUDENTS

Hardware: 1. Standalone Desktops with Linux OS - 38 Nos
Software: 1. C Compiler

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3									3	
CO2	3	2	3	3	2					3			2	
CO3	3	2	3	3									2	
Total	9	7	9	9									7	
Score	3	3	3	3	2					3			3	

COURSE CODE	COURSE TITLE	L	T	P	C
IMA1451	DISCRETE MATHEMATICAL STRUCTURES	3	0	0	3

OBJECTIVES

- To study the concepts of classical logic, normal forms and its applications.
- To understand the fundamental concepts of fuzzy sets, fuzzy logic, fuzzy propositions and fuzzy quantifiers
- To learn the basic concepts in graph theory and prove simple properties.
- To study the algebraic systems namely, semigroups, monoids and groups.
- To study the concept of Boolean algebra.

UNIT I LOGIC AND PROOFS 9

Propositional Logic – Propositional equivalences – Predicates and quantifiers – Nested quantifiers – Rules of inference – Introduction to proofs – Proof methods and strategy – Normal forms – Applications to switching circuits.

UNIT II FUZZY LOGIC 9

Fuzzy set theory: Crisp sets and fuzzy sets – Operations: Complements, Union, Intersection – Fuzzy logic: Multivalued logic – Fuzzy propositions – Fuzzy quantifiers.

UNIT III GRAPH THEORY 9

Graphs – Graph terminology and special types of graphs – Subgraphs – Matrix representation of graphs and graph isomorphism – Connectivity – Eulerian and Hamilton graphs –Trees: Properties, Distance and Center.

UNIT IV ALGEBRAIC SYSTEMS 9

Algebraic systems – Semi groups and monoids – Groups – Subgroups -Normal subgroup - Cosets - Homomorphisms – Lagrange's theorem – Definitions and examples of Rings, Fields and Finite Fields.

UNIT V BOOLEAN ALGEBRA 9

Relation – Equivalence realtion - Partial order relation – Posets – Lattices – Properties of lattices – Lattices as algebraic systems – Sublattices – Direct product and Homomorphism; Boolean algebra – Stone's representation Theorem.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Obtain simple proofs using propositions and predicates	**K3**
CO2	Obtain the truth values of fuzzy propositions and fuzzy quantifiers	**K3**
CO3	find Eulerian and Hamiltonian circuits in various graph structures.	**K3**
CO4	Explain basic concepts in group theory	**K3**
CO5	Solve problems in partial ordering relations, lattices and Boolean algebra.	**K3**

TEXTBOOKS

1. Kenneth H Rosen, Discrete Mathematics and its Applications, Seventh Edition, Special Indian edition, Tata McGraw Hill, New Delhi, 2017.
2. Tremblay J P and Manohar R, Discrete Mathematical Structures with Applications to Computer Science, Thirtieth edition, Tata McGraw Hill, New Delhi, 2011.
3. George, J. Klir. And Yuan, B., Fuzzy sets and Fuzzy Logic, Theory and Applications, Prentice Hall of India Pvt. Ltd., 2015.

REFERENCE BOOKS

1. Ralph P Grimaldi, Discrete and Combinatorial Mathematics: An Applied Introduction, Fourth Edition, Pearson Education Asia, 2007.
2. Eric Lehman, F Tom Leighton, Albert R Meyer, Mathematics for Computer Science, Samurai Media Limited, 2017.
3. Thomas Koshy, Discrete Mathematics with Applications, Elsevier Publications, 2006.
4. H.-J. Zimmermann, Fuzzy Set Theory - and Its Applications, Springer link, 2001.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										
CO2	3	2										1
CO3	3	2										1
CO4	3	2										
CO5	3	2										1
Total	15	10										3
Score	3	2										1

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1401	**ALGORITHM DESIGN AND ANALYSIS**	**3**	**0**	**0**	**3**

OBJECTIVES

- To analyze the asymptotic performance of recursive and non-recursive algorithms.
- To apply various problem-solving paradigms and design strategies.
- To demonstrate basic understanding of proof techniques for correctness of algorithms.
- To synthesize efficient algorithms for computational problems and implement those in Python.
- To explain the limitations of algorithmic power.

UNIT I INTRODUCTION AND ANALYSIS 9

Introduction: Fundamentals of algorithmic problem solving – Important problem types; Fundamentals of the Analysis of Algorithm Efficiency: Analysis framework – Asymptotic notations and basic efficiency classes – Mathematical analysis for recursive and non-recursive algorithms - Time complexity using recurrence relations and decision trees - Master theorem.

UNIT II DIVIDE & CONQUER, BACKTRACKING, BRANCH & BOUND 9

Divide and Conquer: Analysis of Mergesort – Quicksort – Multiplication of large integers – Strassen's matrix multiplication – Closest pair of points; Backtracking: N-queens problem – Hamiltonian circuit problem; Branch and Bound: Knapsack problem – Traveling salesman problem.

UNIT III DYNAMIC PROGRAMMING, GREEDY 9

Dynamic Programming: Computing a binomial coefficient – Knapsack problem – Ordering of matrix multiplications – Longest increasing subsequence – Analysis of Floyd-Warshall algorithm; Greedy Algorithms: Analysis of Dijkstra's algorithm - Prim's algorithm – Kruskal's algorithm – Huffman Coding.

UNIT IV ITERATIVE IMPROVEMENT, LINEAR PROGRAMMING 9

Iterative Improvement: Maximum Network Flow – Maximum matching in bipartite graphs - Stable matching; Linear Programming: Optimization problems – LP Formulation – Basic introduction to Simplex method – LP vs ILP.

UNIT V LIMITATIONS OF ALGORITHMIC POWER 9

Limitations of algorithm power: Lower-bound arguments – P, NP and NP-complete problems; Reductions: 3-SAT to CLIQUE; Coping with the limitations: Introduction to Approximation Algorithms using Travelling Salesman Problem (Nearest-Neighbour and Twice-around-the-MST).

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1 Analyze the asymptotic running time of various recursive and non-recursive algorithms **K4**

CO2	Apply algorithm design techniques to solve various computational problems using divide-and-conquer and greedy strategies, and analyze the running time	**K4**
CO3	Apply dynamic programming to solve various computational problems, and compare it with respective greedy solutions	**K5**
CO4	Develop programs using iterative improvement and linear programming techniques	**K3**
CO5	Explain basic ideas of computational complexity classes	**K2**

TEXTBOOKS

1. Anany Levitin, "Introduction to the Design and Analysis of Algorithms", 3rd Edition, Pearson Education, 2012.
2. Thomas H Cormen, Charles E Leiserson, Ronald L Rivest, Clifford Stein, "Introduction to Algorithms", 3rd Edition, PHI Learning Private Limited, April 2022

REFERENCE BOOKS

1. S Dasgupta, C H Papadimitriou, U V Vazirani, "Algorithms",1st Edition, McGraw Hill Education, 2017.
2. Steven S Skiena, "The Algorithm Design Manual", 2nd Edition, Springer, 2008.
3. Jeff Erickson, "Algorithms", 1st Edition, 2019

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2	2	2					2		2	2	
CO2	3	2	2	3	2					2		2	2	
CO3	3	2	2	3	2							2		2
CO4	3	2	2	2	2							2	2	
CO5	3	2	2	2	2					2		2	2	
Total	15	10	10	12	10					6		10	8	2
Score	3	2	2	2	2					2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1402	DATABASE SYSTEMS	3	0	0	3

OBJECTIVES

- To introduce the fundamentals of database systems and conceptual modeling
- To learn SQL and relational model
- To learn database programming and relational database design
- To explore the fundamental concepts of transaction processing, concurrency control and recovery techniques
- To explain Distributed and NOSQL databases.

UNIT I DATABASE SYSTEMS CONCEPTS ARCHITECTURE AND ER MODELLING 10

Characteristics of database – Database users – Data models, Schemas – Three-schema architecture – Database system environment – Centralized and client/server DBMS architectures – Data modeling using ER model – Enhanced-ER model –Object Relational Model Introduction – Mapping an EER Schema to an ODB Schema

UNIT II RELATIONAL DATA MODEL 10

Relational Model: Concepts – Constraints – violations; Relational Algebra; Basic SQL: Data Definition – Data Manipulation; dealing NULL – Tuples – Correlated Subqueries- Nested queries– Inner JOINs and Outer JOINs –Aggregate functions – Grouping- Triggers and Views.

UNIT III DATABASE PROGRAMMING AND DESIGN 9

Database Programming Techniques: Overview and Issues – Embedded SQL – JDBC; Design guidelines – Functional dependencies – First, second and third Normal Forms – Boyce-Codd Normal Forms; FD: Inference rules – Minimal cover; ER-to-relational mapping.

UNIT IV TRANSACTION, CONCURRENCY AND RECOVERY 8

Transaction Processing: Concepts – ACID properties – schedules-serializability; Concurrency control: Two-phase locking technique – Timestamp Ordering; Recovery: Concepts – Deferred update – Immediate update.

UNIT V DISTRIBUTED DATABASE SYSTMES and NOSQL DATABASE 8

Distributed Database Concepts – Data fragmentation and Replication – Allocation techniques Introduction to NOSQL Systems – The CAP Theorem – Document-Based NOSQL Systems and MongoDB – Graph based NOSQL systems.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Explain the database concepts, apply ER models and ODB models for a database application	**K3**
CO2	Apply SQL for relational data model	**K3**

CO3	Choose appropriate database programming techniques, database design theory and normalization for a real-world problem.	**K5**
CO4	Apply concurrency control and recovery mechanisms for transaction processing systems	**K3**
CO5	Explain the distributed database systems and apply queries on NOSQL databases	**K3**

TEXTBOOKS

1. Ramez Elmasri, Shamkant B Navathe, “Fundamentals of Database Systems”, 7th Edition, Pearson, 2016.
2. Raghu Ramakrishnan, “Database Management Systems”, 4th Edition, Tata McGraw Hill, 2010.

REFERENCE BOOKS

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan,” Database System Concepts”, 7th Edition , 2021.
2. Hector Garcia-Molina, Jeffrey D Ullman, Jennifer Widom, “Database Systems: The Complete Book”, 2e, Pearson.
3. C. J. Date, A. Kannan and S. Swamynathan, “An Introduction to Database Systems”, 8th ed, Pearson Education, 2006
4. Thomas M Connolly, Carolyn E Begg, “Database Systems – A Practical Approach to Design, Implementation and Management”, 6th edition, 2015, Global Edition, Pearson.
5. Jeffrey D Ullman, Jennifer Widom, “A First Course in Database Systems”, 3rd Edition, Pearson Education, 2014.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2											2	
CO2	3	2	3										2	
CO3	3	2	2		3	2			3	2	2		2	2
CO4	3	3											2	
CO5	3	3											2	
Total	15	11	5						3	2	2		10	2
Score	3	3	3		3	2			3	2	2		2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1403	INTRODUCTION TO ARTIFICIAL INTELLIGENCE	3	1	0	4

OBJECTIVES

- To study the fundamental concepts of AI agents and environments.
- To learn the methods of problem solving in AI using various search strategies.
- To understand the concepts of knowledge representation and inference using logic.
- To understand the concepts of knowledge representation and inference under uncertainty.
- To learn some applications in text and robotics.

UNIT I FOUNDATIONS 8

Introduction: What is AI; Intelligent Agents: Agents and environments – Good behavior – The nature of environments – Structure of agents; Philosophical Foundations: Weak AI – Strong AI – Ethics and risks of developing AI; AI: The Future of AI: AI Components – AI architectures.

UNIT II PROBLEM SOLVING & SEARCH TECHNIQUES 13

Solving Problems by Searching: Problem solving agents – Example problems – Search Algorithms - Uninformed search strategies – Informed search strategies – Heuristic functions; Search in Complex Environments: Local search algorithms and optimization problems; Adversarial Search and Games – Game Theory - Optimal decisions in games – Heuristic Alpha-beta tree search.

Tutorial topics: Implementation of Uninformed & Informed search strategies, Problem solving in Minmax and Alpha & Beta pruning.

UNIT III KNOWLEDGE REPRESENTATION & REASONING 13

Logical Agents: Knowledge-based agents – Propositional logic – Propositional theorem proving; First order logic: Syntax and semantics for first order logic – Using first order logic; Inference in first order logic: Propositional versus first order logic – Unification and lifting – Forward chaining – Backward chaining – Resolution.

Tutorial topics: Problem solving in Propositional logic and First order logic using Resolution technique and Inference techniques.

UNIT IV UNCERTAIN KNOWLEDGE AND REASONING 13

Quantifying Uncertainty: Acting under uncertainty – Basic probability notation – Inference using full joint distributions – Bayes' rule & its use – Naïve Bayes models; Probabilistic Reasoning: The semantics of Bayesian networks – Exact inference in Bayesian networks.

Tutorial topics: Problem solving in Bayes' rule and Full joint distribution, Implementation of uncertainty handling using Fuzzy reasoning.

UNIT V COMMUNICATION, PERCEIVING AND ACTING 13

Natural Language Processing: Language Models – Grammar – Parsing – Augmented Grammars – Complications of Real Natural Language – Natural Language Tasks; Robotics: Robots – Robot hardware – Problem solving using Robot – Perception – Planning and Control – Planning uncertain movements – Reinforcement learning in Robotics – Humans and Robots – Alternative Robotic frameworks – Application Domains.

Tutorial topics: Participation as a team in NLP challenges / tasks, Design of Robot for real time applications using Reinforcement learning.

TOTAL PERIODS: 60

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Explain different types of environments and agents	**K2**
CO2	Analyze and solve AI problems using search techniques	**K4**
CO3	Solve AI problems using logics and inference techniques	**K3**
CO4	Solve AI problems using uncertain knowledge and probabilistic reasoning	**K3**
CO5	Explain the concepts of Natural Language Processing and Robotics and assess the importance of AI using a suitable application	**K5**

TEXTBOOKS

1 Stuart Russell, Peter Norvig, "Artificial Intelligence – A Modern Approach", 4th Edition, Pearson Education / Prentice Hall of India, 2015.

REFERENCE BOOKS

1 Elaine Rich, Kevin Knight, "Artificial Intelligence", 2nd Edition, Tata McGraw-Hill, 2003.

2 Dawn W Patterson, "Introduction to Artificial Intelligence and Expert Systems", 1st Edition, Pearson Education India, 2015.

3 Andreas Muller, Sarah Guido, "Introduction to Machine Learning with Python: A Guide for Data Scientists", Shroff/O'Reilly, 1st edition, 2016.

4 Prateek Joshi, "Artificial Intelligence with Python", 1st edition, Packt Publishing Limited,2017.

5 David Poole, Alan Mackworth, "Artificial Intelligence: Foundation of Computational Agents", 2nd Edition, Cambridge University Press, 2017

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2											2	
CO2	3	2	2	3									2	2
CO3	3	2	2	3									2	
CO4	3	2	2	3									2	
CO5	3	3	2	3	2			3	3	3		3	2	3
Total	15	11	8	12	2			3	3	3		3	10	5
Score	3	3	2	3	2			3	3	3		3	2	3

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1404	MICROPROCESSORS AND MICROCONTROLLERS	3	0	0	3

OBJECTIVES

- To understand the Architecture of 8086 microprocessor
- To learn the design aspects of I/O and Memory Interfacing circuits
- To interface microprocessors with supporting chips
- To study the Architecture of 8051 microcontroller
- To design a microcontroller-based system.

UNIT I THE 8086 MICROPROCESSOR 9

Introduction to 8086 – Microprocessor architecture – Addressing modes – Instruction set and assembler directives – Assembly language programming – Stacks – Procedures – Macros – Interrupts and interrupt service routines – Byte and String Manipulation.

UNIT II 8086 SYSTEM BUS STRUCTURE 9

8086 signals – Basic configurations – System bus timing – System design using 8086 – I/O programming – Introduction to Multiprogramming – System Bus Structure – Multiprocessor configurations – Coprocessor, closely coupled and loosely Coupled configurations – Introduction to advanced processors.

UNIT III I/O INTERFACING 9

Memory interfacing and I/O interfacing – Parallel communication interface – Serial communication interface – D/A and A/D Interface – Timer – Keyboard /display controller – Interrupt controller – DMA controller – Programming and applications Case studies: Traffic Light control, LED display, Keyboard display interface.

UNIT IV THE 8051 MICROCONTROLLERS 9

Architecture of 8051 – Special Function Registers (SFRs) – I/O Pins ports and circuits – Instruction set – Addressing modes – Assembly language programming.

UNIT V INTERFACING MICROCONTROLLER 9

Programming 8051 Timers – Serial port programming – Interrupts programming – LCD & key- board interfacing – ADC, DAC & Sensor interfacing – External memory interface – Stepper motor and waveform generation – ARM processors: Architecture – Programming Model.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Summarize the basic architecture, operations and apply the programming concepts of microprocessor 8086.	**K3**
CO2	Outline the design of basic and multiprocessor systems and their bus timings.	**K2**
CO3	Build 8086 interfaces with memory, I/O and other peripheral chips.	**K6**

CO4	Summarize the basic architecture, operations and apply the programming concepts of microcontroller 8051.	**K3**
CO5	Apply programming concepts to implement microcontroller interfaces for different applications.	**K3**

TEXTBOOKS

1 Douglas V Hall, "Microprocessors and Interfacing, Programming and Hardware", Tata McGraw Hill, 2012.

2 Mohamed Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", 2nd Edition, Pearson Education, 2011.

REFERENCE BOOKS

1 A K Ray, K M Bhurchandi, "Advanced Microprocessors and Peripherals", 3rd edition, Tata McGraw Hill, 2012.

2 Barry B Bray, "The Intel Microprocessor 8086/8088, 80186, 80286, 80386 and 80486 - Architecture, Programming and Interfacing", 8th Edition, PHI, 2011.

3 Mohamed Rafiquazzaman, "Microprocessor and Microcomputer based System Design", 2nd Edition, Universal Book Stall, 1995.

4 Yu-Cheng Liu, Glenn A Gibson, "Microcomputer Systems: The 8086/8088 Family - Architecture, Programming and Design", 2nd Edition, Prentice Hall of India, 2007.

5 Kenneth J Ayala, "The 8051 Microcontroller Architecture, Programming and Applications", 2nd edition, Penram International, 1996.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2											2	
CO2	3													
CO3	3	2	3							3			3	
CO4	3	2											2	
CO5	3	3	3									2	3	3
Total	15	11	6							3		2	10	3
Score	3	2	3							3		2	3	3

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1405	SOFTWARE ENGINEERING PRINCIPLES AND PRACTICES	2	0	2	3

OBJECTIVES

- Explore the SDLC Models and Estimation Techniques
- Understand the Requirement Engineering Process and UML Models
- Get familiar with Design Concepts and Architectural Styles.
- Develop Software Testing program for software Modules
- Explore the current trend in Software development – Agile and DevOps.

UNIT I SOFTWARE PROCESS MODELS 6

Introduction to Software Engineering; Objectives, Principles and Practices; The Software Development Life Cycle; Methodologies Paradigm and Practices: Process methodologies – Development paradigms – Development practices; Project Planning Process.

UNIT II SOFTWARE REQUIREMENTS 6

Software Requirements: Functional and non-functional – Security requirements – User requirements- System requirements – Software requirements document; Requirement Engineering Process: Feasibility studies – Requirements elicitation and analysis – Requirements validation – Software Project Estimation: Decomposition techniques – Empirical estimation models – The make/buy decision – Project scheduling.

UNIT III DESIGN CONCEPTS 6

Design Concepts: Design process – Design concepts – Modularity, Coupling and cohesion – Design model – Modeling principles; Structured Design; Architectural Design: Architectural styles; Architecture for Network based Applications – Decentralized Architectures.

UNIT IV SOFTWARE TESTING 6

Software Testing Fundamentals; Internal and External Views of Testing: White box testing – Basis path testing – Control structure testing– Black box testing – Unit testing – Integration testing – Regression testing – Validation testing – System testing – Security testing; Testing Tool; Debugging; Software Implementation: Coding Practices and Principles; Maintenance: Types.

UNIT V Agile & DEVOPS 6

Agile Development: Agile Teams – Team and Scrum – Branches – Pull Requests – Reviews – Integration – Agile Iterations – Reporting and fixing bugs; Dev/Ops: From development to deployment – Three-Tier – Github, Introduction to MLOps-- MLFlow and Optuna.

TOTAL PERIODS: 30

Suggested Experiments

1. Identify a problem statement, perform requirements analysis, design the system and implement the system using software Engineering Principles.
2. Create an SRS that outlines the Functional Requirements, Non-functional Requirements and Constraints for a specific application.
3. Model the given list of requirements using level-0 DFD and evolve the further stages of DFD for a specific application.
4. Convert the given DFD into a suitable architecture design.
5. Explore Git and GitHub commands and Practice Source code management on GitHub.
6. Demonstrate continuous integration and development with GitLab
7. Explore MLFlow for a Machine Learning task.
8. Explore Optuna for Hyper Parameter tuning with a ML task.

LAB HOURS: 30

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Choose an appropriate process model and estimate project cost and effort required by applying software engineering principles.	**K5**
CO2	Identify and analyze the requirements and construct their models.	**K4**
CO3	Apply systematic procedure for software design	**K3**
CO4	Compare and contrast the various testing and maintenance activities	**K2**
CO5	Make use of agile development, Devops and MLOps	**K3**

TEXTBOOKS

1 Roger S Pressman, Bruce R Maxin "Software Engineering – A Practitioner's Approach", McGraw Hill International Edition, Eighth Edition, 2015. (Unit 1,2,3,4)

2 Armando Fox and David Patterson, Engineering Software as a Service: An Agile Approach Using Cloud Computing", Strawberry Canyon LLC, Second Beta Edition, 2021.(Unit 5)

REFERENCE BOOKS

1 Ian Sommerville, "Software Engineering", Tenth Edition, Pearson Education Asia , 2017.

2 Stephen R Schach, "Software Engineering", Tata McGraw-Hill Publishing Company Limited, 2007.

3 Len Bass, Ingo Weber and Liming Zhu, —"DevOps: A Software Architect's Perspective", Pearson Education, 2016.

4 Mark Treveil, and the Dataiku Team- "Introducing MLOps" - O'Reilly Media- 2020.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3		3						2			
CO2	3	3	3		3					3				
CO3	3	3	3		3	2	2	3	3			2	3	2
CO4	3	3	3		3									
CO5	3	3	3		3									
Total	15	15	15		15	2	2	3	3	3	2	2	3	2
Score	3	3	3		3	2	2	3	3	3	2	2	3	2

COURSE CODE	COURSE TITLE	L	T	P	E	C
IHS1476	INDIAN CONSTITUTION	3	0	0	0	0

OBJECTIVES

- To teach the history and philosophy of the Indian constitution.
- To summarize the powers and functions of the Indian government.
- To explain the structure and functions of local administration.
- To demonstrate the organization and working of the Judiciary.
- To discuss financial power and emergency provisions.

UNIT I INTRODUCTION 9

Historical background – Government of India act – Indian councils act – Making of the constitution -Philosophy of the Indian constitution – Preamble.

UNIT II GOVERNEMTN OF THE UNION 9

Powers and Functions of President and Prime Minister - Council of Ministers – President in relation to his council - Legislature structure and functions of Lok Sabha and Rajya Sabha – Speaker.

UNIT III GOVERNMENTS OF THE STATES AND LOCAL GOVERNMENT 9

The state executive: General structure – Governor – Council of ministers – State legislature. Local government - Panchayat – Municipality– Power authority and responsibilities municipalities.

UNIT IV THE JUDICATURE 9

Organization and Composition of Judiciary – Constitution – Appointment – Qualifications – Powers and functions of the supreme court – High courts – Control over subordinate courts.

UNIT V THE FEDERAL SYSTEM 9

Distribution of financial powers: Need, principles-Underlaying distribution of tax revenues-Distribution of legislative power – Interstate relation - Emergency provisions.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1 Understand the history and philosophy of the Indian constitution.
CO2 Realize the powers and functions of the Indian government.
CO3 Acquire awareness of the structure and functions of local administration.
CO4 Enhance knowledge about the organization and composition of the judiciary.
CO5 Explore the distribution of financial powers and emergency provisions.

TEXTBOOKS

1 Basu D.D, “Introduction to Indian Constitution”, Prentice Hall of India, New Delhi, 2015.
2 Gupta D.C, “Indian Government and Politics”, Vikas Publishing House, New Delhi, 2010.

REFERENCE BOOKS

1. Pylee M V, “Introduction to the Constitution of India”, Vikas Publishing House, New Delhi, 2011.
2. Kashyap S, “Our Constitution”, National Book Trust, New Delhi, 2010.
3. “The Constitution of India, 1950 (Bare Act”), Government Publication.
4. Jain M P, “Indian Constitution Law”, 7th Edition., Lexis Nexis, 2014.
5. Busi S N, Ambedkar B R ,“Framing of Indian Constitution”, 1stEdition, 2015.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1						2		2	2	2		2		
CO2						2		2	2	2		2		
CO3						2		2	2	2		2		
CO4						2		2	2	2		2		
CO5						2		2	2	2		2		
Total						10		10	10	10		10		
Score						2		2	2	2		2		

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1411	DATABASE SYSTEMS LABORATORY	0	0	3	1.5

OBJECTIVES

- To understand data definitions and Data Manipulation command
- To learn about the use of nested and join queries.
- To understand procedural extensions of databases
- To design a database schema for an application using ER model, Normalization
- To implement a database application using Front-end tools

SUGGESTED EXPERIMENTS

1. Data Modelling
2. Data Definition Commands
   Creating tables with constraints, constraint violations
   Schema modifications
3. Data Manipulation Commands
   Update operations
   Simple SQL queries
   Transaction Control statements - Savepoint and Rollback
4. Complex SQL Queries
   Nested Queries
   Correlated Subqueries
   Joins and Outer Joins
   Aggregate functions
   Grouping and Ordering commands.
5. Views
6. Database Programming:
   PL/SQL - Procedures and Functions
7. Triggers
8. Queries of MongoDB
9. Queries for Graph database
10. Implement a database application by applying database design and database programming using library class.
    Develop GUI using front end tool.
    Develop a connection between front end and database.
    Query the database using DML, joins and subqueries.
    Implement database programming.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Construct queries using SQL in database creation and manipulation and develop PL/SQL blocks using database programming constructs.	**K3**
CO2	Construct queries using MonogoDB and Graph database	**K3**
CO3	Design a database schema and develop an application using IDE that interacts with a DBMS server via API.	**K6**

Software Requirements: Oracle, NoSQL

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2		2									2	
CO2	3	3											2	
CO3	3	3	3	3	3	2	2	2	3	2	3		2	2
Total	9	9	3	5	3	2	2	2	3	2	3		6	2
Score	3	3	3	3	3	2	2	2	3	2	3		2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1412	**ALGORITHMS LABORATORY**	**0**	**0**	**2**	**1**

OBJECTIVES

- To implement recursive and non-recursive algorithms.
- To apply various problem-solving paradigms and design strategies.
- To synthesize efficient algorithms for computational problems and implement those in Python.

SUGGESTED EXPERIMENTS

1. Recursive algorithms: Fibonacci, Factorial, Checking palindrome.
2. Divide & Conquer: Inversion count using Mergesort, Quicksort, Median of medians.
3. Backtracking: Hamiltonian Circuit problem.
4. Branch & Bound: Knapsack problem.
5. Dynamic Programming: Longest Common Subsequence, Longest Palindromic Subsequence, Subset Sum problem
6. Greedy: Prim's, Kruskal's, Coin change problem
7. Iterative improvement: Maximum Network Flow (Eg: A road network or oil pipeline network)

LAB PERIODS: 30

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Develop Python code for simple recursive and non-recursive algorithms.	**K3**
CO2	Develop algorithms and Python code for problems using Dynamic Programming technique and analyze their time complexity.	**K3**
CO3	Develop algorithms and Python code using Greedy technique and analyze their time complexity.	**K3**

LABORATORY REQUIREMENT FOR BATCH OF 38 STUDENTS

Software: Python 3.11 compiler

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2		2	2								2	2
CO2	3	2	2		2					2			2	
CO3	3	2	2		2					2			2	
Total	9	6	4	2	6					4			6	2
Score	3	2	2	2	2					2			2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1413	MICROPROCESSORS AND MICROCONTROLLERS LABORATORY	0	0	3	1.5

OBJECTIVES

- To understand simple assembly language programs concepts and features
- To write assembly language programming for 8086
- To understand MASM programming
- To design different, I/O interfaces with microprocessors
- To write assembly language programming for 8051

SUGGESTED EXPERIMENTS

8086 Programs using kits.

1. Basic arithmetic and Logical operations
2. String manipulations
3. Sorting and searching
4. Code conversion, Decimal arithmetic and Matrix operations.

8086 Programs using MASM.

1. Floating point operations
2. Password checking, Print system date and time
3. Counters and Time Delay
4. Case Conversion and Message Displaying

Peripherals and Interfacing Experiments

1. Traffic light controller
2. Stepper motor control
3. Keyboard and Display controller
4. Parallel interface
5. D/A interface (Waveform Generation)

8051 Experiments using kits.

1. Basic arithmetic and logical operations
2. Cube, 1's count and 2's complement of a number
3. Unpacked BCD to ASCII

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Develop 8086 assembly language programs for arithmetic, logical, string operations and BIOS interrupt concepts	**K3**
CO2	Build different I/O interfaces with 8086	**K3**
CO3	Apply 8051 assembly language programming concepts for arithmetic and logical operations	**K3**

LABORATORY REQUIREMENT FOR BATCH OF 38 STUDENTS

Hardware:
1. Standalone Desktops - 30 Nos
2. 8086 development kits - 30 Nos
3. Interfacing Units - Each 10 Nos
4. Microcontroller kits- 30 Nos

Software:
1. MASM software

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO 1	**PO2**	**PO3**	**PO4**	**PO 5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
CO1	3	2		3	2					3			2	
CO2	3	2	2	3						3			2	3
CO3	3	2		3						3			2	
Total	9	6	2	9	2					9			6	3
Score	3	2	2	3	2					3			2	3

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1501	APPLIED OPTIMIZATION TECHNIQUES	3	1	0	4

OBJECTIVES

- To formulate optimization problems
- To learn to solve optimization problems using local descent methods, first-order methods, and second-order methods, direct methods, stochastic methods and population methods
- To formulate and solve linear constraint optimization problems
- To understand multi-objective optimization problems.

UNIT I GRADIENTS, BRACKETING 12

Derivatives: Derivatives -- Derivatives in Multiple Dimensions -- Numerical Differentiation -- Automatic Differentiation. Bracketing: Fibonacci Search -- Golden Section Search -- Quadratic Fit Search -- Bisection Method.

UNIT II LOCAL DESCENT, FIRST-ORDER, SECOND-ORDER 12

Local Descent: Descent Direction Iteration -- Line Search -- Trust Region Methods – Termination Conditions. First-Order: Gradient Descent -- Conjugate Gradient -- Momentum -- Adagrad -- RMSProp -- Adam. Second-Order: Newton's Method -- Quasi-Newton Methods.

UNIT III DIRECT, STOCHASTIC 12

Direct Methods: Cyclic Coordinate Search -- Powell's Method -- Hooke-Jeeves -- Generalized Pattern Search -- Nelder-Mead Simplex Method. Stochastic Methods: Noisy Descent -- Mesh Adaptive Direct Search -- Simulated Annealing -- Cross-Entropy Method.

UNIT IV LINEAR CONSTRAINED OPTIMIZATION 12

Constraints: Constrained Optimization -- Transformations to Remove Constraints -- Lagrange Multipliers -- Inequality Constraints -- Duality -- Penalty Methods -- Interior Point Methods. Linear Constrained Optimization: Problem Formulation -- Simplex Algorithm -- -- Dual Certificates

UNIT V POPULATION, MULTI-OBJECTIVE OPTIMIZATION 12

Population: Initialization – Genetic Algorithms – Particle Swarm Optimization. *Multi-Objective Optimization*: Pareto Optimality -- Constraint Methods -- Multiobjective Population Methods -- Preference Elicitation

TOTAL PERIODS: 60

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Solve optimization problems using bracketing method,	**K3**
CO2	Solve optimization problems using local descent methods, first-order methods, and second-order methods,	**K3**
CO3	Solve optimization problems using direct methods, stochastic methods and population methods,	**K3**

CO4	Formulate and solve linear constraint optimization problems,	**K3**
CO5	Solve multi-objective optimization problems.	**K3**

TEXTBOOKS:

1. Mykel J Kochenderfer, Tim A Wheeler. Algorithms for Optimization, The MIT Press, 2019
2. Jeffrey Paul Wheeler. An Introduction to Optimization with Applications in Machine Learning and Data Analytics, Chapman and Hall/CRC, 2023

REFERENCE BOOKS:

1. S Boyd, L Vandenberghe. Convex optimization, Cambridge University press, 2009
2. M Deisenroth, A Faisal, C Ong. Mathematics for Machine Learning, Cambridge University Press, 2020

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										
CO2	3	2										1
CO3	3	2										1
CO4	3	2										
CO5	3	2										1
Total	15	10										3
Score	3	2										1

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1502	INTRODUCTION TO MACHINE LEARNING	3	0	0	3

OBJECTIVES

- To understand machine learning problems
- To apply various supervised, unsupervised learning algorithms for a given scenario
- To understand the dimensionality reduction techniques

UNIT I INTRODUCTION 9

Introduction: Machine learning; Examples of Machine Learning Applications; Classification – Regression – Unsupervised learning – Reinforcement learning; Preliminaries: Testing machine learning algorithms, Basic statistics, Bias-variance tradeoff.

UNIT II SUPERVISED LEARNING 9

Regression: Linear Regression – Classifiers: Support Vector Machine; Probabilistic Learning: Conditional Probability, Naive Bayes Classifier; Decision Tree using ID3 - Classification and Regression Trees (CART); Ensemble Methods -- Bagging -- Boosting -- Random Forest.

UNIT III NEURAL NETWORKS & ASSOCIATION RULE MINING 9

The brain and the neuron – Neural networks – MLP: Example, Deriving forward and backward propagation – Association rule mining: Apriori algorithm.

UNIT IV UNSUPERVISED LEARNING & REINFORCEMENT LEARNING 9

Clustering Algorithms – K-Means; Dimensionality Reduction: Principal component analysis; Reinforcement Learning: Markov decision process – Q-learning Algorithm.

UNIT V EVALUATION OF MACHINE LEARNING MODELS 9

Guidelines for machine learning algorithms, K-fold Cross validation, Bootstrapping, Measuring classifier performance - Assessing a classification algorithm and Comparing two classification algorithms.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1	Explain the basic concepts of machine learning	**K2**
CO2	Apply supervised algorithms for different classification problems	**K3**
CO3	Construct neural networks in machine learning	**K3**
CO4	Apply unsupervised and reinforcement learning techniques to various problems	**K3**
CO5	Evaluate and compare different machine learning models	**K5**

TEXTBOOKS:

1. Stephen Marsland, “Machine Learning – An Algorithmic Perspective”, 2nd Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2015.
2. Ethem Alpaydin, “Introduction to Machine Learning”, 3rd Edition, The MIT Press, 2014.

REFERENCE BOOKS:

1 Jason Bell, “Machine learning – Hands on for Developers and Technical Professionals”, 1st Edition, Wiley, 2014.
2 Peter Flach, “Machine Learning: The Art and Science of Algorithms that Make Sense of Data”, 1st Edition, Cambridge University Press, 2012.
3 Richert, Willi, “Building machine learning systems with Python”, Packt Publishing, 2013.
4 Tom M Mitchell, “Machine Learning”, McGraw-Hill Education (India), 2013.
5 Y S Abu-Mostafa, M Magdon-Ismail, H T Lin, “Learning from Data”, AML Book Publishers,2012.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3		3											
CO2	3	3	3		3	2		2		2			2	3
CO3	3	3	3		3	2		2		2		2	2	3
CO4	3	3	3		3	2		2		2			2	
CO5	3	3	3										2	
Total	15	12	15		9	6		6		6		2	8	6
Score	3	3	3		3	2		2		2		2	2	3

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1503	WEB APPLICATION DEVELOPMENT	3	0	0	3

OBJECTIVES

- To learn front and back-end technologies
- To develop microservices
- To develop web applications Java-based framework

UNIT I HTML & CSS 9

Web Essentials: Servers, Clients, Communication; HTTP protocol: Request and Response Messages; Web Server: Vulnerabilities; HTML5: Table, List, Image, Form; CSS3: Types of style sheets, Selectors, Box Model, Inheritance, Transitions, Animations

UNIT II JAVASCRIPT & DOM 9

JavaScript: Function, Object, Array, Built-in objects (String and Date); JSON: Parse, Stringify; Event handling: Form, Mouse and Keyboard events; DOM: Document tree, Node object, Document object

UNIT III SERVLET PROGRAMMING 7

Servlets: Architecture, Life Cycle, Parameter data; Web based storage: Session objects, Cookies and URL rewriting

UNIT IV MICROSERVICES USING SPRING BOOT 10

Spring Boot: Foundational features, Rest Controllers, Database access for Spring Boot App, CRUD Repository, Configuration and inspection of Spring Boot App, Testing for Spring Boot Application.

UNIT V FRONTEND FRAMEWORK USING VUEJS 10

VusJS: Basics, Components, Styling with Vue JS, Functions and Routing, State management, Integration of Vue JS with Spring Boot

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Make use of HTML5 and CSS3 to design modern web site	**K3**
CO2	Utilize Javascript and DOM to implement dynamic web page	**K3**
CO3	Develop web applications using Servlets	**K3**
CO4	Develop micro services using Spring Boot	**K3**
CO5	Develop full stack web applications using Vue JS and Spring Boot	**K6**

TEXTBOOKS:

1 Jeffrey C, Jackson, “Web Technologies A Computer Science Perspective”, Pearson Education, 2011. (Units 1,2,3)

2 Mark Heckler, Spring Boot: Up and Running, O'Reilly Media, Inc, February 2021 (Unit 4)

REFERENCE BOOKS

1 Callum Macrae, Vue.js: Up and Running, O'Reilly Media, Inc., March 2018 (Unit 5)
2 David McFarland, “CSS3: The missing manual”, O’Reilly Media, December 2012. (Unit 1)
3 Matthew MacDonald, “HTML5: The missing manual”, O’Reilly Media, August 2011

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3									2	2	
CO2	3	3	3									2	2	
CO3	3	3	3		3	2				3			2	3
CO4	3	3	3		3	2				3		2	2	3
CO5	3	3	3		3	2	2		3	3		2	2	3
Total	15	15	15		9	6	2		3	9		8	8	9
Score	3	3	3		3	2	2		3	3		2	2	3

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1504	PRINCIPLES OF COMPUTER NETWORKS	3	0	0	3

OBJECTIVES

- To provide a broad overview of computer networking and the services of the application layer.
- To understand the functions and protocols of the transport layer.
- To learn the functionalities of network layer and its routing algorithms.
- To understand the services provided by the link layer and Wireless LAN technologies.
- To familiarize the students with advanced topics such as SDN and Cloud computing.

UNIT I COMPUTER NETWORK AND INTERNET 9

Introduction - Internet- Network Edge - Network Core - Performance - Protocol Layers. **Application Layer:** Principles of Network Applications - The Web and HTTP - Electronic Mail in the Internet - DNS -The Internet's Directory Service - Peer-to-Peer Applications - Video Streaming and Content Distribution Networks - Socket Programming: Creating Network Applications

UNIT II TRANSPORT LAYER 9

Introduction and Transport-Layer Services - Multiplexing and Demultiplexing - Connectionless Transport: UDP - Principles of Reliable Data Transfer - Connection-Oriented Transport: TCP - Principles of Congestion Control - TCP Congestion Control

UNIT III NETWORK LAYER 9

Overview of Network Layer - Switching - The Internet Protocol (IP): IPv4, Addressing - Network Address Translation (NAT) - IPv6.
Routing Algorithms - The Link-State (LS) Routing Algorithm - The Distance-Vector (DV) Routing Algorithm - Intra-AS Routing in the Internet: OSPF - Routing Among the ISPs: BGP.

UNIT IV LINK LAYER AND LANS 9

Introduction to the Link Layer - The Services Provided - Error-Detection and -Correction Techniques - Parity Checks - Check summing Methods - Cyclic Redundancy Check (CRC) - Multiple Access Links and Protocols - Channel Partitioning Protocols - Random Access Protocols. Switched Local Area Networks - Link-Layer Addressing and ARP - Ethernet - Link-Layer Switches - Virtual Local Area Networks (VLANs) - Link Virtualization - Data Center Networking.

.

UNIT V WIRELESS, MOBILE AND EMERGING NETWORK TECHNOLOGIES 9

Wireless and Mobile Networks - Introduction - Wireless Links and Network Characteristics - CDMA - WiFi: 802.11 Wireless LANs - Cellular Internet Access - Mobility Management: Principles - Mobile IP - Managing Mobility in Cellular Networks. Cloud computing: Introduction - Layers and types of Clouds - Cloud Infrastructure. Software-Defined Networking (SDN): Fundamental Characteristics - SDN Operation - SDN Devices.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Design scalable, secure, and fault-tolerant network architectures choosing appropriate application-layer protocols.	**K5**
CO2	Apply flow control and congestion control mechanisms in network communication.	**K3**
CO3	Compare and contrast different routing algorithms and protocols.	**K3**
CO4	Apply error detection and correction techniques, random access protocols and addressing at the link layer.	**K3**
CO5	Understand the application of wireless and mobile network principles and the impact of SDN and cloud computing technologies.	**K2**

TEXTBOOKS

1 James Kurose and Keith Ross, "Computer Networking: A Top-Down Approach", 7th edition, (ISBN-13: 978-0133594140), 2017, Pearson. (Unit I, II, III, IV, V)

2 Behrouz A Forouzan, Data Communications and Networking, 5thEdition TMH, 2017.

3 Larry Peterson and Bruce Davie, Computer Networks: A Systems Approach Morgan Kaufmann, 6th Edition, 2019.

REFERENCE BOOKS

1 Rajkumar Buyya, James Broberg, Andrzej Goscinski, "Cloud Computing: Principles and Paradigms", (ISBN978-0-470-88799-8), 2013, John Wiley publications. (UNIT V)

2 Paul Göransson Chuck Black, "Software Defined Networks: A Comprehensive Approach", (ISBN: 978-0-12-416675-2), 2014, Morgan Kaufmann.

3 William Stallings, "Data and Computer Communications", 10th Edition, Pearson Education, 2013.

4 W. Richard Stevens, "Unix Network Programming: Networking APIs: Sockets and XTI (Volume 1),

5 Nader F Mir, "Computer and Communication Networks", 2nd Edition, Prentice Hall, 2014.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2							2		3	3	2
CO2	3	3											2	
CO3	3	2										2	2	
CO4	3	2										2	2	
CO5	3	2											2	
Total	15	12								2		7	11	2
Score	3	3	2							2		3	3	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1511	WEB APPLICATION DEVELOPMENT LABORATORY	0	0	3	1.5

OBJECTIVES

- To develop web applications using Java Servlets.
- To develop web applications using Vue JS, and Spring Boot.

SUGGESTED EXPERIMENTS

1. Build a web page using Table, Lists, Image and anchor elements. (Eg. : Bio-Data)
2. Create a website using HTML5 and CSS3 elements.
3. Validate a registration form using Javascriptusing event handling mechanisms.
4. Develop a web application with servlet and MySQL. (Ex: User authentication)
5. Develop a Spring Boot micro service for testing REST APIs using POSTMAN
6. Develop a Spring Boot micro service (Ex: CRUD operations)
7. Develop a Vue JS application to test the routing concepts
8. Develop a Vue JS application to implement the state management concept
9. Develop a Full stack web application for shopping cart using Vue JS, Spring Boot and MySQL
10. Mini project - Develop a web application with Java based framework considering alternate design options and techniques.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Create website using front end technologies	**K3**
CO2	Build web applications using Java Servlets	**K3**
CO3	Develop a web application using Vue JS and Spring Boot, for a given set of requirements by applying suitable design options and techniques.	**K6**

LABORATORY REQUIREMENT FOR BATCH OF 38 STUDENTS

Hardware:
Standalone Desktops - 38 Nos

Software:
Tomcat Server, IDE: Spring Tool Suit (STS), MySQL

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		3	3								2		
CO2	3	3	3	3	3	2						2	2	3
CO3	3	3	3	3	3	2							2	3
CO4	3	3	3	3	3	2				2		2	2	
CO5	3	3	3	3	3		2		3	2	3	2	2	
Total	15	12	15	15	12	6	2		3	6	3	10	8	6
Score	3	3	3	3	3	2	2		3	3	3	3	2	3

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1512	MACHINE LEARNING ALGORITHMS LABORATORY	0	0	4	2

OBJECTIVES

- To apply supervised machine learning technique
- To apply unsupervised machine learning technique
- To understand feature selection methods
- To apply appropriate machine learning strategy for any given problem

SUGGESTED EXPERIMENTS

1. Working with Python packages - Numpy, Scipy, Scikit-learn, Matplotlib
2. Application of linear regression (Loan amount prediction)
3. Application of support vector machine (Classification of E-Mail spam data)
4. Application of decision tree algorithm (Prediction of Diabetes)
5. Applications of Random Forest and AdaBoost ensemble techniques
6. Application of neural network (Handwritten character recognition)
7. Application of K-means clustering (Iris Clustering)
8. Applications of dimensionality reduction techniques on any dataset
9. Mini project: Evaluate supervised / unsupervised machine learning algorithms for real-time applications in any of the following domains:
   (a) Text processing (b) Image processing (c) IoT systems

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Apply supervised and unsupervised learning techniques for various problems.	**K3**
CO2	Apply ensemble techniques to solve the problems and demonstrate the working of dimensionality reduction methods.	**K3**
CO3	Evaluate a solution for open-ended real-world applications with the use of suitable machine learning algorithms.	**K6**

TOTAL PERIODS: 60

LABORATORY REQUIREMENT FOR BATCH OF 38 STUDENTS

Hardware:
Python 3.x, JupyterNotebok
Numpy, Scipy, MatplotLib, Pandas
Machine Learning Libraries: Scikit-Learn

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		3											
CO2	3	3	3	3	3	2		2		2			2	3
CO3	3	3	3	3	3	2		2		2		2	2	3
CO4	3	3	3	3	3	2		2		2			2	
CO5	3	3	3										2	
Total	15	12	15	12	12	6		6		6		2	8	6
Score	3	3	3	3	3	2		2		2		2	2	3

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1513	COMPUTER NETWORKS LABORATORY	0	0	3	1.5

OBJECTIVES

- To find the network statistics and understand the speed and traffic on the network.
- To learn downloading web page and socket programming.
- To use Wireshark to investigate the captured packets.
- To implement error handling facilities of link layer.
- To simulate routing, congestion control algorithms and wireless topologies.

SUGGESTED EXPERIMENTS

1. Apply the following networking tools to check the status, performance and record the observations.
    a. netstat, ifconfig, iwconfig, ping, route, nmap, tcpdump, ping, dig, traceroute, mtr.
2. Develop a HTTP web client program to download a web page using TCP sockets.
3. Develop client server applications using TCP and UDP sockets. Modify server to handle multiple clients concurrently.
4. Use Wireshark to capture network traffic on a specific network interface.
    a. Explore and investigate the captured packets,
    b. Apply filters and
    c. Analyze various aspects of the traffic.
5. Develop an application to simulate the working of DNS, its database, name resolution and error handling.
6. Implement error detection and correction functionalities using socket programming.
    a. Checksum
    b. CRC / Hamming code
7. Create a simple network with multiple nodes, links, and traffic flows using a network simulator (such as NS3).
    a. Configure IP addresses and routing protocols for the nodes.
    b. Measure network performance metrics such as latency and throughput.
8. Develop a program in NS3 to simulate packet transmission between nodes.
    a. Generate different types of traffic flows, such as TCP and UDP, and analyze packet loss, delay, and retransmission rates.
    b. Use NS3's tracing capabilities to monitor and record packet-level information.
9. Evaluate different routing protocols (e.g., OSPF, RIP, AODV) using NS3. Set up a network topology and compare the routing performance of different protocols under varying network conditions (e.g., congestion, link failures). Measure metrics such as packet delivery ratio, end-to-end delay, and routing table updates.
10. Implement and evaluate various TCP congestion control algorithms (e.g., Reno, Cubic, BBR) using NS3.
    a. Simulate a network with multiple TCP connections and analyze the impact of different congestion control algorithms on network throughput, fairness, and congestion avoidance.
11. Design a wireless network topology with nodes using different wireless technologies (e.g., Wi-Fi, Bluetooth, Zigbee) using NS3.
    a. Simulate node movements.
    b. Measure network performance metrics such as signal strength, throughput, and packet loss. Analyze the impact of node mobility on network performance.

TOTAL PERIODS: 45

Software:

1. C / Python / Equivalent Compiler.
2. Network simulator like NS3/OPNET/ Packet Tracer / Equivalent

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Analyze the network statistics and performance using networking tools. Examine the network traffic using a packet analyzer.	**K4**
CO2	Implement client – server applications using socket programming. Implement error detection and correction codes.	**K3**
CO3	Simulate network topologies, with congestion control algorithms, routing algorithms and evaluate their performance, using a simulation tool.	**K5**

REFERENCE BOOKS:

1 Lewis Van Winkle, "Hands-On Network Programming with C: Learn socket programming in C and write secure and optimized network code" 2019, Packt Publishing Limited.

2 Laura Chappell, "Wireshark Network Analysis: The Official Wireshark Certified Network Analyst Study Guide", Chappell University; 2nd edition.

3 NS3: https://www.nsnam.org/docs/tutorial/html/resources.html

4 by Jason Edelman, Matt Oswalt, Scott Lowe, "Network Programmability and Automation: Skills for the Next-Generation Network Engineer" 2018, O'Reilly Media; 1st edition.

5 E. Aboelela, Network Simulation Experiments Manual, Third Edition, Morgan Kaufmann 2003.

6 J. Liebeherr, M. El Zarki, "Mastering Networks, An Internet Lab Manual", Pearson Education, 2004.

7 J. S. Beasley, Networking, Pearson Education, 2004.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO 1	**PO2**	**PO 3**	**PO 4**	**PO5**	**PO 6**	**PO7**	**PO 8**	**PO 9**	**PO10**	**PO 11**	**PO12**	**PSO 1**	**PSO2**
CO1	3	3	2	3	3					2			2	2
CO2	3	2		3									2	
CO3	3	2		3	3							2	2	
Total	9	7	2	9	6					2		2	6	2
Score	3	3	2	3	3					2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1601	AUTOMATA AND FORMAL LANGUAGES	3	0	0	3

OBJECTIVES

- To construct automata for regular expressions
- To acquire brief knowledge about automata languages
- To analyze context free grammars and construct its push down automata
- To understand Turing machines and their capabilities
- To understand undecidable problems.

UNIT I FINITE AUTOMATA AND REGULAR EXPRESSIONS 9

Basic Mathematical Notation and Techniques; Deterministic and Non-deterministic Finite Automata; (DFA) -- Finite automata with epsilon transitions -- Equivalence of FAs -- Minimization of FA; Regular Expressions and Languages: Regular expressions -- Finite automata and regular expressions.

UNIT II REGULAR LANGUAGES AND CONTEXT FREE LANGUAGES 9

Properties of Regular Languages: Proving languages not to be regular; Chomsky's Hierarchy of Languages; Context-Free Grammar and Languages: Context-Free Grammar (CFG) -- Parse trees -- Ambiguity in grammars and languages; Normal Forms for Context Free Grammars: Eliminating useless symbols -- Computing the generating and reachable symbols -- Eliminating null productions -- Eliminating unit productions – Chomsky Normal Form (CNF) -- Greibach Normal Form (GNF).

UNIT III PUSHDOWN AUTOMATA 9

Pushdown Automata (PDA): Definition of the Pushdown automaton -- The languages of a PDA -- Equivalence of PDAs and CFGs -- Deterministic Pushdown automata; Properties of Context Free Languages: Pumping Lemma for Context Free Languages.

UNIT IV TURING MACHINES 9

Turing machines (TM) –- computable languages and functions -- Turing machine constructions -- storage in finite control -- Extensions to the Basic Turing Machine.

UNIT V UNDECIDABILITY 9

Undecidability: Language that is not Recursively Enumerable (RE) -- Undecidable problem that is RE -- Undecidable problems about Turing machines -- Post's Correspondence Problem (PCP) -- Other undecidable problems.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Construct automata, regular expression for any given pattern	**K3**
CO2	Compare the formal relationships among machines, languages and Context free grammars.	**K5**
CO3	Design the Push down Automata for context free language.	**K3**
CO4	Construct Turing machines for any language.	**K3**

CO5 Explain the Decidability or Undecidability of various problems **K2**

TEXTBOOKS

1. Michael Sipser, "Introduction to the Theory of Computation" Cengage Learning, 2012.
2. Hopcroft J E, Motwani R, Ullman J D, "Introduction to Automata Theory, Languages and Computations", Pearson Education, 2021.

REFERENCE BOOKS

1. Meduna, A., 2012. Automata and languages: theory and applications. Springer Science & Business Media.
2. Harry R Lewis, Christos H Papadimitriou, "Elements of the Theory of Computation", Prentice Hall of India,2nd Edition,2003.
3. Peter Linz, "An Introduction to Formal Language and Automata", Narosa Publishers, 3rd Edition,2002.
4. Mishra K L P, Chandrasekaran N, "Theory of Computer Science – Automata, Languages and Computation", Prentice Hall of India, 3rd Edition,2004.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2										3	3
CO2	3	2								2			3	
CO3	3	2											3	3
CO4	3	2										2	3	3
CO5	3	2											2	
Total	15	10	2							2		2	14	9
Score	3	2	2							2		2	3	3

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1602	INTRODUCTION TO INTERNET OF THINGS	3	0	0	3

OBJECTIVES

- To understand the basics of IoT devices, protocols, communication APIs and deployment templates
- To design the simple IoT systems using Raspberry Pi/Arduino
- To understand various IoT protocols
- To design an IoT system using cloud environments
- To develop IoT solutions for industries.

UNIT I INTRODUCTION TO INTERNET OF THINGS 9

Basic computer networking to Internet of things: Network Types -- Layered network models -- Addressing -- TCP/IP transport Layer. Definition and Characteristics of IoT -- Physical Design of IoT -- Logical Design of IoT -- IoT Enabling Technologies -- IoT Levels & Deployment Templates -- IoT and M2M

UNIT II BUILDING IOT SYSTEMS 9

IoT Physical devices and Endpoints: Basic building blocks of IoT Device -- Raspberry Pi -- Linux on Raspberry Pi – Interfaces and Sensors -- Programming Raspberry Pi with Python --Python packages for IOT: JSON -- XML -- HTTPLib -- URLLib -- SMTPLib -- XMPP -- Contiki OS -- Other IoT Platforms: Arduino -- Intel Galileo and Beaglebone boards.

UNIT III IOT PROTOCOLS 9

Introduction to IoT Protocols -- 802.15.4 -- 6LoWPAN -- IEEE 802.11 -- WiFi -- 802.15 Bluetooth – Zigbee -- CoAP.

UNIT IV CLOUD OFFERINGS AND IOT CASE STUDIES 9

Cloud Storage Models and Communication APIs for IoT-- WAMP- Python Web Application framework-- Designing a RESTful Web API-- Amazon Web Services for IoT-- MQTT --Case studies for IoT Design: Home automation-- Smart Agriculture.

UNIT V INDUSTRIAL INTERNET OF THINGS (IIOT) 9

Introduction -- Industrial Process-- The Computer Integrated Manufacturing Pyramid (CIM)-- IIoT data flow-- Understanding the IIoT edge: features of the edge -- architecture and implementations. Designing IOT industrial solution with cloud services.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Explain the basics of IoT devices, protocols, communication APIs and deployment templates.	**K2**
CO2	Design simple IoT systems using Raspberry Pi/Arduino	**K3**
CO3	Choose appropriate protocols for a specific IoT application	**K3**
CO4	Evaluate various cloud offerings and design IoT systems using cloud	**K5**

environments

CO5 Design IoT solutions for industries. **K3**

TEXTBOOKS:

1. Sudip Misra, Anandarup Mukherjee and Arijit Roy, “Introduction to IoT”, Cambridge University Press: 09 January 2021
2. Arshdeep Bahga, Vijay Madisetti, Internet of Things: A hands-on Approach, University Press, 2015 (1st edition)
3. Giacomo Veneri, "Antonio Capasso, "Hands-On Industrial Internet of Things Create a Powerful Industrial IoT Infrastructure Using Industry 4.0", 2018

REFERENCE BOOKS:

1. Adrian McEwen Hakim Cassimally, Designing the Internet of Things,Wiley, Nov2013, (1st edition)
2. Olivier Hersent, David Boswarthick, Omar Elloum, ``The Internet of Things Key applications and Protocols", Wiley, 2012.
3. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand, David Boyle,"From Machine - to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3												2	
CO2	3	2	2		2	2	3	2		2		2	2	3
CO3	3		2		**2**								2	
CO4	3	2	2		2					2		2	2	
CO5	3	2	2		2	2	3	2					2	2
Total	15	3	8		8	4	6	4		4		4	10	5
Score	3	2	2		2	2	3	2		2		2	2	3

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1603	DISTRIBUTED SYSTEMS DESIGN	3	0	0	3

OBJECTIVES

- To introduce the computation and communication models of distributed systems
- To illustrate the issues of synchronization and collection of information in distributed systems
- To educate distributed mutual exclusion and distributed deadlock detection techniques
- To elucidate agreement protocols and Fault Tolerance mechanisms in Distributed Systems
- To explain the features of Peer-to-Peer systems and memory consistency models

UNIT I INTRODUCTION 8

Introduction: Definition-Relation to computer system components -- Motivation -- Relation to parallel multiprocessor/multicomputer systems -- Message-passing systems versus shared memory systems -- Primitives for distributed communication -- Synchronous versus asynchronous executions -- Design issues and challenges; Global state of a distributed system -- Cuts of a distributed computation -- Past and future cones of an event -- Models of process communications.

UNIT II LOGICAL TIME AND GLOBAL STATE 10

Logical Time: Physical clock synchronization: NTP -- A framework for a system of logical clocks -- Scalar time -- Vector time; Message ordering and group communication: Message ordering paradigms -- Group communication – Causal order (CO) Total order; Global state and snapshot recording algorithms: Introduction – System model and definitions – Snapshot algorithms for FIFO channels - Necessary and sufficient conditions for consistent global snapshots – Finding consistent snapshots

UNIT III DISTRIBUTED MUTEX AND DEADLOCK 10

Distributed mutual exclusion algorithms: Introduction – Preliminaries – System Model, Requirements and Performance Metrics -- Lamport's algorithm, Correctness and Performance -- Ricart–Agrawala algorithm, Correctness and Performance -- Token-based algorithms -- Suzuki–Kasami's broadcast algorithm, Correctness and Performance**;** Deadlock detection in distributed systems: Introduction -- System model – Preliminaries -- Models of deadlocks -- Knapp's classification of distributed deadlock detection algorithms -- Chandy–Misra–Haas algorithm for the AND model -- Chandy–Misra–Haas algorithm for the OR model.

UNIT IV CONSENSUS AND RECOVERY 10

Consensus and agreement algorithms: Problem definition -- Overview of results -- Agreement in a failure-free system (synchronous or asynchronous) -- Agreement in (message-passing) synchronous systems with failures; Check pointing and rollback recovery: Introduction -- Background and definitions -- Issues in failure recovery --Checkpoint-based recovery – Logbased rollback recovery -- Koo–Toueg coordinated check pointing algorithm -- Juang– Venkatesan algorithm for asynchronous checkpointing and recovery.

UNIT V PEER TO PEER AND DISTRIBUTED SHARED MEMORY 7

Peer-to-peer computing and overlay graphs: Introduction – Data indexing and overlays -- Tapestry; Distributed shared memory: Abstraction and advantages -- Memory consistency models -- Lamport's Bakery Algorithm.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Explain the foundations of Distributed Systems	**K2**
CO2	Analyse the correctness of algorithms for synchronization and state consistency problems	**K4**
CO3	Evaluate the performance metrics of the resource sharing techniques in Distributed systems	**K5**
CO4	Make use of the working model of consensus and reliability of Distributed Systems	**K3**
CO5	Explain the fundamentals of Peer-to-Peer Systems	**K2**

TEXTBOOKS:

1 Kshemkalyani Ajay D, Mukesh Singhal.“Distributed computing: Principles, Algorithms and Systems”. Cambridge University Press, 2011

2 Mukesh Singhal,Niranjan G Shivaratri. “Advanced Concepts in Operating Systems”. McGraw-Hill, 1994

REFERENCE BOOKS:

1 George Coulouris, Jean Dollimore, Tim Kindberg, “Distributed Systems Concepts and Design”, Fifth Edition,Pearson Education, 2012

2 Pradeep K Sinha, “Distributed Operating Systems: Concepts and Design”, Prentice Hall of India,2007

3 Tanenbaum A S, Van Steen M, “Distributed Systems: Principles and Paradigms”, Pearson Education, 2007

4 Liu M L, “Distributed Computing, Principles and Applications”, Pearson Education, 2004

5 Nancy A Lynch, “Distributed Algorithms”, Morgan Kaufman Publishers, USA, 2003

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3										2	3	2
CO2	3	3	3							2		2	3	2
CO3	3	3	3							2		2	3	2
CO4	3	3	3							2		2	3	2
CO5	3											2	3	
Total	15	12	9							6		10	15	8
Score	3	3	3							2		2	3	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1604	BIG DATA MANAGEMENT	3	0	0	3

OBJECTIVES

- To know the fundamental concepts of big data management.
- To understand the basics of data modelling and its implications.
- To learn different data models adopted in big data.
- To get introduced to big data management systems like key-value stores and graph databases.
- To learn various supporting tools for developing an application using document and columnar databases.

UNIT I BIG DATA MANAGEMENT 7

Introduction to Big Data and Data Management - Data Modeling and Management Platforms - Defining Data Models - Structures of Data Models - Modeling with Unstructured and Streaming Data.

UNIT II HADOOP & SPARK 10

Hadoop Introduction - HDFS - Internals of MapReduce - Hadoop Ecosystem - Spark Introduction - Spark Transformations and Actions - Spark RDD Practice - Spark Data Frames and SQL.

UNIT III DATA LAKE DEVELOPMENT WITH BIG DATA 8

Introduction - Need for Data Lake - Data Intake - Data Integration, Quality and Enrichment - Data Discovery and Consumption - Data Governance.

UNIT IV DOCUMENT AND GRAPH DATABASES 10

Introduction - JSON and Data Operations - Working with Databases: Pruning data from MongoDB - Backing up a Database - Restoring a Database - Security; Programmatic Access: Accessing MongoDB using PHP and Python – Graph Databases an Overview – Neo4j – Modelling data for Neo4j – Use Case Examples: Recommender Systems & Impact Analysis and Simulation – Visualization for Neo4j.

UNIT V KEY-VALUE STORE AND COLUMNAR DATABASES 10

Approaches to Big Data –Introduction to NoSQL – Key-Value Store: Redis - Introduction to Cassandra – Architecture – CassandraQL (CQL) – Configuring and Managing a Cluster – Integrating with Apache Spark.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Illustrate the different data models and identify data operations needed for designing information systems.	**K2**
CO2	Build distributed data processing applications using Apache Hadoop and Spark.	**K3**
CO3	Apply a data model to suit the characteristics of Data Lake.	**K3**

CO4	Apply Big Data Management System for building a system using MongoDB and Graph Databases.	**K3**
CO5	Design an application using Columnar Database.	**K6**

TEXTBOOKS:

1 James Lee, Tao Wei, Suresh Kumar Mukhiya, "Hands-On Big Data Modeling", Packt Publication, 2018. (Unit 1)

2 Chanchal Singh, Manish Kumar, "Mastering Hadoop 3", Packt Publication, 2019. (Unit 2)

3 Pradeep Pasupuleti, Beulah Salome Purra, "Data Lake Development with Big Data", Packt Publication, 2015. (Unit 3)

REFERENCE BOOKS:

1 Vinoo Das, "Learning Redis", Packt Publications, 2015. (Unit 5)

2 Jerome Baton, Rik Van Bruggen, "Learning Neo4j 3.x", 2nd Edition, Packt Publishers, 2017 (Unit 4)

3 Aaron Ploetz, Tejaswi Malepati, Nishant Neeraj, "Mastering Apache Cassandra 3.x", 3rd Edition, Packt Publishers, 2018 (Unit 5).

4 Shannon Bradshaw, Eoin Brazil, Kristina Chodorow, "MongoDB: The Definitive Guide", 3rd Edition, 2019 (Unit 4).

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2										2	
CO2	3	2	2		3	2				2			2	2
CO3	3	2	2		3	2				2		2	2	3
CO4	3	2	2		3	2				2		2	2	3
CO5	3	2	2		3	2				2		2	2	3
Total	15	10	10		12	8				8		6	10	11
Score	3	2	2		3	2				2		2	2	3

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1661	COMPETITIVE PROGRAMMING	1	0	2	2

OBJECTIVES

- Implement number theory and combinatorics algorithms using efficient techniques
- Develop and implement string algorithms
- Apply standard programming techniques to develop and implement graph algorithms
- Solve computational geometry problems
- Apply combination of standard algorithms to solve practical applications

UNIT I SORTING, NUMBER THEORY, COMBINATORICS 2

Heapsort - Scheduling events - Primality Testing - Co-primes - Euclid's Algorithm - Generating Permutations - Maximum Subarray Sum – Sum of series – Knapsack problems

UNIT II STRING ALGORITHMS 2

Longest Common Subsequence – Longest Palindromic Sequence – Edit Distance – Substring Search

UNIT III GRAPH ALGORITHMS 2

Minimum Spanning Tree – Shortest Paths – Topological Sorting – Detecting Cycles – Finding diameter of a graph – Network Flows – Bipartite Matching – Disjoint Set Union with Path Compression

UNIT IV COMPUTATIONAL GEOMETRY 2

Paths in a grid – Closest pair of points – Finding the Convex Hull - Counting tilings

UNIT V PRACTICAL APPLICATIONS 7

Google Maps – Dijkstra's and A* algorithms; Tim Sort – Insertion Sort and Merge Sort; Machine learning algorithms – kNN Algorithms – Logistic Regression

THEORY PERIODS: 15
LAB PERIODS: 30

SUGGESTED EXPERIMENTS:

1. Sorting: Heapsort using Fibonacci heap, Scheduling events (Eg: Railway scheduling, Resource Scheduling in networks and OS)
2. Number Theory: Primality Testing, Co-primes, Euclid's Algorithm (Eg: Implement RSA Algorithm)
3. Combinatorics: Generating Permutations, Maximum Subarray Sum, Sum of series, Knapsack problems (Ex: Courier pickup and delivery via bin packing)
4. String Algorithms: Longest Common Subsequence, Longest Palindromic Subsequence, Longest Increasing Subsequence, Longest Decreasing Subsequence, Edit Distance, Substring Search (Eg: Text search in a given file, automatic spelling correction)
5. Graph Algorithms: Realizing communication, social media and transportation network problems (Eg: Minimize cost of laying optical fibre cables by telecom providers)

6. Computational Geometry: Collision detection systems (Eg: Detecting obstructions in robotics)

SYSTEM REQUIREMENTS:

The questions should be hosted on platforms like codechef, leetcode, and hackerrank, and monitored for speed of response, correctness and efficiency of the solutions.

COURSE OUTCOMES:

On successful completion of this course, the student will be able to:

- **CO1** Develop and implement number theory and combinatorics-based problems in computer science (K3)
- **CO2** Develop and implement string algorithms (K3)
- **CO3** Apply known programming paradigms to solve graph problems (K3)
- **CO4** Solve problems in computational geometry efficiently (K3)
- **CO5** Combine and apply known algorithms to solve real-life computational problems (K5)

TEXTBOOKS

1. Competitive Programming 4: The Lower Bound of Programming Contests in the 2020s by Steven Halim, Felix Halim, Suhendry Effendy, 2022
2. Guide to Competitive Programming: Learning and Improving Algorithms Through Contests by Antti Laaksonen, 2018
3. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, “Introduction to Algorithms”, Third Edition, 2012

REFERENCE BOOKS

1. Algorithms by Jeff Erickson (freely available online)
2. Robert Sedgewick and Kevin Wayne, “Algorithms”, Fourth Edition, 2011
3. J. Klienberg and E. Tardos, Algorithm Design, 2013
4. Data Structures and Algorithm Analysis in C++, Mark Allen Weiss, 2007
5. S. Dasgupta, C. Papadimitrou, U Vazirani, Algorithms, First Edition, 2006

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	3			2		2	2	3	2	3
CO2	3	2	2	3	3			2		2	2	3	2	3
CO3	3	2	2	3	3			2		2	2	3	2	3
CO4	3	2	2	3	3			2		2	2	3	2	3
CO5	3	2	2	3	3			2		2	2	3	2	3
Total	15	10	10	15	15			10		10	10	15	10	15
Score	3	2	2	3	3			2		2	2	3	2	3

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1611	IOT DESIGN LABORATORY	0	0	3	1.5

OBJECTIVES

- To build simple IoT systems using Arduino/Raspberry Pi and sensors.
- To build low-cost embedded systems using various communication protocols and web APIs
- To develop cloud based IoT solutions for real time applications.

SUGGESTED EXPERIMENTS

1. Interface Arduino board to read analog and digital values using Light Dependent Resistor and Ultrasonic sensors.
2. Interface Raspberry Pi board to read analog and digital values using temperature and humidity sensors.
3. Construct a Raspberry Pi based system to control the LED using a switch.
4. Interface Arduino/Raspberry Pi with a sensor and LED to read the status in a smartphone using Bluetooth protocol.
5. Develop an Arduino/Raspberry Pi based system which communicates to the cloud for sending and retrieving the temperature and humidity data.
6. Develop an Arduino/Raspberry Pi based system to publish/subscribe temperature data using MQTT.
7. Develop an Arduino/Raspberry Pi based system to measure the light intensity in the room and output the data to a web API.
8. Mini Project (Suggestions: Develop a system to analyse the quality of drinking water using required IoT devices, cloud, mobile and web app, Develop a basic home automation system. using cloud platform, develop a basic smart agriculture system using cloud platform)

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Build simple IoT systems using Arduino/Raspberry Pi and sensors	**K3**
CO2	Build low-cost embedded systems using various communication protocols and web APIs	**K3**
CO3	Develop cloud based IoT solutions for real time applications	**K6**

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2				3	2		2			2	3
CO2	3	2	2		2	2	3	2		2			2	3
CO3	3	2	2	3	2	2	3	2	2	2		2	2	3
Total	9	6	6	3	4	4	9	6	2	6		2	6	9
Score	3	2	2	3	2	2	3	2	2	2		2	2	3

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1612	BIG DATA MANAGEMENT LABORATORY	0	0	3	1.5

OBJECTIVES

- To learn big data management tools
- To learn different big data management systems based on key-value store and graph databases.
- To learn supporting tools to develop an application using document and columnar databases.

SUGGESTED EXPERIMENTS

1. Using Hadoop

- Word count: Counts the number of each word in any text file.
- First char count: Same as before, but for each first letter of each word
- Inverted index: Given any text file, it builds an inverted index.
- Log parser:
  - For any given file with log records like:
    10.223.157.186 - - [15/Jul/2022:14:58:59 -0700] “GET / HTTP/1.1” 403 202
  - It first filters those whose status code is not 2XX.
  - Then, count the number of requests for each URL. Then, count the number of requests for each month for 2022. Finally, the count of requests for each hour for the year 2022.
- **Bakery**
  - Given a dataset which consists of the following files:
  - customers.csv: information about the bakery’s customers
  - goods.csv: information about the baked goods offered for sale by the bakery.
  - items.csv: itemized receipt information for purchases
  - reciepts.csv: general receipt information for purchases
  - We count the total amount of money spent by each user, which users have bought more than once per day, the list of those dates and the total number of units sold for each product.

2. Using Spark:

- Importing and viewing a dataset using PySpark.
- Data cleaning and preprocessing using PySpark.
- Using SparkSQL to run SQL-like queries on the dataset.
- Calculating various statistics, such as sum, average, and count.
- Grouping and aggregating data based on specific attributes.
- Creating temporary tables and views in SparkSQL.

3. Explore the Data Lake with Azure Synapse Serverless SQL and Spark

4. Develop an application for the following concepts, i) fraud detection, ii) digital asset management using GraphDB and Redis.

5. Develop an application for the bi-cycle rental system in a universityusing MongoDB.

6. Develop a simple project using Cassandra Cloud Database Management System.

TOTAL PERIODS: 45

HARDWARE:

Intel i5, 16 GB RAM systems - 35 Systems.

SOFTWARE:

Linux / Ubuntu OS, Java, Apache Hadoop, Apache Casandra, Apache Spark, MongoDB - open-source License for Microsoft Azure Synapse and Spark.

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Apply Apache Hadoop and Spark for processing big data.	**K3**
CO2	Apply a data model to suit the data characteristics using Data Lake for an application.	**K3**
CO3	Build and deploy a simple project using document and columnar databases.	**K6**

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2	3	3	2			2	2		2	2	2
CO2	3	2	2	3	3	2			2	2		2	2	3
CO3	3	2	2	3	3	2			2	2		2	2	3
Total	9	6	6	9	9	6			6	6		6	6	8
Score	3	2	2	3	3	2			2	2		2	2	3

COURSE CODE	COURSE TITLE	L	T	P	E	C
ICS1701	DESIGN OF COMPILERS	3	0	0	0	3

OBJECTIVES

- To learn various phases of a compiler
- To learn various parsing techniques
- To understand intermediate code generation
- To learn to implement code generator
- To learn to implement code optimization

.

UNIT I INTRODUCTION TO COMPILERS 9

Language processors – Phases of compiler – Role of lexical analyzer – Input buffering – Specification of tokens; Recognition of tokens: Conversion of Regular expression to DFA; Lexical analyzer generator: Structure of lex program – Lookahead operator and conflict resolution.

UNIT II SYNTAX ANALYSIS 9

Syntax Analysis: Role of Parser – Writing grammars for language constructs; Types of grammars: Ambiguity – Deterministic and recursive; Top down parsers: Recursive descent parser – Predictive parser; Bottom up parsers: SLR Parser – CLR Parser – LALR Parser; Error handling and recovery in syntax analyzer; Syntax analyzer generator: Structure of YACC program – Creating YACC lexical analyzers with lex.

UNIT III INTERMEDIATE CODE GENERATION 9

Syntax directed definitions: Synthesized attribute – Inherited attribute – Dependency graph – Evaluation order of syntax directed definitions; Intermediate languages: Syntax tree – Three address code; SDD for type checking – Declarations – Evaluation of expressions and flow of control statements – Addressing array elements.

UNIT IV CODE GENERATION 9

Code Generation: Issues in code generation – Design of a simple code generator - Register allocation and assignment; Instruction selection: Tree translation schemes – Code generation by tilling an input tree; Optimal code generation for expressions.

UNIT V CODE OPTIMIZATION 9

Principal sources of optimization – Peephole optimization – DAG; Optimization of basic blocks: local and global optimizations; Global data flow analysis: Reaching Definition – Live Variable Analysis.

TOTAL PERIODS(THEORY): 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Construct a lexical analyzer for a sample language	**K3**
CO2	Apply different parsing algorithms to develop the parsers for the given	**K3**

	grammar	
CO3	Build syntax directed translation for programming language constructs	**K3**
CO4	Develop a simple code generator	**K3**
CO5	Choose appropriate optimization techniques at source code and target code levels	**K5**

TEXTBOOKS

1. Alfred V Aho, Monica S Lam, Ravi Sethi, Jeffrey D. Ullman, "Compilers: Principles, Techniques and Tools", 2nd Edition, Pearson Education, 2009. (All units)
2. Keith D Cooper, Linda Torczon, "Engineering a Compiler", 3rd Edition, Morgan Kaufmann Publishers, 2022.

REFERENCE BOOKS

1. Jeremy G. Siek, "Essentials of Compilation: An Incremental Approach in Racket", The MIT Press, 2023.
2. Randy Allen, Ken Kennedy, "Optimizing Compilers for Modern Architectures: A Dependence Based Approach", Morgan Kaufmann Publishers, 2001.
3. Andrew W. Appel, "Modern Compiler Implementation in C", Cambridge University Press, 1st edition, 2004.
4. Watson, Des, "A Practical Approach to Compiler Construction", 1st edition, Springer-Verlog, 2017.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3										2	3	
CO2	3	3										2	3	3
CO3	3	3											2	3
CO4	3	3											2	
CO5	3	3	3									2	3	3
Total	15	15	3									6	13	9
Score	3	3	3									2	3	3

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1702	CRYPTOGRAPHY AND DATA SECURITY	3	0	0	3

OBJECTIVES

- To provide an in-depth understanding of cryptography theories, algorithms and systems
- To understand the fundamentals of cryptography and number theory
- To use the standard security algorithms to provide confidentiality, integrity and authentication for any applications.
- To make use of application protocols to design and manage a secure system and the importance of system security and its vulnerabilities
- To emphasizes on how to apply and implement cryptography in practice

UNIT I Introduction to Security and Number system 9

Basics of Security: CIA Triad – Threats, Attacks and Services; Classical Cryptography: Substitution – Transposition – One-time Pad – Cryptanalysis; Number Theory: Modular Arithmetic – Euclidean Theorem – Extended Euclidean Theorem – Algebraic Structures – Galois Field – Prime Numbers – Fermat's Theorem – Euler's Phi function – Euler's Theorem – Chinese Remainder theorem – Modular Exponentiation –Logarithms – Elliptic Curve Arithmetic.

UNIT II Symmetric Cryptography 9

Modern Cryptography: Symmetric Cipher – Block and Stream Cipher; Feistel Ciphers: Data Encryption Standard (DES) – DES Structure – Key Generation – Simplified DES – Linear and Differential cryptanalysis –Triple DES; Advanced Encryption Standard (AES): Basic Structure – Transformations – Key Expansions Process – Analysis of AES – Modes of operation; RC4.

UNIT III Public Key Cryptography 9

Public Key Cryptosystems: RSA Algorithm – ElGamal Cryptosystems – Diffie-Hellman key exchange – Elliptic curve cryptography; Hash functions: Hash algorithms – Secure Hash Algorithm SHA – MD5 – Message Authentication Codes; Quantum Cryptography: Quantum Key Distribution – Threshold Cryptography.

UNIT IV Data Integrity 9

Secure Communication and Message Integrity: Encryption vs. Message Authentication - Message Authentication Codes - Constructing Secure Message Authentication Codes – CBCMAC Collision-Resistant Hash Functions – NMAC and HMAC – Constructing CCA; Secure Encryption Schemes: Obtaining Privacy and Message Authentication.

UNIT V Security Practices 9

Digital Signatures Schemes: Digital Certificate – Key Management; Kerberos – Key Agreement and Distribution; PKI – X.509 Certificate; E-Mail Security – PGP – S/MIME; IP security – Virtual Private Network (VPN) ; Web Security – Secure Socket Layer (SSL); Transport Layer Security: Secure Electronic Transaction (SET); Blockchain; Wireless LAN: Wireless LAN Security – Network Access Control and Cloud Security.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Apply and analyze the number theoretic foundations of cryptography	**K3**
CO2	Apply the different cryptographic operations of symmetric key algorithms	**K3**
CO3	Apply the different cryptographic operations of public key cryptographic techniques	**K3**
CO4	Apply the various authentication schemes and hash algorithms	**K3**
CO5	Explain the different security mechanisms for diverse applications	**K2**

TEXTBOOKS

1. Jonathan Katz, YehudaLindell, "Introduction to Modern Cryptography",3rd Edition (Chapman & Hall/CRC Cryptography and Network Security Series), 2020.
2. Wenbo Mao, "Modern Cryptography – Theory and Practice", Pearson Education, 2004.
3. Behourz Forouzan, DebdeepMukhopadyay, "Cryptography and Network Security", Tata McGraw Hill Education Pvt. Ltd, New Delhi, 2010.
4. Gilles van Assche, "Quantum Cryptography and Secret-Key Distillation", Cambridge University Press, 2010.
5. Charles P Pfleeger, Shari Lawrence Pfleeger, "Security in computing", 3rd Edition,Prentice Hall of India,2006.

REFERENCE BOOKS

1. Handbook of Applied Cryptography by A. Menezes, P. Van Oorschot, S. Vanstone. Free!
2. A Graduate Course in Applied Cryptography by D. Boneh and V. Shoup. Free!

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2		2	2		2		2		2	2	
CO2	3	2			2							2	2	
CO3	3	2			2							2	2	
CO4	3	2											2	3
CO5	3	2					2						2	
Total	15	10											10	
Score	3	2	2		2	2	2	2		2		2	2	3

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1761	MICROSERVICES	2	0	2	3

OBJECTIVES

- Understand and demonstrate microservices.
- Explore and deploy microservices in a container
- Modify configuration techniques using Kubernetes and Jenkins
- To be familiar with Microservice design patterns.
- Explore XML, Web services and SOA.

UNIT I MICROSERVICES 5

An Introduction to Microservices; A case study on Migration to Microservices -- Planning for Migration -- Applying Microservices Criteria -- Converting to Microservices – Building and Deployment of Application.

UNIT II CONTAINERS 5

Docker Containers: Virtual Machines -- Containers -- A Simple Example; Docker Interface: Key Docker Commands -- Docker file -- Docker Compose; Case Study: Containerizing a Helpdesk Application: Containerizing Microservices.

UNIT III ORCHESTRATION AND DESIGN PATTERNS 7

Container Orchestration: Kubernetes -- Kubectl -- Kubernetes Cluster – Jenkins -- Benefits of using microservices architecture patterns—Design Patterns: Aggregator pattern -- API Gateway pattern — Pub Sub patten—Circuit Breaker pattern – Decomposition pattern.

UNIT IV XML AND WEB SERVICES 7

XML document structure – Well-formed and valid documents – DTD – XML Schema – Parsing XML using DOM, SAX – XPath - XML Transformation and XSL – X Query

UNIT V SERVICE ORIENTED ARCHITECTURE 6

Characteristics of SOA, Benefits of SOA-- Service descriptions – WSDL – Messaging with SOAP – Service discovery – UDDI-- Service-Level Interaction Patterns – Orchestration and Choreography.

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TOTAL PERIODS: (THEORY) 30

SUGGESTED EXPERIMENTS

1. Create a Catalog application as a Microservice.
2. Working with Docker, Docker Commands, Docker Images and Containers for content management.
3. Develop a simple containerized application using Docker.
4. Install and set up Kubernetes, explore the environment.

5. Automate the process of running containerized application developed using Kubernetes.
6. Install and set up Jenkins, explore the environment.
7. Demonstrate continuous integration and development using Jenkins.
8. Apply a suitable microservice design pattern for a catalog application.
9. Develop a structured XML document.
10. Explore XSLT and XLS Query.

TOTAL PERIODS: (LAB)30

Required Software

Docker and Docker Desktop, Kubernetes, Jenkins, git bash, GitHub, Puppet, MLFlow and Optuna

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Build a service and convert into a microservices	**K3**
CO2	Create a container and deploy a microservice	**K5**
CO3	Choose configuration features using Kubernetes and Jenkins	**K5**
CO4	Apply Microservices Design patterns for a problem.	**K3**
CO5	Inspect and explore XML document with XSLT and XLS Query	**K4**

TEXTBOOKS

1 Parminder Singh, Kocher Boston, “Microservices and Containers’, Addison-Wesley, 2018. (Unit 1,2,3)

2 Richardson, Chris. *Microservices patterns: with examples in Java*. Simon and Schuster, Manning, 2018. (Unit 3)

3 Ron schmelzer et al, “XML and Web Services”, Pearson Education, 2002. (Unit 4)

4 Thomas Erl, “Service Oriented Architecture: Concepts, Technology and Design”, Pearson Education, 2005. (Unit 5)

REFERENCE BOOKS

1 Sandeep Chatterjee and James Webber, “Developing Enterprise Web Services: An Architect’s Guide”, Prentice Hall, 2004.

2 Thomas Uphill, ``Mastering Puppet", Second Edition,PACKT Publishing, 2016

3 Scott Coulton, ``Puppet for Containerization", PACKT Publishing, 2016

4 Cesar de la Torre, Bill Wagner, Mike Rouses, ``.NET Microservices: Architecture for Containerized .NET Applications’, Microsoft Corporation, V5.) Edition, 2020.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3		2			2	2	2		2	3	3
CO2	3	3	3		2			2	2	2		2	3	3
CO3	3	3	3		2			2	2	2		2	3	3
CO4	3	3	3		2			2	2	2		2	3	3
CO5	3	3	3		2			2	2	2		2	3	3
Total	15	15	15		10			10	10	10		10	15	15
Score	3	3	3		2			2	2	2		2	2	3

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1762	RESEARCH PRACTICES AND METHODLOGIES	1	0	2	2

OBJECTIVES

To impart knowledge and skills required for research and IPR

- Problem formulation, analysis and solutions.
- Technical paper writing / presentation without violating professional ethics
- Patent drafting and filing patents.

UNIT I RESEARCH PROBLEM FORMULATION AND PLANNING 3

Research Methodology-Introduction: Objectives of Research - Types of Research - Research Approaches - Research Process; Defining the Research Problem: Selecting the Research Problem - Necessity of Defining the Problem - Technique Involved in Defining a Problem.

UNIT II LITERATURE REVIEW 3

Literature survey: Scope and objectives of research problem - Methodologies – Analysis of Experimentation – Limitations and Research gaps – Plagiarism and research ethics.

UNIT III TECHNICAL WRITING / PRESENTATION 3

Effective technical writing, how to write a report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

UNIT IV DATA ANALYSIS 3

Data Analysis: Data Preparation; Sampling techniques: Random sampling, stratified sampling, systematic sampling and cluster sampling; Testing of Hypotheses: t-test, F test and chi-square test and their applications in research studies; Error Analysis

UNIT V INTELLECTUAL PROPERTY RIGHTS (IPR) 3

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development.

TOTAL PERIODS (THEORY): 15

LAB ACTIVITIES

A technical report or paper writing requires a student to obtain information from a variety of sources (i.e., Journals, Conference proceedings, Book chapters etc.), consolidate, draw conclusions and write as a report. The work involves the following steps:

- Selecting an area, narrowing the area into a topic and identifying the problem with its objectives.
- Collecting the relevant literature

- Reading the papers, understanding the contributions of the authors, preparing an abstract or outline of the paper and discussing
- Critically analyzing research papers that have been read, linking them and drawing conclusions
- Identifying research gaps and formulating a new problem statement
- Writing the technical report about the topic, literature, comparison and observation
- Presenting the report
- Data preparation and sampling
- Data analysis using statistical tests
- Converting the idea to proposal for funding

Lab Periods: 30

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to

1. Identify a topic, formulate research problem, analyze and find its limitations (K3)
2. Collect literature, consolidate, prepare technical report and write a survey paper (K4)
3. Describe data analysis, IPR and patent filing process. (K2)

TEXTBOOKS

1. C.R. Kothari and Gaurav Garg, "Research Methodology – Methods & Techniques", September 2019, 4th Edition, New Age International Publishers

REFERENCES

1. Prabhat Pandey and Meenu Mishra Pandey, "Research Methodology: Tools and Techniques", Bridge Center, 2015.
2. Ranjit Kumar, "Research Methodology: A Step-by-Step Guide for beginners", SAGE Publications Pvt. Ltd; Fourth edition, 2023.
3. Debora J Halbert, "Resisting Intellectual Property", Routledge Taylor & Francis Group, 2007.
4. Kenneth S. Bordens & Bruce Barrington Abbott, "Research design and Methods", Mc Graw Hill, 9th Edition, 2013.
5. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, Keying E. Ye, "Probability and Statistics for Engineers and Scientists", Pearson Prentice Hall, Pearson; 9th edition, 2010.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3		2			2		3		2	3	2
CO2	3	3	3		2			2		3		2	3	2
CO3	2	2	2		2			2		3		2	3	2
Total	8	8	8		6			6		9		6	9	6
Score	3	3	3		2			2		3		2	3	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1711	SECURITY LABORATORY	0	0	4	2

OBJECTIVES

- Learn different cipher techniques.
- Implement the algorithms DES, AES, RSA and Diffie-Hellman.
- Implement hashing techniques such as SHA-1, MD-5.
- Develop a digital signature scheme.

SUGGESTED EXPERIMENTS

1.Write a program to implement the following cipher techniques to perform encryption and decryption

i. Caesar Cipher
ii. Playfair Cipher
iii. Hill Cipher

2. Write a program to implement the following transposition techniques

(i) Rail fence technique –Row major transformation
(ii) Rail fence technique - Column major transformation

3. Write a program to implement DES algorithm
4. Write a program to implement AES algorithm
5. Write a program to implement RSA Encryption algorithm
6. Write a program to implement the Diffie-Hellman Key Exchange mechanism. Consider one of the parties as Alice and the other party as bob.
7. Write a program to calculate the message digest of a text using the SHA-1 algorithm.
8. Write a program to calculate the message digest of a text using the MD-5 algorithm.
9. Write a program to implement digital signature standard.
10. Demonstrate Intrusion Detection System using any tool (snort or any other equivalent s/w)
11.Create a simple blockchain to understand hashing and the chain structure. Implement a basic proof-of-work algorithm.
12. Mini Project

TOTAL PERIODS: 60

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Build symmetric and asymmetric algorithms.	**K3**
CO2	Construct and analyze code for various Authentication schemes.	**K4**
CO3	Apply the principles of digital signature.	**K3**

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

SOFTWARE: C / C++ / Java / Python or equivalent compiler
HARDWARE: Standalone desktops – 30 Nos. (or) Server supporting 30 terminals or more

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO 1	**PO2**	**PO 3**	**PO 4**	**PO5**	**PO 6**	**PO7**	**PO 8**	**PO 9**	**PO10**	**PO1 1**	**PO12**	**PSO 1**	**PSO2**
CO1	3	3	2	3	2					2			2	3
CO2	3	2		3						2			2	
CO3	3	2		3	2					2		2	2	
Total	9	7	2	9	4					6		2	6	3
Score	3	2	2	3	2	2	2	2		2		2	2	3

COURSE CODE	COURSE TITLE	L	T	P	E	C
ICS1712	COMPILERS LABORATORY	0	0	2	0	1

OBJECTIVES

- To develop a lexical analyzer
- To develop a parser
- To implement intermediate code generator
- To implement code generator
- To apply code optimization

.

SUGGESTED EXPERIMENTS

1.Implementation of lexical analyzer using C
2. Implementation of lexical analyzer using LEX Tool
3. Implementation of left recursion elimination
4. Implementation of recursive descent parser
5. Implementation of desk calculator using YACC
6. Implementation of syntax analyzer using LEX and YACC
7. Generation of TAC for a simple program using LEX and YACC
8. Implementation of code optimization techniques
9. Implementation of code generation for the given TAC.
10. Implementation of lexical analyzer using LLVM.
11. Use modern tools and technologies to design a new optimized compiler that takes a novel language and generates the machine language as a team.

TOTAL PERIODS: (LAB)30

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Develop an analysis part of a compiler which includes lexical analysis, syntax analysis and intermediate code generation.	**K3**
CO2	Develop the synthesis part of a compiler which includes code optimization and code generation.	**K3**
CO3	Design and construct a compiler for a simple language using modern tools.	**K6**

LABORATORY REQUIREMENT FOR BATCH OF 38 STUDENTS

Hardware: 1. Standalone Desktops with Linux OS - 38 Nos
Software: 1. C Compiler

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	3	3								3	
CO2	3	3	3	3									2	
CO3	3	3	3	3	3				3	2	3		3	3
Total	9	9	9	9	6				3	2	3		8	3
Score	3	3	3	3	3				3	2	3		3	3

COURSE CODE	COURSE TITLE	L	T	P	E	C
ICS1718	PRODUCT DEVELOPMENT PROJECT - PHASE I	0	0	6	3	4

OBJECTIVES

1. To identify a specific problem for the current need of the society and to collect related information through detailed review of literature, in team,
2. To develop a methodology to solve the identified problem (as a software app or hardware product)
3. To prepare project reports and presentations.

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Identify a societal problem and perform the requirement and feasibility analysis to identify customer needs and market demands, as a team.	**K3**
CO2	Analyse related literature on the selected problem and identify suitable tools / techniques / components required.	**K4**
CO3	Define the product requirements and functionalities of the system, conceptualize and design a solution.	**K6**
CO4	Analyse the risk, mitigation and impact of the solution in society or environment, with ethical considerations, through experiential learning.	
CO5	Communicate and collaborate using documentation and presentation.	

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3									3	
CO2	3	3	2	3	3					3	3	3	3	3
CO3	3	3	3	3	3					2	3		3	2
CO4						3	3							3
CO5								3	3	3				
Total	9	9	7	9	6	3	3	3	3	8	6	3	9	8
Score	3	3	3	3	3	3	3	3	3	3	3	3	3	3

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1801	MODERN DATA STRUCTURES AND ALGORITHMS	3	0	0	3

OBJECTIVES

- Learn to use hierarchical data structures
- Prove algorithms using standard proof techniques
- Understand NP completeness and develop approximation algorithms for NP-hard problems
- Learn to develop randomized algorithms
- Solve computational problems using linear programming techniques

UNIT I HIERARCHICAL DATA STRUCTURES 9

Balanced Trees: Red-black trees - Properties of Red-black trees - Rotations - Insertion – Deletion - B-Trees - Basic operations on B-Trees; Concurrent Data Structures: Shared Counters - Stacks – Queues - Linked Lists.

UNIT II CORRECTNESS OF ALGORITHMS 9

Techniques to Prove Correctness: Proof by Induction using Mergesort as an example – Proof by Exchange Argument using Dijkstra's as an example – Proof by Loop Invariant using Insertion Sort as an example; Disprove Correctness: Using counterexamples with Greedy for 0-1 Knapsack as an example.

UNIT III NP-COMPLETENESS AND APPROXIMATION ALGORITHMS 9

P vs NP; NP-Complete problems; Reductions: INDEPENDENT SET to CLIQUE - CLIQUE to VERTEX-COVER; Decision problems vs Optimization problems; Approximation ratio for maximization and minimization problems; 2-approximation algorithm for vertex cover using greedy matching; Greedy (ln n-approximation) Algorithm for Set Cover – Practical Applications in Network Routing and Scheduling

UNIT IV RANDOMIZED ALGORITHMS 9

Randomized Algorithms: What Is Randomness - Elementary Probability Theory; Models of Randomized Algorithms – First Model using Randomized MAX-SAT - Second Model using Randomized Quicksort; Classification of Randomized Algorithms – Las Vegas and Monte Carlo – Practical Applications in Cryptography and Machine Learning.

UNIT V LINEAR PROGRAMMING 9

Linear Programming: Objective functions - Primal-Dual method for hitting set problem; Rounding LP solutions - 2-approximation algorithm for vertex cover using LP rounding – Practical Applications in Supply Chain Management and Transportation

THEORY PERIODS: 45

COURSE OUTCOMES:

On successful completion of this course, the student will be able to:

CO1	Use hierarchical data structures using trees and heaps to develop algorithms	**K2**
CO2	Prove correctness of algorithms using standard proof techniques	**K5**
CO3	Apply reductions to show hardness of computational problems, and develop approximation algorithms for NP-hard problems	**K3**
CO4	Develop randomized algorithms	**K3**
CO5	Make use of linear programming techniques to solve computational problems	**K3**

TEXTBOOKS

1 Robert Sedgewick and Kevin Wayne, "Algorithms", Fourth Edition, 2011
(Unit 1)

2 Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, "Introduction to Algorithms", Third Edition, 2012
(Units 2, 3 and Unit 1)

3 David. P. Williamson and David. P. Shmoys, "The Design of Approximation Algorithms", First Edition, 2011
(Units 5)

4 Mark Moir and Nir Shavit, "Concurrent Data Structures" in Handbook of Data Structures and Applications (Editors: Dinesh P. Mehta &Sartaj Sahni), Second Edition, 2018
(Unit 1)

5 J. Hromkovic, Design and Analysis of Randomized Algorithms: Introduction to Design Paradigms (Texts in Theoretical Computer Science, An EATCS Series, 2005th Edition)
(Unit 4)

REFERENCE BOOKS

1 S. Dasgupta, C. Papadimitrou, U Vazirani, Algorithms, First Edition, 2006

2 J. Klienberg and E. Tardos, Algorithm Design, 2013

3 Data Structures and Algorithm Analysis in C++, Mark Allen Weiss, 2007

4 Rajeev Motwani, Prabhakar Raghavan, "Randomized Algorithms", First Edition, 2004

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3										2	3	
CO2	3	3			3					2		2		2
CO3	3	3		3	3					2		2		2
CO4	3	3		3	3					2		2		2
CO5	3	3	3	3	3					2		2		2
Total	15	15	3	9	12					8		10	3	8
Score	3	3	3	3	3					2		2	3	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1802	PARALLEL ARCHITECTURES	3	0	0	3

OBJECTIVES

- To understand the evolution of parallelism in computer architecture
- To understand the state-of-the-art architectures
- To study shared memory and distributed memory systems
- To study Memory Architectures, Memory Technology and Optimization
- To understand the design challenges in domain specific architectures

UNIT I FUNDAMENTAL PRINCIPLES AND INSTRUCTION LEVEL PARALLELISM 9

Fundamental Principles of Computer Design - Measuring and Reporting Performance, Instruction Level Parallelism and Its Exploitation: Concepts and Challenges, Branch Prediction, Overcoming Data Hazards with Dynamic Scheduling – Hardware-based Speculation, – Multiple Issue Processors.

UNIT II VECTOR, SIMD, AND GPU ARCHITECTURES 9

Vector architecture - SIMD Instruction set extensions for Multimedia – Graphics processing units – Detecting and enhancing loop-level parallelism – Crosscutting issues.

UNIT III THREAD-LEVEL PARALLELISM 9

Multithreading - Multiprocessors - Centralized and Distributed Shared Memory Architectures – Cache Coherence Issues - Performance Issues – Synchronization Issues – Models of Memory Consistency

UNIT IV MEMORY HIERARCHY DESIGN 9

Fundamentals of memory concepts - Optimizations of Cache Performance - Memory Technology and Optimizations – Name Mapping Implementations - Virtual Memory and Virtual Machines - Design of Memory Hierarchies.

UNIT V DOMAIN-SPECIFIC ARCHITECTURES 9

Multicore Computers: performance issues– Multicore organization- Warehouse-scale computers: Programming models and workloads – Warehouse-scale computer architectures – Cloud computing

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Summarize the principles of computer architecture and instruction-level parallelism to understand the concepts and challenges	**K2**
CO2	Choose the suitable SIMD architecture to enhance and exploit the data level parallelism	**K3**
CO3	Apply the characteristics of multithreading multiprocessors, and identify various issues in shared memory architecture	**K3**

CO4	Analyse the concepts of optimization to build the memory systems.	**K4**
CO5	Compare and understand the Domain-Specific architectures	**K3**

TEXTBOOKS

1. John L. Hennessey and David A. Patterson, Computer Architecture – A quantitative approach, Morgan Kaufmann / Elsevier, Sixth Edition, 2019
2. David Culler, Jaswinder Pal Singh, Anoop Gupta, Parallel Computer Architecture: A Hardware / Software Approach, The Morgan Kaufmann Series in Computer Architecture and Design, 1997

REFERENCE BOOKS

1. William Stallings, Computer Organization and Architecture, Pearson Education Inc., Tenth Edition, 2016
2. Aharon Yadin, Computer Systems Architecture, CRC Press, 2016
3. Douglas Comer, Essentials of Computer Architecture, CRC Press, Second Edition, 2017.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3										2	2	
CO2	3	2											2	
CO3	3	3	3										2	
CO4	3	2	3										2	
CO5	3	2								3		2	2	2
Total	15	12	6							3		4	10	2
Score	3	2	3							3		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1811	MODERN DATA STRUCTURES AND ALGORITHMS LABORATORY	0	0	2	1

OBJECTIVES

- Learn to implement hierarchical data structures
- Develop and implement approximation algorithms for NP-hard problems
- Develop and implement randomized algorithms
- Solve computational problems using linear programming techniques

SUGGESTED EXPERIMENTS:

1. Insertion and querying Red-black trees
2. Insertion and querying B-trees
3. Implement concurrent stacks and queues
4. Implement shared counters and concurrent linked lists
5. Reducing INDEPENDENT_SET to CLIQUE
6. Reducing CLIQUE to VERTEX_COVER
7. Greedy matching to compute an approximate vertex cover
8. Greedy algorithm for set cover
9. Randomized Quicksort
10. Simple linear programming problems (using SciPy or PuLP)

ADDITIONAL EXPERIMENTS:

1. Using a combination of Dijkstra's and A* algorithms to simulate Google Maps
2. Competitive programming questions

LAB PERIODS: 30

COURSE OUTCOMES:

On successful completion of this course, the student will be able to:

CO1 Develop and implement algorithms using hierarchical data structures like trees and heaps (**K2)**

CO2 Develop and implement reductions and approximation algorithms for NP-hard problems (**K3)**

CO3 Develop and implement randomized algorithms and linear programming solutions (**K3)**

LABORATORY REQUIREMENT FOR BATCH OF 38 STUDENTS

Software:

Python 3.11 compiler

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3		3							2	3	
CO2	3	3	3	3	3					2		2		2
CO3	3	3		3	3					2		2		2
Total	9	9	6	6	9					4		6	3	4
Score	3	3	3	3	3					2		2	3	2

COURSE CODE	COURSE TITLE	L	T	P	E	C
ICS1818	PRODUCT DEVELOPMENT PROJECT - PHASE II	0	0	10	6	7

OBJECTIVES

1. To develop detailed product design specifications based on Phase I requirements and feasibility analysis.
2. To prepare comprehensive project plans and budgets to guide the implementation of product development activities.
3. To develop a prototype and test product iterations to refine functionality and usability.

COURSE OUTCOMES:
On successful completion of this course, the student will be able to:

CO1	Design and document detailed product specifications with project plan and budget to guide the development process	**K4**
CO2	Develop functional prototypes for societal systems and create digital public goods, with due concern for ethics	**K6**
CO3	Conduct iterative testing to enhance product performance and user experience	**K4**
CO4	Analyze feedback from multidisciplinary team of people and refine product designs	**K4**
CO5	Apply best practices in developing the solutions, documentation and presentation.	

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	2					3	3		3	3
CO2	3	3	3	3	3		3					3	2	3
CO3	3	3	3	3	3				3				3	3
CO4	3	2	3		2				3	1			3	3
CO5						3		3	3	3		2		2
Total	12	11	12	9	10	3	3	3	9	7	3	5	11	14
Score	3	3	3	3	3	3	3	3	3	3	3	3	3	3

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1916	INTERNSHIP AND SEMINAR	0	0	0	2

OBJECTIVES

- To develop logical thinking skills
- To apply strategies of solving quantitative problems
- To cultivate oral communication
- To think critically and innovate

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1 Survey literature and identify gaps in the research **K3**

CO2 Solve engineering problems with social relevance **K6**

CO3 Write good documentation and give technical presentation

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3		2		1			3	3	3
CO2	3	3	3	3	2						3		3	3
CO3						3		3	3	3		2		2
Total	6	6	6	6	5	3	2	3	4	3	3	5	6	8
Score	3	3	3	3	3	3	2	3	2	3	3	3	3	3

COURSE CODE	COURSE TITLE	L	T	P	E	C
ICS1918	RESEARCH PROJECT - PHASE I	0	0	14	6	9

OBJECTIVES

- To develop skills to formulate a complex engineering problem with an awareness of issues pertaining to society, health, safety, law, environment, culture, and to examine the impact of the proposed solution on these issues.
- To carry out the survey of related literature and find out the research gap
- To explore use of new tools, techniques and algorithms required to carry out the projects.
- To gain experience in organization and implementation of a project and extending it (in Phase 2)
- To be able to follow the guidelines and prepare technical report of the project
- To develop skills in team management and presentation

COURSE OUTCOMES

At the end of this course, students will be able to:

CO1: Formulate complex engineering problems and choose suitable technologies and tools required to solve them effectively (K4)

CO2: Survey related literature on the proposed problem and its feasibility (K4)

CO3: Design a high level solution by applying software engineering principles (K6)

CO4: Divide the work among team members to optimally manage time and complexity

CO5: Document and present a solution

CO6: Analyse issues pertaining to society, health, safety, law, environment, and culture applicable to the project and examine the impact of the proposed solution on these issues.

CO7: Apply best practices and follow ethics in developing solutions

Evaluation criteria

Review 1	Marks	Review 2	Marks	Review 3	Marks
1.Problem Formulation 2. Literature Review and feasibility study 3. Application of knowledge in problem-solving	70%	1.Design decisions 2.Design methodology 3.Developing and conducting experiment 4. System evaluation	70%	1.Design Solution 2. Project demonstration 3. Performance analysis	70%

1.Project management 2.Oral presentation 3.Presentation: interaction 4.Team coordination and effort 5.Written report	30%	1. Team motivation 2. Identifying issues pertaining to society, health, safety, law, environment, culture relevant to the project 3. Written report and interaction in presentation 4. Originality of the report	30%	1. Demonstrating knowledge of and need for sustainable development 2. Team coordination and execution 3. Project report 4. Originality of the report	30%

COURSE OUTCOMES (CO) MAPPED TO PROGRAM OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	3	3					3	2		3	2
CO2	3	3	2	3	2					2	3	3	3	3
CO3	3	3	3	3	3						3		3	3
CO4									3					
CO5									3	3			3	3
CO6						3	3							
CO7								3					-	2
Total	9	9	8	9	8	3	3	3	6	8	8	3	12	13
Score	3	3	3	3	3	3	3	3	3	3	3	3	3	3

COURSE CODE	COURSE TITLE	L	T	P	E	C
ICS1018	RESEARCH PROJECT - PHASE II	0	0	22	6	12

OBJECTIVES

- To apply knowledge gained at various stages of the degree program
- To develop ability to solve problems from its identification and literature survey till the successful solution
- To prepare project reports and to present the work in reviews before panels

COURSE OUTCOMES

At the end of this course, the students will be able to:

CO1: Use suitable technologies and tools to solve complex engineering problems effectively (K4)
CO2: Construct optimal solutions by applying software engineering principles (K6)
CO3: Select the best among alternative design techniques for solving the proposed complex engineering problem (K5)
CO4: Divide the work among team members to optimally manage time and complexity
CO5: Evaluate performance of the solution, using appropriate metrics (K5)
CO6: Analyse impact of the proposed solution on the issues pertaining to society, health, safety, law, environment, culture, and conform to ethical principles
CO7: Document the solution, present the solution, and publish the research outcome in conferences, journals and for patents.

Evaluation Criteria

Review 1	Marks	Review 2	Marks	Review 3	Marks
1.Design decisions 2.Design methodology 3.Design alternatives	70%	1. Design solution 2. Design improvement 3. System evaluation	70%	1. Project demonstration 2. Project innovation 3. Performance analysis	70%
1. Project management 2. Oral presentation 3. Team coordination and effort 4. Written report	30%	1.Team motivation 2. Written report and interaction in presentation 3. Originality of report	30%	1. Project report 2. Manuscript preparation and submission to journal / conferences	30%

COURSE OUTCOMES (CO) MAPPED TO PROGRAM OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	3	3					3	2		3	2
CO2	3	3	2	3	2					2	3	3	3	3
CO3	3	3	3	3	3						3		3	3
CO4									3					
CO5			3	3									3	3
CO6						3	3							
CO7								3	3	3				2
Total	9	9	11	12	8	3	3	3	6	8	8	3	12	13
Score	3	3	3	3	3	3	3	3	3	3	3	3	3	3

MANAGEMENT ELECTIVES

COURSE CODE	COURSE TITLE	L	T	P	E	C
IBA1541	PRINCIPLES OF MANAGEMENT	3	0	0	0	3

OBJECTIVES

- To sketch the Evolution of Management.
- To extract the functions and principles of management.
- To learn the application of the principles in an organization.
- To study the various HR related activities.
- To analyze the position of self and company goals towards business.

UNIT I INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS 9

Definition of Management – Science or Art – Manager Vs Entrepreneur- types of managers managerial roles and skills – Evolution of Management – Scientific, human relations , system and contingency approaches – Types of Business organization- Sole proprietorship, partner- ship, company-public and private sector enterprises- Organization culture and Environment – Current trends and issues in Management.

UNIT II PLANNING 9

Nature and purpose of planning – Planning process – Types of planning – Objectives – Set- ting objectives – Policies – Planning premises – Strategic Management – Planning Tools and Techniques – Decision making steps and process.

UNIT III ORGANISING 9

Nature and purpose – Formal and informal organization – Organization chart – Organization structure – Types – Line and staff authority – Departmentalization – delegation of authority – Centralization and decentralization – Job Design - Human Resource Management – HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management.

UNIT IV DIRECTING 9

Foundations of individual and group behaviour – Motivation – Motivation theories – Motivational techniques – Job satisfaction – Job enrichment – Leadership – types and theories of leadership – Communication – Process of communication – Barrier in communication – Effective communication – Communication and IT.

UNIT V CONTROLLING 9

System and process of controlling – Budgetary and non-Budgetary control techniques – Use of computers and IT in management control – Productivity problems and management – Control and performance – Direct and preventive control – Reporting

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1 Have some basic knowledge on international aspect of management
CO2 Ability to understand management concept of organizing
CO3 Ability to understand management concept of directing
CO4 Ability to understand management concept of controlling.

TEXTBOOKS

1 Harold Koontz, Heinz Weihrich, "Essentials of Management", Tata McGraw Hill, 1998
2 Stephen P Robbins, Mary Coulter, "Management", Prentice Hall (India) Pvt. Ltd., 10th Edition, 2009.

REFERENCE BOOKS

1 Robert Kreitner, Mamata Mohapatra, "Management", Biztantra, 2008
2 Stephen A Robbins, David A Decenzo, Mary Coulter, "Fundamentals of Management", Pearson Education, 7th Edition, 2011.
3 Tripathy P C, Reddy P N, "Principles of Management", Tata McGraw Hill, 1999.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1						3		3	2		3	1		
CO2						3		3	2		2	1		
CO3					3	3		3		2	2	1		
CO4						3	2	3			1	1		
Score					3	3	2	3	2	2	2	1		

COURSE CODE	COURSE TITLE	L	T	P	E	C
IBA1542	TOTAL QUALITY MANAGEMENT	3	0	0	0	3

OBJECTIVES

- Teach the need for quality, its evolution, basic concepts, contribution of quality gurus, TQM framework, Barriers and Benefits of TQM
- Explain the TQM Principles for application
- Define the basics of Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA
- Describe Taguchi's Quality Loss Function, Performance Measures and apply Techniques like QFD, TPM, COQ and BPR
- Illustrate and apply QMS and EMS in any organization.

UNIT I INTRODUCTION 9

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of product and service quality – Definition of TQM – Basic concepts of TQM – Gurus of TQM (Brief introduction)– TQM Framework- Barriers to TQM – Benefits of TQM.

UNIT II TQM PRINCIPLES 9

Leadership - Deming Philosophy, Quality Council, Quality statements and Strategic planning Customer Satisfaction – Customer Perception of Quality, Feedback, Customer complaints, Ser- vice Quality, Kano Model and Customer retention – Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition & Reward and Performance Appraisal–Continuous process improvement – Juran Trilogy, PDSA cycle, 5S and Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating and Relationship development.

UNIT III TQM TOOLS & TECHNIQUES I 9

The seven traditional tools of quality - New management tools - Six-sigma Process Capability Bench marking - Reasons to benchmark, Benchmarking process, What to Bench Mark, Understanding Current Performance, Planning, Studying Others, Learning from the data, Using the findings, Pitfalls and Criticisms of Benchmarking - FMEA - Intent, Documentation, Stages: Design FMEA and Process FMEA.

UNIT IV TQM TOOLS & TECHNIQUES II 9

Quality circles – Quality Function Deployment (QFD) – Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures – Cost of Quality – BPR.

UNIT V QUALITY MANAGEMENT SYSTEM 9

Introduction - Benefits of ISO Registration - ISO 9000 Series of Standards - Sector - Specific Standards - AS 9100, TS16949 and TL 9000 – ISO 9001 Requirements - Implementation - Doc- umentation - Internal Audits - Registration - ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction – ISO 14000 Series Standards – Concepts of ISO 14001 – Requirements of ISO 14001- Benefits of EMS.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1 Apply TQM concepts in a selected enterprise [K3].

CO2 Apply TQM principles in a selected enterprise [K3].

CO3 Understand Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA [K2].

CO4 Understand Taguchi's Quality Loss Function, Performance Measures and apply QFD, TPM, COQ and BPR [K2].

CO5 Apply QMS and EMS in any organization [K3].

TEXTBOOKS

1 Dale H Besterfiled, Carol B Michna, Glen H Bester Field, Mary B Sacre, Hemant Urdhwareshe, Rashmi Urdhwareshe, "Total Quality Management", Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.

REFERENCE BOOKS

1 Joel E Ross, "Total Quality Management – Text and Cases", Routledge.,2017.

2 Kiran D R, "Total Quality Management: Key Concepts and Case Studies", Butterworth Heinemann Ltd, 2016.

3 Oakland J S, "TQM – Text with Cases", Butterworth–Heinemann Ltd, Oxford, Third Edition, 2003.

4 Suganthi L, Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt Ltd, 2006

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1						3		3	2		3	1		
CO2						3		3	2		2	1		
CO3					3	3		3		2	2	1		
CO4						3	2	3			1	1		
Score					3	3	2	3	2	2	2	1		

COURSE CODE	COURSE TITLE	L	T	P	E	C
IBA143	WORK ETHICS, CORPORATE SOCIAL RESPONSIBILITY AND GOVERNANCE	3	0	0	0	3

OBJECTIVES

- To impart the value of professional practices with code of conduct and ethical values
- To discuss the various outlooks of roles and responsibilities with work ethics.
- To introduce the Indian constitutional statutes for ethical practices by citizens
- To analyze the ethical commitments to be hold by industry with protecting environment
- To insist on corporate and social responsibilities through Governance practices and regulation.

UNIT I INTRODUCTION 9

Ethics - Definition & nature, Characteristics, Attributes of Ethics - Business Ethics; Ethical theories; Causes of unethical behavior; Ethical abuses; Work ethics; Code of conduct; Public good.

UNIT II ETHICS THEORY AND BEYOND 9

Management of Ethics - Ethics analysis [Hosmer model]; Ethical dilemma; Ethics in practice - ethics for managers; Role and function of ethical managers - Comparative ethical behaviour of managers; Code of ethics; Competitiveness, organizational size, profitability and ethics; Cost of ethics in Corporate ethics evaluation.

UNIT III LEGAL ASPECTS OF ETHICS 9

Political - legal environment; Provisions of the Indian constitution pertaining to Business; Political setup - major characteristics and their implications for business; Prominent features of MRTP &FERA. Social - cultural environment and their impact on business operations, Salient features of Indian culture and values.

UNIT IV ENVIRONMENTAL ETHICS 9

Economic Environment; Philosophy of economic grow and its implications for business, Main features of Economic Planning with respect to business; Industrial policy and framework of government contract over Business; Role of chamber of commerce and confederation of Indian Industries.

UNIT V CORPORATE SOCIAL RESPONSIBILITY AND GOVERNANCE 9

Definition- Evolution- Need for CSR; Theoretical perspectives; Corporate citizenship; Business practices; Strategies for CSR; Challenges and implementation; Evolution of corporate governance; Governance practices and regulation; Structure and development of boards; Role of capital market and government; Governance ratings; Future of governance- innovative practices; Case studies with lessons learnt.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1 Understand ethical issues in workplace and have good practices in professional duties. [K2]

CO2 Learn roles and responsibilities in professional career as a team worker

CO3 Understand the legal aspects in Indian constitutional for protection of societal values. [K2]

CO4 Analyze the economic development by industry with importance to environment protection. [K4]

CO5 Understand need of good Governance in a corporate with ethical organizational behavior. [K2]

TEXTBOOKS

1 S A Sherlekar, "Ethics in Management", Himalaya Publishing House, 2009.

2 William B Werther, David B Chandler, "Strategic Corporate Social Responsibility", Sage Publications Inc, 2011.

3 V V Robert, A G Monks, Nell Minow, "Corporate Governance", John Wiley and Sons, 2011.

REFERENCE BOOKS

1 V W H Shaw, "Business Ethics", Cengage Learning, 2007.

2 Beeslory, Michel, Evens, "Corporate Social Responsibility", Taylor and Francis, 1978.

3 Philip Kotler, Nancy Lee, "Corporate Social Responsibility: Doing the Most Good for Company and Your Cause", Wiley, 2005.

4 Subhabrata Bobby Banerjee, "Corporate Social Responsibility: the Good, the Bad and the Ugly", Edward Elgar Publishing, 2007.

5 Satheesh kumar, "Corporate Governance", Oxford University, Press, 2010.

6 Bob Tricker, "Corporate Governance – Principles, Policies and Practices", Oxford University Press, 2009

7 Larue Tone Hosmer, Richard D, "The Ethics of Management", Irwin Inc, 1995.

8 Joseph A Petrick, John F Quinn, "Management Ethics – Integrity at Work", Sage, 1997.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1								3	1	1		2		
CO2								3	1	1		2		
CO3						3	2	3	1	1		2		
CO4								3	1	1	3	2		
CO5								3	1	1	2	2		
Score						3	2	3	1	1	2	2		

PROFESSIONAL ELECTIVES

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1561	ETHICAL HACKING	2	0	2	3

OBJECTIVES

To understand the basics of computer-based vulnerabilities.
To explore different foot printing, reconnaissance and scanning methods
To expose the enumeration and vulnerability analysis methods
To understand hacking options available in Web and wireless applications
To practice tools to perform ethical hacking to expose the vulnerabilities

UNIT I INTRODUCTION 6

Ethical Hacking Overview - Role of Security and Penetration Testers - Penetration-Testing Methodologies- Laws of the Land - Overview of TCP/IP- The Application Layer - The Transport Layer - The Internet Layer - IP Addressing- Network and Computer Attacks - Malware - Protecting Against Malware Attacks- Intruder Attacks - Addressing Physical Security

UNIT II RECONNAISSANCE AND SCANNING NETWORKS 6

Footprinting Concepts - Footprinting through Search Engines, Web Services, Social Networking Sites, Website, Email - Competitive Intelligence - Footprinting through Social Engineering - Footprinting Tools - Network Scanning Concepts - Port-Scanning Tools - Scanning Techniques - Scanning Beyond IDS and Firewall.

UNIT III ENUMERATION AND VULNERABILITY ANALYSIS 6

Enumeration Concepts - NetBIOS Enumeration – SNMP, LDAP, NTP, SMTP and DNS Enumeration - Vulnerability Assessment Concepts - Desktop and Server OS Vulnerabilities - Windows OS Vulnerabilities - Tools for Identifying Vulnerabilities in Windows- Linux OS Vulnerabilities- Vulnerabilities of Embedded OSs.

UNIT IV SYSTEM HACKING 6

Hacking Web Servers - Web Application Components- Vulnerabilities - Tools for Web Attackers and Security Testers Hacking Wireless Networks - Components of a Wireless Network – Wardriving- Wireless Hacking - Tools of the Trade

UNIT V NETWORK PROTECTION SYSTEMS 6

Access Control Lists. - Cisco Adaptive Security Appliance Firewall - Configuration and Risk Analysis Tools for Firewalls and Routers - Intrusion Detection and Prevention Systems - Network Based and Host-Based IDSs and IPSs - Web Filtering - Security Incident Response Teams – Honeypots..

TOTAL PERIODS: 30

SUGGESTED EXPERIMENTS:

1. Install Kali or Backtrack Linux / Metasploitable/ Windows XP
2. Practice the basics of reconnaissance.
3. Using FOCA / SearchDiggity tools, extract metadata and expanding the target list.
4. Aggregates information from public databases using online free tools like Paterva's Maltego.
5. Information gathering using tools like Robtex.
6. Scan the target using tools like Nessus.
7. View and capture network traffic using Wireshark.
8. Automate dig for vulnerabilities and match exploits using Armitage FOCA : http://www.informatica64.com/foca.aspx

Nessus : http://www.tenable.com/products/nessus.
Wireshark : http://www.wireshark.org.
Armitage : http://www.fastandeasyhacking.com/.
Kali or Backtrack Linux, Metasploitable, Windows XP

PRACTICAL EXERCISES: 30 Hours

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Apply the knowledge of TCP/IP model, ethical hacking roles, penetration-testing methodologies, and the legal framework governing cybersecurity.	**K3**
CO2	Make use of different foot printing, reconnaissance and scanning methods.	**K3**
CO3	Identify and demonstrate the enumeration and vulnerability analysis methods.	**K3**
CO4	Plan sophisticated attacks on web and wireless networks,	**K3**
CO5	Evaluate the advanced network protection systems to enhance the security posture of a network.	**K5**

TEXTBOOKS

1 Michael T. Simpson, Nicholas D. Antill, Robert S. Wilson, "Hands-On Ethical Hacking and Network Defense", Fourth Edition, Cengage Learning, 2023.

2 Patrick Engebretson, "The Basics of Hacking and Penetration Testing: Ethical Hacking and Penetration Testing Made Easy", SYNGRESS, 2013

3 Dafydd Stuttard, Marcus Pinto,"The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws", Wiley 2011

REFERENCE BOOKS

1 Black Hat Python: Python Programming for Hackers and Pentesters, Justin Seitz , 2014

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3			3	2		2		2		3	3	2
CO2	3	2			3								2	
CO3	3	2			3			2				2	2	
CO4	3	2	2		3							2	2	
CO5	3	2			3								2	
Total	15	11			15					2		7	11	2
Score	3	2	2		3	2		2		2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1521	ADVANCED GRAPH THEORY	3	0	0	3

OBJECTIVES

- To gain an understanding of the basic concepts in graph theory and demonstrate simple properties.
- To investigate the use of tree graphs for modeling and searching within communication networks.
- To optimizing task scheduling through graph models: matchings, partitions, and domination.
- To understand the definition of a graph coloring and the impact of planarity, and its connection to Euler's formula.
- To understand the concepts P, NP, NP-completeness, and basic NP-Complete Problems.

UNIT I GRAPH FUNDAMENTALS **9**

Graphs: matrices and isomorphisms – Decomposition and Special Graphs: Paths, cycles, and Trails – Vertex degrees and Counting – Directed Graphs.

UNIT II TREES AND DISTANCES **9**

Basic properties of Trees – Distance in Trees and Graphs - Spanning Trees in Graphs – Optimization and Trees - Minimum Spanning Tree – Shortest Paths - Trees in Computer Science.

UNIT III MATCHINGS **9**

Maximum matchings- Hall's Matching Condition – Min-Max Theorems – Independent Sets and Covers – Dominating sets.

UNIT IV COLORING AND PLANAR GRAPHS **9**

Vertex Coloring and Upper Bounds – Brooks's Theorem – Drawing in the Plane – Dual Graphs – Eulers's Formula.

UNIT V APPLICATION OF GRAPH THEORY **9**

The connector problem – Construction of Reliable communication networks – The Chinese postman problem – The travelling salesman problem – A storage problem – Job sequencing problem – Making a road system one way.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Examine the concept of isomorphism between graphs, special graphs, and directed graph models, and demonstrate basic properties.	**K3**
CO2	Evaluate the spanning trees in graph models and study the optimization of communication networks, including their role in search processes.	**K4**
CO3	Leverage graph-based techniques for efficient task scheduling: matching resources, partitioning workloads, and strategically locating facilities,	**K3**

	dominating sets.	
CO4	Solve graph coloring problems and the interplay between planarity and the beauty of Euler's formula.	**K3**
CO5	apply the graph theory concepts in real time problems	**K3**

TEXTBOOKS

1. Douglas B. West. “Introduction to Graph Theory - Second edition” Prentice Hall, 2001.
2. Michael R Garey, David S Johnson “Computers and intractability: a guide to the theory of NP-completeness” San Francisco : W. H. Freeman Publisher , 1979.

REFERENCE BOOKS

1. Gary Chartrand, Ping Zhang, “Chromatic graph theory”, Chapman & Hall/CRC, 2009.
2. Kenneth H Rosen, “Discrete Mathematics and its Applications”, 7th Edition, Special Indian edition, Tata McGraw Hill, New Delhi, 2017.
3. Ralph P Grimaldi, “Discrete and Combinatorial Mathematics: An Applied Introduction”, 4th Edition, Pearson Education Asia, 2007.
4. Eric Lehman, F Tom Leighton, Albert R Meyer, “Mathematics for Computer Science”, Samurai Media Limited, 2017.
5. Oded Goldreich, “P, NP, and NP-Completeness: The Basics of Computational Complexity”, Cambridge University Press, 2010.
6. Chartrand G., Lesniak L., Zhang P. “Graphs and digraphs”, CRCP, 2010.

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1562	**IMAGE PROCESSING AND ANALYSIS**	**2**	**0**	**2**	**3**

OBJECTIVES

- To understand basics of digital images
- To understand spatial and frequency domain processing
- To learn image segmentation techniques
- To learn feature detection and multi-resolution analysis
- To learn various applications of image processing

UNIT I FUNDAMENTALS OF IMAGE PROCESSING 6

Introduction -- Fields that use digital image processing -- Steps in Image Processing Systems -- Image Acquisition -- Sampling and Quantization -- Pixel Relationships. Image enhancement in the spatial domain: Basic gray-level transformation, histogram processing, Enhancement using arithmetic and logic operators.

UNIT II IMAGE ENHANCEMENT AND RESTORATION 6

Basic spatial filtering: Smoothing filters; Sharpening filters; Frequency Domain processing: Fourier Transform -- DFT and FFT; Filtering operations in frequency domain; Restoration: Model of Image Degradation/Restoration Process, Noise Models -- Filters for noise removal in Spatial and Frequency domain.

UNIT III IMAGE SEGMENTATION 6

Thresholding techniques: Region growing -- splitting and merging -- Adaptive -- Otsu method; Edge detection; Edge linking via Hough transform -- Template matching; Gradient operation; Hysteresis Thresholding - Canny operator – Laplacian operator; Image morphology -- Binary and Gray Level morphology operations -- Morphological watersheds.

UNIT IV FEATURE DETECTION AND RECOGNITION 6

Boundary representation and detections – Boundary Descriptors --- texture descriptors -- regional descriptors; Object Recognition: Patterns and patterns classes, recognition based on decision–theoretic methods, matching, optimum statistical classifiers, neural networks, structural methods – matching shape numbers, string matching.

UNIT V MULTI RESOLUTION ANALYSIS, COLOR IMAGE PROCESSING AND IMAGE COMPRESSION 6

Multi Resolution Analysis: Image Pyramids -- Multi resolution expansion -- Wavelet Transforms; Fast Wavelet transforms. Color Image Processing: Color models, color transforms, smoothing and sharpening, color segmentation. Fundamentals, image compression models, error-free compression, lossy predictive coding, image compression standards.

TOTAL PERIODS: (THEORY)30

SUGGESTED EXPERIMENTS (30 Hours)

1. Perform the following tasks:
    - Image resizing
    - Image type conversion
    - Extraction of color bands
    - Creation of synthetic image
2. Generate noisy images by adding Uniform, Gaussian, Salt and pepper noise to an input image. Observe the performance of smoothing filters in the spatial domain.
3. Identify a night vision dataset. Apply suitable filtering techniques to improve the contrast of the images.

4. Take a low contrast image and do the following:
    - Generate a histogram of the image and observe how the intensity values are distributed.
    - Apply histogram equalization and matching.

5. Select a noisy image dataset. Apply smoothing / sharpening filters in the frequency domain to improve the quality of the images.

6. Segment an image
    - By calculating a threshold setting using the histogram of brightness values.
    - Using adaptive thresholding
    - Using watershed algorithm

5. Take a microscope cell image that has undergone a threshold operation. Perform the following morphological transform.
    - erosion and dilation with a circular structuring element
    - erosion and dilation with a square structuring element
    - closing and opening with a cross shaped structuring element

6. Generate the edges of an image by applying the following edge detection operators: Roberts, Sobel, Prewitt, Laplacian and Canny operators.

7. Perform line, circle, and ellipse detection using Hough transform for medical images.

8. Write a program to implement a discrete wavelet transform and its inverse for an image. (The user can decide the number of decomposition). Apply Daubechies, Haar and Morlet.

9. Consider images of following characteristics:
    - With features of varying sizes
    - With features of varying sizes that are not convex
    - With a series of lines of approximately the same length
    - With features with different numbers of internal holes.

Develop a program to count the features, label the pixels with a unique identifying number, and measure the area, total perimeter for the images.

10. Case study of Google's WebP image format

TOTAL PERIODS: (LAB)30
TOTAL: 60

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1	Explain the fundamental concepts of a digital image processing system	**K2**
CO2	Apply image enhancement and restoration techniques in spatial and frequency domains	**K3**
CO3	Make use of image segmentation techniques for object detection	**K3**

CO4	Choose appropriate techniques for object enhancement, detection, recognition, and classification in various applications	**K5**
CO5	Analyze the multi resolution methods and image transforms for color images	**K4**

TEXTBOOKS

1 Rafael C.Gonzalez, Richard E.Woods, "Digital Image Processing", Fourth Edition, Pearson Education, 2018 (Units I, II, III, IV)

2 Wilhelm Burger, Mark J. Burge, "Principles of Digital Image Processing : Core Algorithm", Springer, 2009 (Unit V)

REFERENCE BOOKS

1 Anil K.Jain, "Fundamentals of Digital Image Processing", PHI, 2006.

2 Rafael C. Gonzalez, Richard E.Woods, Eddins, "Digital Image Processing using MATLAB", Second Edition, Tata McGraw-Hill, 2009.

3 Davis, E. R., "Machine Vision", Second Edition, 1997.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO1 1**	**PO12**	**PSO 1**	**PSO2**
CO1	3	2		2									2	
CO2	3	2											2	
CO3	3	2											2	
CO4	3	3	3	3	3					2		2	2	2
CO5	3	2	2										2	
Total	15	11	5	5	3					2		2	10	2
Score	3	3	3	3	3					2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1563	USER EXPERIENCE DESIGN(TCP)	2	0	2	3

OBJECTIVES

- To understand the goals and principles of interface design
- To study life cycle models and identify the requirements for interface design
- To learn effective prototypes for construction of user interface design
- To know about user testing
- To use tools to develop UI design for mobile application.

UNIT I FOUNDATIONS OF INTERACTION DESIGN 6

Interaction design – Good and poor design – Goals of interaction design – Design and usability principles; Conceptual models – Interface metaphors – Interaction paradigms – From conceptual models to physical design.

UNIT II PROCESS AND REQUIREMENTS 6

Activities of interaction design – Key characteristics of interaction design process – Lifecycle models; Establish requirements – Different kinds of requirements – Data gathering; Data interpretation and analysis.

UNIT III DESIGN AND CONSTRUCTION 6

Prototyping and construction – Low-fidelity prototyping – High-fidelity prototyping – Compromises in prototyping – Construction: from design to implementation; Conceptual Design: Moving from requirements to first design – Perspectives for developing a conceptual model – Expanding the conceptual model – Scenarios and prototypes in conceptual design.

UNIT IV EVALUATION AND TESTING 6

What, why, and when to evaluate – Hutchworld case study; Evaluation paradigms and techniques; User testing – Experiments – Predictive models.

UNIT V MOBILE HCI 6

Mobile Ecosystem: Platforms – Application frameworks; Types of Mobile Applications: Widgets – Applications – Games; Mobile Information Architecture – Mobile 2.0 – Mobile Design: Elements of Mobile Design– Tools.

TOTAL PERIODS: (THEORY)30

SUGGESTED EXPERIMENTS

1. Identify a problem to develop an application by applying principles of interaction design.
2. Make use of user interaction to figure out all the user requirements and analyze the data collected.
3. Create a prototype and conceptual models as per the requirements using UX design.
4. Test the UX design.
5. Convert the prototype into a Mobile App using UI tools.

TOTAL PERIODS: (LAB)30

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Explain the fundamentals of user interaction design	**K2**
CO2	Identify the different kinds of requirements based on use interaction and perform data analysis.	**K3**
CO3	Create an efficient prototype to communicate and model the design definitions.	**K5**
CO4	Apply UX design in a case study and evaluate the design.	**K3**
CO5	Analyze user satisfaction on using different mobile applications.	**K4**

TEXTBOOKS

1. Preece J, Rogers Y, Sharp H, "Interaction design: Beyond Human-Computer Interaction", 6th edition John Wiley & Sons Ltd, 2023. (Unit 1 to 4)
2. Brian Fling, "Mobile Design and Development", 1st Edition, O'Reilly Media Inc, 2009. (Unit 5)

REFERENCE BOOKS

1. Preece J, Rogers Y, Sharp H, Baniyon D, Holland S and Carey T, "Human Computer Interaction", Addison-Wesley, 1994
2. B. Shneiderman, "Designing the User Interface", Addison Wesley 2000 (Indian Reprint).
3. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, "Human Computer Interaction", 3rd Edition, Pearson Education, 2004.
4. Bill Scott and Theresa Neil, "Designing Web Interfaces", 1st Edition, O'Reilly, 2009.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2											
CO2	3	3	2		2	2				2			2	
CO3	3	2	3		2	2				2		2	2	
CO4	3	2	3		2	2				2		2	2	3
CO5	3	3	3		2	2				2		2	2	3
Total	15	13	13		8	8				8		6	8	6
Score	3	2	2		2	2				2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1522	PROGRAMMING PARADIGMS	3	0	0	3

OBJECTIVES

- To introduce various programming paradigms
- To understand programming paradigms such as imperative, object-oriented, logic, functional and concurrent with illustrative examples.

UNIT I IMPERATIVE PROGRAMMING 9

Role of programming languages; Programming paradigms; Structured programming: Data representation – Describing syntax and semantics – Binding, scope – Type checking, Type equivalence - Procedure activations – Design issues - Examples in C.

UNIT II OBJECT ORIENTED PROGRAMMING 9

Abstract datatypes– object model– object-oriented thinking – Proper inheritance – Multiple inheritance – Virtual functions, dynamic binding – Run time type checking – Design issues - Examples in Java/Python.

UNIT III FUNCTIONAL PROGRAMMING 9

Elements of functional programming: Values and operations – Approaches to expression evaluation – Lexical scope – Type checking; Scheme: Expressions – Lists – Predicate functions – Control flow – Tail recursion - Examples.

UNIT IV LOGIC PROGRAMMING 9

Logic and Horn clauses, resolution – recursion - Prolog: Data structures – Programming techniques – Control – Cuts – Examples.

UNIT V CONCURRENT PROGRAMMING 9

Concurrency concepts – Synchronization strategies – Semaphores – Monitors – Message Passing – Examples in Java – Threads.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1	Analyse the features of imperative programming paradigm with suitable examples	**K4**
CO2	Evaluate the concepts of object-oriented programming paradigm with examples in Java or Python	**K5**
CO3	Examine functional programming paradigm and explore suitable examples	**K4**
CO4	Examine logic programming paradigm and explore suitable examples in Prolog	**K4**
CO5	Explain concurrent programming paradigm and explore some examples in Java	**K2**

TEXTBOOKS

1. Ravi Sethi,Viswanatha K V, “Programming Languages:Concepts and constructs”, 2nd Edition,Pearson, 2011
2. Allan B Tucker,RobertE Noonan, “Programming Languages: Principles and Paradigms”, 2nd Edition,McGrawHill, 2007

REFERENCE BOOKS

1. MichaelScott, “Programming Language Pragmatics”, 4th Edition,Morgan Kaufmann, 2015
2. Robert W Sebesta, “Concepts of Programming Languages”, 12th Edition, Pearson, 2018
3. Maurizio Gabbrielli, SimoneMartini, “Programming Languages: Principles and Paradigms”, Springer, 2010

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	3	3	3							2			2	3
CO3	3	2	2	3	2							2	2	3
CO4	3	2	2	3	2								2	3
CO5	3	2												
Total	15	11	7										6	9
Score	3	3	3	3	2					2		2	2	3

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1564	SOFT COMPUTING(TCP)	2	0	2	3

OBJECTIVES

- To introduce the ideas of fuzzy sets and fuzzy logic
- To study the characteristics of various types of associative memory networks
- To provide the mathematical background for carrying out the optimization associated with neural network learning and genetic algorithms
- To gain insight in Hybrid Learning Models

UNIT I INTRODUCTION 6

Difference between Hard and Soft computing, Requirement of Soft computing, Applications of Soft Computing. **Fuzzy Systems**: Fuzzy Set theory, Fuzzy versus Crisp set, Fuzzy Relation, Fuzzification, Minmax Composition, Defuzzification Method, Fuzzy Logic, Fuzzy Rule based systems, Predicate logic, Fuzzy Decision Making, Fuzzy Control Systems, Fuzzy Classification.

UNIT II ASSOCIATIVE MEMORY NETWORK 6

Training algorithm for Pattern Association – Autoassociative Memory Network - Heteroassociative Memory Network - Bidirectional Associative Memory (BAM) - Hopfield Networks: Discrete Hopfield Network, Continuous Hopfield Network

UNIT III CONVENTIONAL OPTIMIZATION 6

Derivative-based Optimization: Descent Methods – The Method of Steepest Descent – Classical Newton's Method – Step Size Determination – Conjugate gradient Methods – Analysis of Quadratic Case

UNIT IV HEURISTIC OPTIMIZATION ALGORITHMS 6

GEnetic Algorithms: Genetic algorithm and search space – general genetic algorithm – operators – Generational cycle – stopping condition – constraints – classification; Simulated Annealing – Random Search – Particle Swarm Optimization – Ant Colony Optimization.

UNIT V NEURO FUZZY MODELING 6

Adaptive Neuro-Fuzzy Inference Systems: Architecture – Hybrid Learning Algorithm – Learning Methods that Cross-fertilize ANFIS and RBFN; Coactive Neuro Fuzzy Modeling: Framework Neuron Functions for Adaptive Networks

TOTAL PERIODS: (THEORY)30

SUGGESTED EXPERIMENTS

1. Implement basic operations of fuzzy sets (union, intersection, complement)
2. Develop fuzzy logic systems for tasks such as automatic washing machines or traffic light control and analyze their performance under different input conditions.
3. Implement the auto associative memory network using the Hebbian learning rule.

4. Implement the BAM algorithm and train the network to establish bidirectional associations between pairs of patterns.
5. Implement Classical Newton's Method for optimizing a given function.
6. Implement the simulated annealing algorithm for solving a combinatorial optimization problem (e.g., traveling salesman problem).
7. Implement a genetic algorithm to solve a basic optimization problem (e.g., finding the maximum value of a function).
8. Implement an ANFIS model using a sample dataset and train it using the hybrid learning algorithm.

TOTAL PERIODS:(LAB)30

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Apply fuzzy logic for solving real world problems	**K3**
CO2	Apply the concepts of associate memory networks in solving computational problems.	**K3**
CO3	Apply derivative based optimization techniques on computational problems	**K3**
CO4	Choose an appropriate heuristic optimization algorithm to solve the given problem	**K5**
CO5	Explain the use of neuro-fuzzy hybrid models	**K2**

TEXTBOOKS

1 J S R Jang, C T Sun, E Mizutani, "Neuro-Fuzzy and Soft Computing", PHI / Pearson Education, 2004. (Unit I, III & V)

2 S. N. Sivanandan, S. N. Deepa, "Principles of Soft Computing", Wiley Publications, 3rd Edition, 2018 (Unit II, IV)

REFERENCE BOOKS

1 S Rajasekaran, G A Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm:Synthesis & Applications", Prentice-Hall of India Pvt. Ltd., 2006.

2 Timothy J Ross, "Fuzzy Logic with Engineering Applications", McGraw-Hill, InternationalEditions, Electrical Engineering Series, Singapore, 1997

3 Davis E Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", AddisonWesley, N.Y., 1989.

4 Stamatios V Kartalopoulos, "Understanding Neural Networks and Fuzzy Logic Basic concepts& Applications", IEEE Press, PHI, New Delhi, 2004.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO1 1**	**PO12**	**PSO 1**	**PSO2**
CO1	3	2		1									2	
CO2	3	2											2	
CO3	3	2											2	
CO4	3	3	3	3	2					2		2	2	2
CO5	3	2	2										2	
Total	15	11	5	4	2					2		2	10	2
Score	3	3	3	2	2					2			2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1621	WIRELESS SENSOR NETWORKS AND PROTOCOLS	3	0	0	3

OBJECTIVES

- To study sensor node hardware and design principles.
- To study the functionalities of various MAC protocols for WSNs.
- To understand the working of data centric routing protocols in WSNs.
- To understand the working of localization and topology control in WSNs.
- To explore the various platforms and tools for WSN.

UNIT I INTRODUCTION TO WIRELESS SENSOR NETWORKS 9

Challenges – Applications; Single node architecture: Hardware components - Energy consumption of sensor nodes; Network architecture: Sensor network scenarios - Optimization goals - Design principles - Service interfaces - gateway concepts.

UNIT II MEDIUM ACCESS CONTROL LAYER 9

Fundamentals of wireless MAC protocols - Low duty cycle protocols and wakeup concepts - Contention Based protocols - Schedule-Based protocols - The IEEE 802.15.4 MAC protocol.

UNIT III DATA CENTRIC ROUTING 9

Query processing - Data aggregation - Localized vs Centralized protocols - Data gathering without memorizing links towards the sink - Data dissemination from the sink - Data gathering based on memorized broadcasting trees - Periodic reports by all sensors - Data gathering with data aggregation.

UNIT IV LOCALIZATION AND TOPOLOGY CONTROL 9

Localization and positioning: Properties - Approaches - Mathematical basics for the laterationproblem - Single-hop localization - Positioning in multihop environments - Topology control Concepts - Controlling topology in flat networks and hierarchical networks - Combining hierarchical topologies and power control - Case Study: Designing types of WSN topology and disseminating data.

UNIT V SENSOR NETWORK PLATFORMS AND TOOLS 9

Sensor Network Hardware: Berkeley Motes -- Arduino IDE -- Node Level Software: Platforms -- Tiny OS -- Imperative Language -- nesC -- Simulators: NS-3, Contiki OS and COOJA IDE, TOSSIM -- State Centric Programming: PIECES.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Explain sensor node architecture and design principles.	**K2**
CO2	Select specific MAC protocols based on the application requirements	**K3**
CO3	Select data-centric routing based on application needs.	**K3**
CO4	Select appropriate localization and topology control schemes for real world applications.	**K3**
CO5	Build sensor networks using WSN simulator	**K6**

TEXTBOOKS

1. Holger Karl, Andreas Willig, 'Protocols and Architectures for Wireless Sensor Networks', John Wiley, 2005. (Unit - 1, 2, 4)
2. Ivan Stojmenovic, Handbook of Sensor Networks: Algorithms and Architectures, Wiley Interscience, 2005. (Unit 3)

REFERENCE BOOKS

1. Feng Zhao, Leonidas Guibas, ``Wireless Sensor Networks", Morgan Kaufmann, 2004 (Unit 5)
2. Abdulrahman Yarali, "Wireless Sensor Networks (WSN): Technology and Applications", Nova Science Publishers, 2020.
3. Senchun Chai, Zhaoyang Wang , Baihai Zhang , Lingguo Cui , Runqi Chai, "Wireless Sensor Networks", Springer, 2020.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												2	
CO2	3	2	2										2	2
CO3	3	2	2										2	2
CO4	3	2	2										2	2
CO5	3	2	2	3	2					2			2	2
Total	15	8	8	3	2					2			10	8
Score	3	2	2	3	2					2			2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1662	NATURAL LANGUAGE PROCESSING	2	0	2	3

OBJECTIVES

- To learn language models and apply text normalization techniques
- To learn word level and syntactic analysis in language processing
- To learn semantics for word embeddings
- To learn coreference resolution for discourse analysis and to learn machine translation
- To learn transformers for solving real time problems

UNIT I INTRODUCTION AND LANGUAGE MODELS 6

Knowledge in language processing – Ambiguity -- NLP Applications; Text Normalization: Word tokenization -- Lemmatization and Stemming; N-gram Language Models -- Sampling -- Smoothing; RNNs and LSTM as language models.

UNIT II WORD LEVEL AND SYNTACTIC ANALYSIS 6

English Word Classes -- Part-of-Speech Tagging; Constituency Grammar: Context-Free Grammar -- Grammar rules for English -- Treebanks; Dependency Parsing: Dependency Relations – Formalisms.

UNIT III SEMANTIC ANALYSIS 6

Lexical Semantics: Word Senses Relations -- WordNet -- Word Sense Disambiguation -- Vector Semantics -- Words and vectors -- Cosine similarity -- TF-IDF -- PPMI – Word2Vec.

UNIT IV COREFERENCE RESOLUTION AND MACHINE TRANSLATION 6

Coreference Resolution: Coreference phenomena – Mention detection – Mention-pair architecture; RNNs for sequence labeling and classification – Stacked and Bi-directional RNN – Machine Translation: Encoder-Decoder with RNNs and LSTM – MT Evaluation.

UNIT V LANGUAGE MODELLING USING TRANSFORMERS 6

The Transformer: A self-Attention Network – Multi-head Attention – Transformer Block – The Input – The language modeling Head; Bidirectional Transformer Encoders: Architecture – Masked language modeling – Next Sentence Prediction.

TOTAL PERIODS:(THEORY)30

SUGGESTED EXPERIMENTS

1. Apply tokenizer, n-grams in text normalization.
2. Apply treebanks for context-free and dependency parsing.
3. Apply TF-IDF, Word2Vec, GloVe, FastText and BERT to vectorize the given text data for classification and word similarity.
4. Use Neural Machine Translation models for machine translation.
5. Use BERT for solving binary classification problem.
6. Apply transformers for solving sequence labeling problems.

TOTAL PERIODS:(LAB)30

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Apply text pre-processing techniques and build the language models	**K3**
CO2	Apply basic levels of knowledge at word level and syntax level in language processing	**K3**
CO3	Apply computational methods in lexical and vector semantics	**K3**
CO4	Explain discourse processing and machine translation systems	**K2**
CO5	Apply transformers and bidirectional transformer encoders for solving classification and sequence labeling and evaluate on real time applications.	**K5**

TEXTBOOKS

1. Daniel Jurafsky and James H Martin, “Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition”, 3rd Edition, Draft, February 2024 (Units I to V)
2. Tanveer Siddiqui, U.S. Tiwary, “Natural Language Processing and Information Retrieval”, Oxford University Press, 2008 (Unit I)

REFERENCE BOOKS

1. Christopher D. Manning, Hinrich Schutze, “Foundations of Statistical Natural Language Processing”, MIT Press, 1999.
2. Steven Bird, Ewan Klein, and Edward Loper, “Natural Language Processing with Python”, O'Reilly, 2009
3. Nitin Indurkhya, Fred J. Damerau, “Handbook of Natural Language Processing”, 2nd Edition, CRC Press, 2010
4. Yoav Goldberg, "Neural Network Methods for Natural Language Processing", Synthesis Lectures on Human Language Technologies, Morgan & Claypool publishers, 2017.
5. Li Deng, Yang Liu, "Deep Learning in Natural Language Processing", Springer, 2018
6. Taweh Beysolow II, "Applied Natural Language Processing - Implementing Machine LearnIng and Deep Learning Algorithms for Natural Language Processing", Apress, 2018
7. Daniel Jurafsky and James H Martin, “Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition”, 2nd Edition, Pearson Education, 2013

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO1 1**	**PO12**	**PSO 1**	**PSO2**
CO1	3	3	3		2								2	
CO2	3	3	3		2								2	
CO3	3	3	3	2	2							2	2	2
CO4	3	2	3	2	3					2		2	2	2
CO5	3	3	3	3	3					2		2	2	2
Total	15	14	15	7	12					4		6	10	6
Score	3	3	3	3	3					2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1622	**COMPUTER VISION**	**3**	**0**	**0**	**3**

OBJECTIVES

- To get knowledge about features and how to represent for matching
- To understand image segmentation and feature based alignment
- To understand deep networks for image understanding
- To learn and apply various deep learning variants
- To learn recent trends in deep learning

UNIT I VISUAL FEATURES, REPRESENTATION AND MATCHING 9

Introduction to Computer Vision, Image formation: Photometric image formation - Digital camera; Image representation: Point operators, Linear filtering, nonlinear filtering, Feature detection and matching: Points and Patches - Edges - Lines. Case Study: Extracting features from Images.

UNIT II SEGMENTATION AND FEATURE-BASED ALIGNMENT 9

Contour tracking – Lines and vanishing points – Segmentation – Normalized cuts – Graph cuts and energy-based methods.2D and 3D feature-based alignment – Pose estimation – Geometric intrinsic calibration – Triangulation – Two-frame structure from motion – Factorization – Bundle adjustment – Motion Estimation – Translational alignment – Parametric motion – Optical flow – Layered motion.

UNIT III DEEP FEEDFORWARD NETWORKS AND CONVOLUTIONAL NEURAL NETWORK 9

Overview of deep feedforward networks: Gradient-Based Learning, Hidden Units, Architecture Design, Back-Propagation and Other Differentiation Algorithms, Regularization for Deep Learning, Convolutional Neural Networks, case-study: Image Classification problems

UNIT IV VARIANTS OF CNN FOR RECOGNITION, DETECTION, AND SEGMENTATION 9

Popular variants of CNN architecture: LeNET-5, AlexNet, VGG, Inception, GoogLeNet, ResNet. Object Detection: YOLO, RetinaNet, R-CNN, Fast-RCNN, Segmentation: Mask RCNN and Instance Segmentation, U-Net and Semantic Segmentation. Case-Study: Disease Detection from Chest X-rayimages.

UNIT V RECENT TRENDS IN DEEP LEARNING ARCHITECTURES 9

Encoder-Decoder Architecture, Attention Mechanism, Transformer Architecture, Generative Adversarial Networks: Adversarial Examples, Basic Concept of GAN, Variant of GANs, Recent Trends: Zero-shot, One-shot, Few-shot Learning.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Apply conventional computer vision concepts	**K3**
CO2	Develop real life applications using feature-based alignment and motion estimation	**K3**
CO3	Choose appropriate CNN model for real time image applications	**K5**

CO4	Develop applications using various CNNs for object detection and segmentation	**K3**
CO5	Explain the recent trends in deep generative models	**K2**

TEXTBOOKS

1. Richard Szeliski, Computer Vision: Algorithms and Applications, 2010. (Unit I, II)
2. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, 2016. (Unit III, IV)
3. Amlan Chakrabarti, Amit Kumar Das, Saptarsi Goswami, Pabitra Mitra; Deep Learning,2022. (Unit V)

REFERENCE BOOKS

1. Dr. Adrian Rosebrock, Deep Learning for Computer Vision with Python, Practitioner Bundle, 2017
2. Valliappa Lakshmanan, Martin Görner, Ryan Gillard, Practical Machine Learning for ComputerVision, 2021
3. Roshani Raut, Pranav D Pathak, Sachin R Sakhare, Sonali Patil, Generative Adversarial Networks and Deep Learning Theory and Applications, 2023
4. Simon Prince, Computer Vision: Models, Learning, and Inference, 2012.
5. David Forsyth, Jean Ponce, Computer Vision: A Modern Approach, 2002.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO1 1	PO12	PSO1	PSO2
CO1	3	2		1									2	
CO2	3	2											2	
CO3	3	2											2	
CO4	3	3	3	3	2					2		2	2	2
CO5	3	2	2										2	
Total	15	11	5	4	2					2		2	10	2
Score	3	3	3	2	2					2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1663	GRAPHICS AND MULTIMEDIA TECHNIQUES	2	0	2	3

OBJECTIVES

- To understand basics of computer graphics output primitives and transformations
- To learn about various color models and animations
- To learn the fundamentals of multimedia systems.
- To introduce multimedia compression and decompression techniques.
- To understand the concepts of hypermedia

UNIT I INTRODUCTION TO GRAPHICS AND TRANSFORMATIONS 6

Introduction to computer graphics – Applications. Output primitives: Points and lines. Two dimensional geometric transformations: Basic transformations – Matrix representations and homogeneous coordinates – Composite transformations; 3D basic transformations

UNIT II COLOR MODELS AND ANIMATION 6

Color Models: Properties of light – Standard primaries and chromaticity diagram – RGB, YIQ, CMY, HSV and HLS color models; Computer Animation: Design of animation sequences – Keyframe systems – Motion specifications.

UNIT III INTRODUCTION TO MULTIMEDIA 6

Multimedia Elements - Multimedia Applications - Multimedia System Architecture - Evolving Technologies for Multimedia Systems - Multimedia Databases

UNIT IV COMPRESSION AND DECOMPRESSION TECHNIQUES 6

Types of Compression - Binary Image Compression Schemes - Color, gray scale, still-video image compression: JPEG - Discrete Cosine Transform. Video Image compression: CCITT H.261 video coding algorithm - MPEG Compression - Audio Compression.

UNIT V MULTIMEDIA AUTHORING AND HYPERMEDIA 6

Multimedia Authoring systems - User Interface Design. Hypermedia Messaging: Hypermedia Message Components - Hypermedia Linking and Embedding.

TOTAL PERIODS:(THEORY)30

SUGGESTED EXPERIMENTS

1. Depict a scene with basic output primitives, simple 2D and 3D objects using a graphical tool like Paint 3D, OpenGL, Blender
2. Apply 2D and 3D transformations on the objects created to create basic animations.
3. Design a multimedia presentation using Canva - Incorporate images, videos, and audio elements. Add transitions and animations to enhance visual appeal.

4. Use a programming language (e.g., Python with Pillow library) to implement the JPEG compression and decompression algorithm. Calculate and compare the compression ratio achieved.Display and compare the original and decompressed images.
5. Use a multimedia editing tool (e.g., Adobe Photoshop, GIMP) to edit and enhance images. Apply filters, adjust color balance, and save the edited images in different formats.
6. Use a video editing tool (e.g., Adobe Premiere, Shotcut) to edit a short video clip. Add transitions, effects, and export the final video in different resolutions.

TOTAL PERIODS:(LAB)30

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Design and apply transformations on 2D and 3D objects	**K3**
CO2	Create simple animations and add visual effects	**K6**
CO3	Illustrate the architecture and components of a multimedia system	**K2**
CO4	Apply image, video compression and decompression techniques	**K3**
CO5	Design a multimedia application with hypermedia elements.	**K5**

TEXTBOOKS

1 Donald Hearn, Pauline Baker M, "Computer Graphics with OpenGL", Pearson Education, 4th Edition, 2013. (Units 1 and 2)

2 Andleigh PK and Thakrar K, "Multimedia Systems", Pearson, 2015. (Units 3,4,5)

REFERENCE BOOKS

1 Ranjan Parekh, Principles of Multimedia, 2nd Edition, McGraw Hill Education, 2013.

2 Ralf Steinmetz, Klara Nahrstedt, "Multimedia, computing, communications and applications", Pearson, 2002.

3 Weixel, Fulton, Barksdale.Morse, "Multimedia Basics", Easwar Press 2004.

4 Tay Vaughan, "Multimedia making It work", Osborne/McGraw-Hill 9th Edition 2014.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2		2									2	
CO2	3	2	2		2				2	2		2	2	2
CO3	3													
CO4	3	2												
CO5	3	2	2										2	
Total	15	8	4	2	2				2	2		2	6	2
Score	3	2	2	2	2				2	2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1623	STATISTICAL METHODS IN DATA ANALYSIS	3	0	0	3

OBJECTIVES

The objective of this course is to

- perform linear discriminant analysis on data.
- apply the concept of principal components and perform factor analysis on data
- model data using techniques when the relationship is non-linear.
- make decisions using logistic regression and link functions
- understand the use of statistical models for forecasting in time series.

UNIT I DISCRIMINANT ANALYSIS 9

Statistical background, linear discriminant function analysis, Estimating linear discriminant functions and their properties.

UNIT II FACTOR ANALYSIS 9

Factor analysis model, Extracting common factors, determining number of factors, Transformation of factor analysis solutions, Factor scores.

UNIT III NON-LINEAR MODELS 9

Non-Linear Regression (NLS): Linearization transforms, their uses & limitations, examination of non-linearity, initial estimates, iterative procedures for NLS, grid search, Newton-Raphson, steepest descent -Regression models: additive model.

UNIT IV GENERALIZED MODELS 9

Predictive modelling and pattern discovery, Logistic Regression: Logit transform, Tests of hypotheses, Wald test, LR test, score test, test for overall regression. Generalized Linear model: Link functions such as Poisson, Binomial.

UNIT V TIME SERIES ANALYSIS 9

Auto - Covariance, Autocorrelation and their properties - Test for trend and seasonality, Exponential and moving average smoothing - Linear time series models: Estimation of ARIMA models- Forecasting using ARIMA models.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	find discriminants, rules to optimally assign new objects to the labelled classes.	**K3**
CO2	reduce the number of variables in regression models using Factor analysis	**K3**
CO3	Apply the nonlinear modelling techniques to interpret data	**K3**
CO4	Apply the testing methods on generalized models to handle massive amounts of data	**K3**
CO5	Analyse time series data and predict future values.	**K4**

TEXTBOOKS

1 J.D. Jobson,"Applied Multivariate Data Analysis", Volume I & II, Springer texts in statistics, New York, Fourth Edition 1999

2 Chris chattfield, Analysis of Time series, CRC press, 2003

REFERENCE BOOKS

1 Draper, N. R. and Smith, H., "Applied Regression Analysis", Third Edition, John Wiley, 1998.

2 T.W. Anderson."An Introduction to Multivariate Statistical Analysis". Wiley, Third edition, 2003

3 D.A. Belsey, E. Kuh and R.E. Welsch ,"Regression Diagnostics , Identifying Influential Data and Sources of Collinearety".

4 Douglas C. Montgomery, Elizabeth A. Peck, G. Geoffrey Vining, "Introduction to Linear Regression Analysis", Fifth Edition, Wiley, 2012.

5 Hosmer, D. W. and Lemeshow, S., "Applied Logistic Regression", Third Edition, Wiley, 2003. 3 Daniel T.Larose, "Data Mining Methods and Models", Wiley-Interscience, 2006

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1624	AGILE METHODOLOGIES	2	1	0	3

OBJECTIVES

- Understand the differences between conventional and agile approaches
- Estimate in an incremental and iterative fashion using practical techniques
- Apply agile principles to a range of decision possibilities
- Apply practices of XP and incremental design

UNIT I INTRODUCTION 9

Introduction to Agile methodologies - Understanding Agile Values - Agile Manifesto –Agile Principles - Delivering the project – Communicating and Working together – Project Execution – Various Agile methodologies - Scrum, XP, Lean, and Kanban.

UNIT II AGILE PRACTICES 9

Reasons for Agile: Professionalism – Reasonable Expectations; Business Practices: Planning – Small Releases – Acceptance Tests; Team Practices: Metaphor – Sustainable Pace – Collective Ownership – Continuous Integration; Technical Practices: Test-Driven – Refactoring – Simple Design – Pair Programming.

UNIT III SCRUM AND SELF-ORGANIZING TEAMS 9

Rules of Scrum – Scrum process – roles – ScrumMaster, Team, Project Manager – Product Manager, Architect, Events and Artifacts – Scrum Planning and Collective Commitment – Case Study: Dutch Railways - Agile Project Management at Intel – A Scrum Odyssey

UNIT IV XP & INCREMENTAL DESIGN 9

Primary practices of XP – Programming practices, Integration practices, Planning practices & Team practices – Understanding XP Principles – Code and Design – Incremental Design and the Holistic XP Practices – XP Design, Planning, Team and Holistic Practices Form

UNIT V LEAN, KANBAN & AGILE COACH 9

Lean Thinking, Commitment, Options Thinking, & Set-Based Development – Eliminate Waste – Use of Value Stream Map – Principles of Kanban – Improving process with Kanban – Visualize the Workflow – Measure and Manage Flow – Introduction to Agile Coach – Principles of Coach.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Explain fundamentals of agile methodology	**K2**
CO2	Apply agile principles for effective project development	**K3**
CO3	Apply Scrum philosophy and practices for better project development	**K3**
CO4	Identify design problems and apply it for incremental design using XP	**K3**
CO5	Apply various tools for agile development	**K3**

TEXTBOOKS

1 Andrew Stellman, Jill Alison Hart, “Learning Agile”, O'Reilly, 2015. (Unit I & III)

2 Andrew Stellman, Jennifer, Greene, “Learning Agile: Understanding Scrum, XP, Lean, and Kanban”, O Reilly, 2015. (Unit IV & V)

REFERENCE BOOKS

1 Robert C Martin, “Clean Agile: Back to Basics”, Pearson, 2019 (Unit II)

2 Andrew Stellman, Jennifer Green, “Headfirst Agile”, O'Reilly, 2017

3 Rubin K, “Essential Scrum: A practical guide to the most popular Agile process”, Addison-Wesley, 2013.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2		3	2	2	2			2	2	2		2		2
CO3		3	2	2	2			2	2	2		2		2
CO4		3	3	2	2			2	2	2		2	2	2
CO5		3		3	2					3			2	2
Total	3	12	7	9	8			6	6	9		6	4	8
Score	3	3	3	2	2			2	2	2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1763	SOFTWARE DEFINED NETWORKS	2	0	2	3

OBJECTIVES

- To understand the use cases and basic architecture of SDN
- To explore various methods of SDN implementations and Open-Source frameworks
- To solve problems using OpenFlow functionalities

UNIT I INTRODUCTION AND USE CASES 7

Introduction to SDN: – Market Landscape - Technical landscape - SDN definition - Use Cases: - Network Virtualization - Switching Fabrics - Traffic Engineering for WANs Software-Defined WANs - Access Networks - Network Telemetry

UNIT II BASIC ARCHITECTURE AND BARE METAL SWITCHES 7

Software Stack - Bare-Metal Switch - Switch Operating System - Network Operating System - Leaf-Spine Fabric - Bare-Metal Switches: Switch-Level Schematic - Forwarding Pipeline - Abstracting the Pipeline – Programs - Fixed-Function Pipelines - Comparison

UNIT III SOFTWARE DEFINED NETWORKING IMPLEMENTATION 8

Network limitations - Network control plane - Forwarding function - Network state function - Configuration function - Separation of functionality – Applications - SDN implementation: - SDN design - Separation of the control and data planes - Edge-oriented networking - SDN operation - Service providers and SDN: - Telecommunication SDN attributes - Telecommunication SDN services.

UNIT IV OPENFLOW 8

Overview of the OpenFlow switch specification - OpenFlow ports - OpenFlow packet-processing pipeline - OpenFlow channel - Message handling - OpenFlow channel connections - Controller modes - Auxiliary connection use for performance and reliability - Flow table synchronization - Bundle messages - OpenFlow configuration-and-management protocol.

TOTAL PERIODS: 30 (Theory)

LIST OF SUGGESTIVE EXERCISES

1. Building variety of topologies using Mininet network emulator
2. Study of command line Linux utilities for Open Virtual Switch (OVS)
3. Building simple OpenFlow switch using Mininet, OVS and Ryu and testing it with flow rule installation
4. Configuring the fields flow rules and inspecting the flow behavior using Wireshark tool
5. Building customized OpenFlow switch by changing the timeouts of installed flow rules
6. Constructing network information collection module for Ryu and display the statistics as online dashboard
7. Devising a threat plan and Implementing DDoS attack from one or more hosts. The changes in network states need to be observed.
8. Building Firewall for blacklisting the attacker on the identifying DDoS threats

TOTAL PERIODS: 30 (lab)

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Apply SDN based solutions for networking use cases	**K3**
CO2	Explain the architecture Switches	**K2**
CO3	Apply SDN implementation ideas for network problems	**K3**
CO4	Develop solutions for network challenges using Open-Source SDN Platforms	**K6**
CO5	Build OpenFlow based solutions for SDN specific challenges	**K6**

TEXTBOOKS

1 Peterson, Cascone, O'Connor, Vachuska, and Davie, "Software-Defined Networks: A Systems Approach", Systems Approach LLC Publishers, 2021 (Units 1 & 2)

2 Patricia A. Morreale, James M. Anderson, "Software Defined Networking", CRC Press, 2014 (Units 3, 4 & 5)

REFERENCE BOOKS

1 Oswald Coker, Siamak Azodolmolky, Software-Defined Networking with OpenFlow - Second Edition, Packt Publishers, 2017

2 James M. Anderson, Patricia A. Morreale, "Software-Defined Networking with OpenFlow - Second Edition", Apple Academic Press, 2014

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO 1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
CO1	3	2												
CO2	3	2												
CO3	3	2											2	2
CO4	3	2	2	2	2					2		2	2	2
CO5	3	2	2	2	2					2		2	2	2
Total	15	10	4	4	4					4		4	6	6
Score	3	2	2	2	2					2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1721	**FUNDAMENTALS OF FOG AND EDGE COMPUTING**	**3**	**0**	**0**	**3**

OBJECTIVES

- To introduce IoT enabling technologies and its opportunities.
- To review underlying technologies, limitations, and challenges along with performance metrics and discuss generic conceptual framework in fog computing.
- To impart the knowledge to log the sensor data and to perform further data analytics.

UNIT I IOT AND CHALLENGES IN FEDERATING EDGE RESOURCES 9

Introduction to Fog and Edge Computing – Relevant Technologies – Hierarchy of Fog and Edge Computing – Business Models – Edge Computing Platforms - Opportunities and Challenges – Challenges in Federating Edge Resources: Networking Challenge – Management Challenge – Modelling Challenge.

UNIT II ORCHESTRATION OF NETWORK SLICES IN FOG, EDGE, AND CLOUD 9

Background - Network Slicing in 5G: Infrastructure Layer - Network Function and Virtualization Layer - Service and Application Layer - Slicing Management and Orchestration; Network Slicing in Software Defined Clouds: Network Aware Virtual Machines Management -and Machine Migration Planning - Virtual Network Functions Management; Network Slicing Management in Edge and Fog.

UNIT III OPTIMIZATION PROBLEMS IN FOG AND EDGE COMPUTING 9

Preliminaries – The Case for Optimization in Fog Computing – Formal Modelling Framework for Fog Computing – Metrics – Quality Attributes – Optimization Opportunities along the Fog Architecture – Optimization Opportunities along the Service Life Cycle.

UNIT IV MIDDLEWARE AND TECHNOLOGIES 9

Need for Fog and Edge Computing Middleware – Design Goals-State-of-the-Art Middleware Infrastructures – System Model; Fog Data Management – Fog Data Life Cycle- Data Characteristics -Data Pre-Processing and Analytics- Data Privacy - Data Storage and Data Placement.

UNIT I APPLICATIONS OF FOG and EDGE COMPUTING 9

Exploiting Fog Computing in Health Monitoring-Smart Surveillance Video Stream Processing at the Edge for Real - Time Human Objects Tracking-Fog Computing Model for Evolving Smart Transportation Applications - Testing Perspectives of Fog - Based IoT Applications - Legal Aspects of Operating IoT Applications in the Fog

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1 Explain the need for IoT and its associated challenges **K2**

CO2	Apply network slicing management and orchestration techniques in simulated fog, edge, and cloud environments.	**K3**
CO3	Select appropriate optimization opportunities along the Fog architecture and service life cycle	**K3**
CO4	Analyze data and application requirements along with pertaining issues in Fog and edge computing	**K4**
CO5	Model Fog and Edge infrastructures for real time application	**K5**

TEXTBOOKS

1 Rajkumar Buyya, and Satish Narayana Srirama, Fog and Edge computing: Principles and Paradigms, 2019, 1st edition, John Wiley & Sons, USA. (Unit I- V)

2 Perry Lea, IoT and Edge Computing for Architects - Second Edition, Packt Publishing, 2020, ISBN: 9781839214806(UNIT IV)

REFERENCE BOOKS

1 Bahga, Arshdeep, and Vijay Madisetti, Cloud computing: A hands-on approach, 2014, 2nd edition, CreateSpace Independent Publishing Platform, USA.

2 Ovidiu Vermesan, Peter Friess, "Internet of Things –From Research and Innovation to Market Deployment", 2014, 1st edition, River Publishers, India.

3 Flavio Bonomi, Rodolfo Milito, Jiang Zhu, Sateesh Addepalli, ―Fog Computing and Its Role in the Internet of Things, MCC'12, August 17, 2012, Helsinki, Finland. Copyright 2012 ACM 978- 1-4503-1519-7/12/08... $15.00.

4 David Jensen, "Beginning Azure IoT Edge Computing: Extending the Cloud to the Intelligent Edge, MICROSOFT AZURE

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2												
CO2	3													
CO3	3	3								3			2	3
CO4	3	2											2	
CO5	3	3	3		3							2	2	3
Total	15	10	3		3					3		2	6	6
Score	3	3	3		3					2		2	2	3

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1722	BUSINESS INTELLIGENCE	3	0	0	3

OBJECTIVES

- Be exposed with the basic rudiments of business intelligence system
- To explore the different knowledge representation tools
- To understand the modeling aspects behind Business Intelligence
- To understand of the business intelligence life cycle and the techniques used in it
- Be exposed with different data analysis tools and techniques

UNIT I BUSINESS INTELLIGENCE 9

Effective and timely decisions – Data, information, and knowledge – Role of mathematical models – Business intelligence architectures: Process of business intelligence system – Cycle of a business intelligence analysis –Ethics and business intelligence.

UNIT II KNOWLEDGE DELIVERY 9

The business intelligence user types – Reporting: Standard reports--Interactive Analysis and Ad Hoc Querying--Parameterized Reports and Self-Service Reporting --Dimensional Analysis--Alerts/Notifications -- Visualization: Charts—Graphs—Widgets--Scorecards and Dashboards--Geographic Visualization; Integrated Analytics -- Considerations: Optimizing the Presentation for the Right Message.

UNIT III EFFICIENCY & BUSINESS MODELLING 9

Efficiency measures – The CCR model: Definition of target objectives- Peer groups – Identification of good operating practices; cross efficiency analysis – virtual inputs and outputs – Data Integration – Datawarehouse- Data Models and Schemas- Multidimensional Data Modeling.

UNIT IV BUSINESS INTELLIGENCE APPLICATIONS 9

Marketing models: Relational marketing- Sales force management; **Logistic and production models:** Supply chain optimization-- Optimization models for logistics planning-- Revenue management systems.

UNIT V BUSINESS ANALYTICS TOOLS 9

SAP Business Intelligence - Zoho Analytics - Microsoft Power BI - Tableau - Oracle BI - IBM Cognos Analytics.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Explain the fundamentals of business intelligence.	**K2**
CO2	Make use of reporting and visualization techniques for business intelligence.	**K3**
CO3	Apply various modeling techniques, explore the pattern and data analysis	**K3**

techniques.

CO4	Analyze and Apply business intelligence methods to various situations.	**K4**
CO5	Select and apply appropriate BI tools for the data visualization.	**K5**

TEXTBOOKS

1. Efraim Turban, Ramesh Sharda, Dursun Delen, "Decision Support and Business Intelligence Systems", 9 th Edition, Pearson 2013. (Unit 1, 2) Last edition
2. Larissa T. Moss, S. Atre, "Business Intelligence Roadmap: The Complete Project Lifecycle of Decision Making", Addison Wesley, 2003. (Unit 3) - Last edition
3. Carlo Vercellis, "Business Intelligence: Data Mining and Optimization for Decision Making", Wiley Publications, 2009. (Units 4, 5) - Last edition

REFERENCE BOOKS

1. David Loshin Morgan, Kaufman, "Business Intelligence: The Savvy Manager‟s Guide", Second Edition, 2012.
2. Cindi Howson, "Successful Business Intelligence: Secrets to Making BI a Killer App", McGraw- Hill, 2007.
3. Ralph Kimball, Margy Ross, Warren Thornthwaite, Joy Mundy, Bob Becker, "The Data Warehouse Lifecycle Toolkit", Wiley Publication Inc.,2007
4. R N Prasad, Seema Acharya, "Fundamentals of Business Analytics", 2nd Edition published by Wiley 2016.
5. U Dinesh Kumar, "Business Analytics: The Science of Data-Driven Decision Making", published by Wiley 2017

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	2		2					2		2	2	2
CO2	3	3	2		2					2		2	2	2
CO3	3	3	2		2					2		2	2	2
CO4	3	3	2		2					2		2	2	2
CO5	3	3	2		2					2		2	2	2
Total	15	15	10		10					10		10	10	10
Score	3	2	2		2					2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1723	GPU COMPUTING	3	0	0	3

OBJECTIVES

- To understand the basics of GPU architectures
- To write programs for massively parallel processors
- To understand the issues in mapping algorithms for GPUs
- To introduce different GPU programming models
- To understand the concepts of OpenCL

UNIT I GPU ARCHITECTURE 9

Evolution of GPU architectures -- Understanding Parallelism with GPU -- Typical GPU Architecture -- CUDA Hardware Overview - Threads, Blocks, Grids, Warps, Scheduling.

UNIT II CUDA PROGRAMMING 9

Memory Handling with CUDA: Shared memory, Global memory, Constant memory and Texture memory Using CUDA -- Multi GPU -- Multi GPU Solutions -- Optimizing CUDA Applications: Problem decomposition, Memory considerations, Transfers, Thread usage.

UNIT I PROGRAMMING ISSUES 9

Common Problems: Resource contentions, CUDA error handling, Parallel programming issues, Synchronization, Algorithmic issues, Finding and avoiding errors.

UNIT I OPENCL BASICS **9**

OpenCL Standard -- Kernels -- Host Device Interaction -- Execution Environment – Memory Model –Solving Basic problems using OpenCL: Matrix Addition, Sorting.

UNIT I ALGORITHMS ON GPU 9

Parallel Patterns: Convolution, Prefix Sum, Sparse Matrix -- Matrix Multiplication -- Programming Heterogeneous Cluster.

TOTAL PERIODS: 45

COURSE OUTCOMES:

On successful completion of this course, the student will be able to:

CO1	Understand GPU architecture	**K2**
CO2	Inspect simple programs to find parallelism and solve using CUDA	**K4**
CO3	Solve parallel programming and algorithmic issues.	**K3**
CO4	Inspect simple programs to find parallelism and solve using OpenCL	**K4**
CO5	Implement efficient algorithms in GPUs for common application kernels	**K3**

TEXTBOOKS

1. Shane Cook, “CUDA Programming: A Developer ’s Guide to Parallel Computing withGPUs (Applications of GPU Computing)”, 1st Edition, Morgan Kaufmann, 2012. [UNIT I, UNIT-II & UNIT-III]
2. . DavidRKaeli, Perhaad Mistry, Dana Schaa, Dong Ping Zhang, “Heterogeneous Computing with OpenCL”, 3rd Edition, Morgan Kauffman, 2015. [UNIT IV & UNIT-V]

REFERENCE BOOKS

1. DavidB Kirk, Wen-mei W Hwu, “Programming Massively parallel Processors – A Hands-on Approach”, 3rd Edition,Morgan Kaufmann, 2016.
2. Nicholas Wilt, “CUDA Handbook: A Comprehensive Guideto GPU Programming”, Addison - Wesley, 2013.
3. Jason Sanders, Edward Kandrot, “CUDA by Example: An Introduction to General Purpose GPU Programming”, Addison - Wesley, 2010.
4. http://www.nvidia.com/object/cuda_home_new.html
5. OpenCL: http://www.openCL.org

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO 1	**PO2**	**PO 3**	**PO 4**	**PO5**	**PO 6**	**PO7**	**PO 8**	**PO 9**	**PO10**	**PO1 1**	**PO12**	**PSO 1**	**PSO2**
CO1	3	3											2	
CO2	3	2	2	3	2								2	2
CO3	3	3											2	2
CO4	3	2	2	3	2								2	2
CO5	3	2											2	2
Total	15	12	4	6	4								10	8
Score	3	2	2	3	2								2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1764	DEEP LEARNING TECHNIQUES	2	0	2	3

OBJECTIVES

- To understand basics of deep neural networks
- To understand CNN and RNN architectures of deep neural networks
- To comprehend advanced deep learning models
- To learn deep learning algorithms and their applications to solve real world problems

UNIT I DEEP NETWORKS BASICS 6

Machine Learning Basics: Capacity - Overfitting and underfitting - Hyperparameters and validation sets - Estimators - Bias and variance - Stochastic gradient descent - Challenges motivating deep learning; Deep Networks: Deep feedforward networks.

UNIT II CONVOLUTIONAL NEURAL NETWORKS 6

Convolution Operation - Sparse Interactions - Parameter Sharing - Equivariance - Pooling-- Convolution Variants: Strided - Tiled-- Transposed and dilated convolutions; CNN Learning: Nonlinearity Functions - Loss Functions - Regularization - Optimizers - Gradient Computation - CNN through Visualization

UNIT III RECURRENT NEURAL NETWORKS 6

Unfolding Graphs - RNN Design Patterns: Acceptor - Encoder-- Transducer; Gradient Computation - Sequence Modeling Conditioned on Contexts - Bidirectional RNN - Sequence to Sequence RNN – Deep Recurrent Networks - Long Term Dependencies; Leaky Units: Skip connections and dropouts.

UNIT IV AUTOENCODERS AND GENERATIVE MODELS 6

Autoencoders: Undercomplete autoencoders - Regularized autoencoders - Stochastic encoders and decoders - Learning with autoencoders; Deep Generative Models: Variational autoencoders - Generative adversarial networks

UNIT V APPLICATIONS USING TRANSFORMER MODELS 6

The Encoder-Decoder Framework - Attention Mechanisms - Hugging Face Transformers - Question answering - Summarization - Image classification – Image captioning.

TOTAL PERIODS:(THEORY)30

SUGGESTED EXPERIMENTS

1. XOR implementation using neural networks.
2. Multi-class Classification using deep neural networks (E.g., Digit recognition)
3. Next word prediction using RNN.
4. Image augmentation using GAN.
6. Apply hugging face transformers for NLP applications
7. Vision transformers for image classification

TOTAL PERIODS:(LAB)30
TOTAL:60

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Explain the basic concepts of deep neural networks	**K2**
CO2	Apply convolution neural networks for real-world problems in image processing	**K3**
CO3	Apply recurrent neural networks and its variants for text analysis	**K3**
CO4	Apply generative models for data augmentation	**K3**
CO5	Choose suitable transformer models for NLP and computer vision applications	**K5**

TEXTBOOKS

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning"', MIT Press, 2016. (Units 1,2,3,4)
2. Lewis Tunstall, Leandro von Werra, Thomas Wolf, "Natural Language Processing with Transformers", O'Reilly Media, Inc., May 2022. (Unit 5)

REFERENCE BOOKS

1. Seth Weidman. "Deep Learning from Scratch: Building with Python from First Principles", O'Reilly Media, Inc, September 2019.
2. Salman Khan, Hossein Rahmani, Syed Afaq Ali Shah, Mohammed Bennamoun, "A Guide to Convolutional Neural Networks for Computer Vision", Synthesis Lectures on Computer Vision, Morgan & Claypool publishers, 2018.
3. Yoav Goldberg, "Neural Network Methods for Natural Language Processing", Synthesis Lectures on Human Language Technologies, Morgan & Claypool publishers, 2017.
4. Santanu Pattanayak, "Pro Deep Learning with TensorFlow: A Mathematical Approach to Advanced Artificial Intelligence in Python", Apress, 2017.
5. Josh Patterson, Adam Gibson, "Deep Learning: A Practitioner's Approach" First Edition, O'Reilly Media, 2017.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO1 1**	**PO12**	**PSO 1**	**PSO2**
CO1	3	2											2	
CO2	3	2	2		3								2	
CO3	3	2	2		3								2	
CO4	3	2			3								2	
CO5	3	3	3	3	3				3	2		2	2	2
Total	15	11	7	3	12				3	2		2	10	2
Score	3	3	3	3	3				3	2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1724	SPEECH PROCESSING AND SYNTHESIS	3	0	0	3

OBJECTIVES

- To explore the fundamentals of digital speech process
- To understand the basic concepts and algorithms of speech processing
- To be familiar with the various speech signal representation, coding and recognition
- techniques
- To study the concepts and evaluation methods of speech synthesis.

UNIT I FUNDAMENTALS OF DIGITAL SPEECH PROCESSING 9

Introduction: Discrete-time signals and systems – Transform representation of signals and systems – Fundamentals of digital filters – Sampling; Process of speech production – Acoustic theory of speech production – Digital models for speech signals.

UNIT II SPEECH SIGNAL ANALYSIS IN TIME DOMAIN 9

Time-dependent processing of speech – Methods for extracting the Parameters: Energy – Average magnitude – Zero-crossing rate; Silence discrimination using ZCR and energy – Short-time auto correlation function – Pitch period estimation using autocorrelation function.

UNIT III SPEECH SIGNAL ANALYSIS IN FREQUENCY DOMAIN 9

Spectrographic displays – Formant extraction – Pitch extraction – Linear predictive coding: Autocorrelation method – Covariance method; Solution of LPC equations – Durbin's Recursive solution – Application of LPC parameters – Pitch detection.

UNIT IV SPEECH RECOGNITION 9

Introduction – Preprocessing – Parametric representation – Speech segmentation – Dynamic time warping – Vector quantization – Hidden Markov Model – Language Models – Developing speech recognition system for real time applications.

UNIT V SPEECH SYNTHESIS 9

Attributes of speech synthesis – Formant speech synthesis – Concatenative speech synthesis – Prosodic modification of speech – Source filter models for prosody modification – Evaluation of TTS system.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Illustrate how the speech production is modelled	**K2**
CO2	Utilize the speech signal in time domain	**K3**
CO3	Utilize the speech signal in frequency domain	**K3**
CO4	Choose the appropriate technique to develop automatic speech recognition system for the real word application	**K5**

CO5 Identify the suitable method in speech synthesis for the given application **K3**

TEXTBOOKS

1. L R Rabiner, R W Schafer, “Digital Processing of Speech Signals”, Pearson Education, Delhi, India, 2004. (Unit 1,2,3)
2. Xuedong Huang, Alex Acero, Hsiao-Wuen Hon, “Spoken Language Processing – A guide to Theory, Algorithm and System Development”, Prentice Hall PTR, 2001. (Unit 4,5)

REFERENCE BOOKS

1. L R Rabiner, B H Jhuang, B Yegnanarayana, “Fundamentals of Speech Recognition”, Pearson Education, 2009.
2. Thomas F Quatieri, “Discrete-Time Speech Signal Processing”, Pearson Education, 2002.
3. Ben Gold, Nelson Morgan, “Speech and Audio Signal Processing”, John Wiley and Sons Inc, 2004.
4. J R Deller Jr, J H L Hansen, J G Proakis, “Discrete-Time Processing of Speech Signals”, Wiley-IEEE Press, NY, USA, 1999.
5. Daniel Jurafsky, James H Martin, “Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition”, 3rd edition, Draft, 2024.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO1 1**	**PO12**	**PSO 1**	**PSO2**
CO1	3	2											2	
CO2	3	2											2	
CO3	3	2											2	
CO4	3	3	3		2					2		2	2	2
CO5	3	2	2										2	
Total	15	11	5		2					2		2	10	2
Score	3	3	3		2					2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1821	INFORMATION SECURITY	3	0	0	3

OBJECTIVES

- To know the various forms of attacks
- To understand the risk management and framing of various security models.
- To learn, to protect using physical secure design and cryptographic techniques
- To know the standard algorithms used to provide authentication and authorization
- To understand real world security protocols

UNIT I INFORMATION SYSTEMS & SOFTWARE ATTACKS 9

Introduction to Information Systems - Trustworthiness of information systems - Security and Access -Security SDLC - Ethical and Professional Issues - Use of Malware - Virus- Worm - Trojan Horse - Logic Bomb - Rootkit - Spyware - Adware – Password Cracking - DoS and DDoS - Spoofing - Sniffing - Man-in-Middle Attack - Phishing - Pharming

UNIT II RISK MANAGEMENT AND SECURITY MODELS 9

Importance of risk Management - Integration of Risk Management in SDLC - Risk Assessment – System Characterizations - Threat Identification - Vulnerability Identification - Control Analysis - Impact Analysis - Risk Determination - Risk Level Matrix - Control Recommendations - Bell-LaPadula model - Biba model - Clark-Wilson model - Information flow model - Noninterference model - Brewer and Nash model - Graham-Denning model - Harrison-Ruzzo-Ullman model.

UNIT III NETWORK SECURITY 9

Security Technology - Digital certificate - Digital Signatures - Firewall – Firewall Configuration Strategies - Packet Filtering– IDS -Cryptography and Network Security - Symmetric Key Encipherment - Asymmetric Key- Encipherment - Integrity, Authentication, and Key Management

UNIT IV AUTHENTICATION & AUTHORIZATION 9

Introduction – Authentication methods – Passwords – Key versus Password – Attacking systems via passwords – Password verification – Biometrics – types of error – Biometric error rates - Introduction – Access control matrix – Compartments – Covert Channel – Inference Control – CAPTCHA

UNIT V CERTIFICATION, ACCREDITATION, AND SECURITY ASSESSMENTS & PROTOCOLS 9

Certification, Accreditation, and Security Assessments Roles and Responsibilities - Delegation of Roles - The Security Certification and Accreditation Process - Security Certification Documentation Accreditation Decisions - Continuous Monitoring - Introduction – SSH – SSL -IPSec – Kerbose – WEP

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Explain software security development life cycle, list of attacks in Network, Host and Information and describe the consequences of the attack	**K2**
CO2	Identify risks in each activity and describe the impact of risk. Apply security models and suggest best model for the given risk	**K3**
CO3	Apply various approaches of intrusion detection systems for network security	**K3**
CO4	Identify the various authentication and authorization techniques	**K3**
CO5	Design security assessments and protocols for the management activities in an organization	**K6**

TEXTBOOKS

1. Behrouz A. Forouzan, "Cryptography and Network Security", McGraw-Hill Education, Third Edition, 2015. (Unit III)
2. Information Security Handbook: A Guide for Managers, National Institute of Standards and Technology, 2006. (Unit I, II, V)
3. Mark Stamp, "Information Security: Principles and Practice", John Wiley & Sons, Third Edition, 2021. (Unit IV)

REFERENCE BOOKS

1. Michael E. Whitman, Herbert J. Mattord, "Principles of Information Security", Cengage Learning, 7th Edition, 2021
2. Jason Andress, "Foundations of Information Security: A Straightforward Introduction", No Starch Press, 2019
3. David Kim, Michael G. Solomon, "Fundamentals of Information Systems Security", Jones & Bartlett Learning, 3rd Edition, 2016
4. William Stallings, "Cryptography and Network Security: Principles and Practice", Pearson, 7th Edition, 2017
5. William Stallings, "Network Security Essentials", Pearson, 6th Edition, 2018

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO 2	P O3	P O4	PO 5	P O6	PO 7	P O8	P O9	PO1 0	PO 11	PO1 2	PSO 1	PSO 2
CO1	3												2	
CO2	3	2			2								2	
CO3	3	2			2								2	
CO4	3				2								2	
CO5	3	2	2		2	2		2		2		2	2	2
Total	15	6	2		8	2		2		2		2	10	2
Score	3	2	2		2	2		2		2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1822	**DATA PRIVACY**	**3**	**0**	**0**	**3**

OBJECTIVES

- To understand the basics of privacy and microdata.
- To understand static data anonymization on multidimensional data.
- To understand static data anonymization on complex data structures.
- To understand the threat to Static Data Anonymization and need for dynamic data protection.
- To understand and analyse privacy preservation techniques.

UNIT I INTRODUCTION 9

Data Privacy and its importance - Need for Sharing Data - Methods of Protecting Data - Importance of Balancing Data Privacy and Utility; Disclosure - Tabular Data - Micro data Approaches to Statistical disclosure control; Microdata concepts – Disclosure risk - Estimating re-identification risk - Microdata masking - Perturbative microdata masking - Information loss in microdata.

UNIT II STATIC DATA ANONYMIZATION ON MULTIDIMENSIONAL DATA 9

Classification of Privacy Preserving Methods - Classification of Data in a Multidimensional Data Set - Group-Based Anonymization - k-Anonymity - l-Diversity - t-closeness.

UNIT III STATIC DATA ANONYMIZATION ON COMPLEX DATA STRUCTURES 9

Privacy Preserving Graph Data - Privacy Preserving Time Series Data - Time Series Data Protection Methods - Privacy Preservation of Longitudinal Data - Privacy Preservation of Transaction Data.

UNIT IV THREATS AND DATA PROTECTION 9

Threats to Data Structures - Threats by Anonymization Techniques; Tokenization - Understanding Tokenization - Use Cases for Dynamic Data Protection - Benefits of Tokenization Compared to Other Methods - Components for Tokenization

UNIT IV PRIVACY PRESERVING 9

Key Functional Areas of Multidimensional Data - Association Rule Mining - Clustering; Test Data Fundamentals - Utility of Test Data - Test Coverage - Privacy Preservation of Test Data - Quality of Test Data - Anonymization Design for PPTDM - Insufficiencies of Anonymized Test.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Explain the basics of privacy and microdata.	**K2**
CO2	Apply static data anonymization on multidimensional data.	**K3**
CO3	Apply static data anonymization on complex data structures.	**K3**
CO4	Apply data protection techniques	**K3**
CO5	Utilise privacy preservation techniques.	**K3**

TEXTBOOKS

1. N. Venkataramanan and A. Shriram, "Data privacy: Principles and practice". CRC Press, 2016. ISBN: 978-1-49-872104-2 (Unit 1 Chapter 1, Unit 2 chapter 2, Unit 3: chapter 3) (Unit 4: Chapter 4,8) (Unit 5: Chapter 5,6)
2. A. Hundepool, J. Domingo-Ferrer, L. Franconi, S. Giessing, and E. S. Nordholt, P.D. Wolf, “Statistical disclosure control”, Wiley, John & Sons, 2012. ISBN No.: 978-1-11-997815-2 (Unit 1 Chapter 1,3)
3. G. T. Duncan, M. Elliot, J.-J. Salazar-González, J.-J. Salazar-Gonzalez, and J. J. Salazar, "Statistical confidentiality: Principles and practice", Springer-Verlag New York, 2011. ISBN: 978-1-44-197801-1
4. C. C. Aggarwal and P. S. Yu, "Privacy-preserving data mining: Models and Algorithms", Springer-Verlag New York, 2008. (ISBN No.: 978-0-387-70992-5)

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO1 1**	**PO12**	**PSO 1**	**PSO2**
CO1	3												2	
CO2	3	2			2								2	
CO3	3	2			2								2	
CO4	3				2								2	
CO5	3		2		2	2		2		2		2	2	2
Total	15	4	2		8	2		2		2		2	10	2
Score	3	2	2		2	2		2		2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1861	AUGMENTED REALITY AND VIRTUAL REALITY(TCP)	2	0	2	3

OBJECTIVES

- To impart the fundamental aspects and principles of AR/VR technologies.
- To know the internals of the hardware and software components involved in the development of AR/VR enabled applications.
- To gain knowledge about AR/VR application development.
- To know the technologies involved in the development of AR/VR based applications.
- To learn about the tracking methods of objects in AR applications.

UNIT I VIRTUAL REALITY AND AUGMENTED REALITY - INTRODUCTION 6

Introduction to Virtual Reality and Augmented Reality – Definition – Introduction to Trajectories and Hybrid Space-Three I's of Virtual Reality – Virtual Reality Vs 3D Computer Graphics – Benefits of Virtual Reality – Components of VR System – Introduction to AR-AR Technologies-Input Devices – 3D Position Trackers – Types of Trackers – Navigation and Manipulation Interfaces – Gesture Interfaces – Types of Gesture Input Devices – Output Devices

UNIT II VR MODELLING 6

Modeling – Geometric Modeling – Virtual Object Shape – Object Visual Appearance – Kinematics Modeling – Transformation Matrices – Object Position – Transformation Invariants –Object Hierarchies – Viewing the 3D World – Physical Modeling – Collision Detection – Surface Deformation – Force Computation – Force Smoothing and Mapping – Behavior Modeling – Model Management.

UNIT III VR PROGRAMMING AND APPLICATIONS 6

VR Programming – Toolkits and Scene Graphs – World ToolKit – Java 3D – Comparison of World ToolKit and Java 3D – Unity3D – Unreal Engine- Oculus SDK - Society-Medical Applications of VR – Education, Arts and Entertainment – Military VR Applications – Emerging Applications of VR – VR Applications in Manufacturing – Applications of VR in Robotics – Information Visualization – VR in Business

UNIT IV AUGMENTED REALITY HARDWARE 6

Taxonomy- Technology and Features of Augmented Reality- Difference between AR and VR, Challenges with AR - AR Systems and Functionality - Augmented Reality Methods - Visualization Techniques for Augmented Reality - Audio Displays, Haptic Displays, Visual Displays, Other sensory displays, Visual Perception, Requirements and Characteristics, Spatial Display Model, Processor System Architecture, Processor Specifications.

.

UNIT V AR TECHNIQUES – MARKER BASED & MARKERLESS TRACKING 6

Introduction to Vuforia Engine - Marker-based Approach: Types of markers, Marker Camera Pose and Identification, Visual Tracking - Marker Types: Template Markers, 2D Barcode markers,

Imperceptible Markers. Marker-less approach: Localization based Augmentation, Real World examples, Tracking Methods: Visual Tracking, Feature based Tracking, Hybrid Tracking.

TOTAL PERIODS:(THEORY)30

SUGGESTED EXPERIMENTS

1. Study of tools like Unity, Maya, 3DS MAX, AR toolkit, Vuforia and Blender.
2. Use primitive objects and apply various projection types by handling cameras.
3. Download objects from asset store and apply various lighting and shading effects.
4. Model three dimensional objects using various modelling techniques and apply textures over them. (Eg: Interior scenes like rooms, houses etc or vehicles like cars, airplanes, spaceships etc)
5. Create three dimensional realistic scenes and develop simple virtual reality enabled mobile applications which have limited interactivity.
6. Add audio and text special effects to the developed application.
7. Develop VR enabled applications using motion trackers and sensors incorporating full haptic interactivity. (Eg: Training and gaming applications)
8. Develop AR enabled applications with interactivity like E-learning environment, Virtual walkthroughs and visualization of historic places.

TOTAL PERIODS:(LAB) 30

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Explain the basics of VR and AR.	**K2**
CO2	Build various 3D objects for VR applications.	**K3**
CO3	Develop VR applications by using different tools and technologies of VR programming	**K6**
CO4	Choose the hardware elements required for AR application.	**K3**
CO5	Build basic AR applications using marker-based and marker less approach	**K3**

TEXTBOOKS

1 Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition. Wiley-IEEE Press, 2003/2006. (Units 1, 2, 3)

2 Dieter Schmalstieg, Tobias Hollerer, “Augmented Reality: Principles & Practice”, Addison Wesley, 2016. (Units 4, 5)

REFERENCE BOOKS

1 Alan B. Crai`g, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, 2013.

2 John Vince, “Introduction to Virtual Reality”, Springer-Verlag, 2004.

3 William R. Sherman, Alan B. Craig: Understanding Virtual Reality – Interface, Application, Design”, Morgan Kaufmann, 2003.

4 Charles Palmer, John Williamson, “Virtual Reality Blueprints: Create compelling VR experiences for mobile”, Packt Publisher, 2018.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3												2	
CO2	3	2	2		2								2	
CO3	3	2	2	1	**2**				1	2		2	2	2
CO4	3	2	2		2							2	2	
CO5	3	2	2	3	2				3	2		2	2	2
Total	15	8	8	4	8				4	4		6	10	4
Score	3	2	2	2	2				2	2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1823	COGNITIVE COMPUTING	3	0	0	3

OBJECTIVES

- To know the theoretical background of cognition.
- To understand the link between cognition and computational intelligence.
- To explore probabilistic programming language.
- To study the computational inference models of cognition.
- To study the computational learning models of cognition.

UNIT I PHILOSOPHY, PSYCHOLOGY AND NEUROSCIENCE 10

Philosophy: Mental-physical Relation – From Materialism to Mental Science – Logic and the Sciences of the Mind – Psychology: Place of Psychology within Cognitive Science – Science of Information Processing –Cognitive Neuroscience – Perception – Decision – Learning and Memory – Language Understanding and Processing.

UNIT II COMPUTATIONAL INTELLIGENCE 9

Machines and Cognition – Artificial Intelligence – Architectures of Cognition – Knowledge Based Systems – Logical Representation and Reasoning – Logical Decision Making –Learning – Language – Vision.

UNIT III PROBABILISTIC PROGRAMMING LANGUAGE 10

WebPPL Language – Syntax – Using Javascript Libraries – Manipulating probability types and distributions – Finding Inference – Exploring random computation – Coroutines: Functions that receive continuations –Enumeration.

UNIT IV INFERENCE MODELS OF COGNITION 7

Generative Models – Conditioning – Causal and statistical dependence – Conditional dependence – Data Analysis – Algorithms for Inference.

UNIT V LEARNING MODELS OF COGNITION 9

Learning as Conditional Inference – Learning with a Language of Thought – Hierarchical Models– Learning (Deep) Continuous Functions – Mixture Models – Case Studies: Cognitive Systems in Healthcare.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Explain the underlying theory behind cognition.	**K2**
CO2	Apply computational intelligence to connect the cognition elements for reasoning and decision making	**K3**
CO3	Build mathematical functions through WebPPL.	**K3**

CO4	Develop applications using cognitive inference model and analyze different generative models.	**K4**
CO5	Build applications using cognitive learning models.	**K3**

TEXTBOOKS

1. Robert A. Wilson, Frank C. Keil, “The MIT Encyclopedia of the Cognitive Sciences”,MIT Press, 1999. (Unit I)
2. Noah D. Goodman, Joshua B. Tenenbaum, The ProbMods Contributors, “Probabilistic Models of Cognition”, Second Edition, 2016, https://probmods.org/. (Unit IV)

REFERENCE BOOKS

1. Jose Luis Bermúdez, Cognitive Science - An Introduction to the Science of the Mind, Cambridge University Press, 2020. (Unit I)
2. Judith Hurwitz, Marcia Kaufman, Adrian Bowles, Cognitive Computing and Big Data Analytics, Wiley Publications, 2015. (Unit II)
3. Noah D. Goodman, Andreas Stuhlmuller, “The Design and Implementation of Probabilistic Programming Languages”, Electronic version of book, https://dippl.org/. 2024. (Unit III)
4. Vijay V Raghavan,VenkatN.Gudivada, VenuGovindaraju, C.R. Rao, Cognitive Computing: Theory and Applications: (Handbook of Statistics 35), Elsevier publications, 2016 (Unit V)

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	3	2	2											2
CO3	3	2	2							2			2	2
CO4	3	2	2							2			2	2
CO5	3	2	2							2			2	2
Total	15	10	8							6			6	8
Score	3	2	2							2			2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1862	BIG DATA TECHNOLOGIES(TCP)	2	0	2	3

OBJECTIVES

- To understand the fundamentals of big data for efficient data management
- To be familiar with core big data technologies used for handling big data
- To comprehend big data frameworks for faster querying and stream processing

UNIT I FUNDAMENTALS OF BIG DATA 4

Understanding Big Data: Concepts and terminology, Big Data Characteristics, Different types of Data, Identifying Data Characteristics - Big Data Architecture - Big Data Storage: File system and Distributed File System, NoSQL, Sharding, Replication, Sharding and Replication, ACID and BASE Properties.

UNIT II HADOOP CORE COMPONENTS 6

Hadoop Architecture - Hadoop Distributed File System (HDFS) –YARN – Hadoop I/O – Map Reduce (MR): Developing MR application – MR working procedure – Types and Formats - Features of Map reduce sorting and joins- Pipelining MapReduce jobs.

UNIT III ANALYSING LARGE DATASETS USING PIG 6

Introduction - Pig Architecture – Grunt shell - Pig Data Model: Data Types, Arithmetic operators, Relational operators – Build-in functions: Eval, Load/Store, Math, String, DateTime, Tuple, Bag, Map – Writing UDF – Control Structures: Embedded PIG using Java – Working with Scripts.

UNIT IV SQL BASED QUERYING USING HIVE 7

Introduction-Hive modules - Data types and file formats - Hive QL-Data Definition and Data Manipulation - Hive QL queries - Hive QL views- Hive scripts, Hive QL Indexes- Aggregate Functions-Bucketing vs Partitioning.

UNIT V UNIFIED ANALYTICS USING SPARK 7

Overview of Spark – Hadoop Overview of Spark – Hadoop vs. Spark – Cluster Design – Cluster Management – performance, Application Programming interface (API): Spark Context, Resilient Distributed Datasets, Creating RDD, RDD Operations, and Saving RDD - Lazy Operation – Spark Jobs - Developing SPARK applications.

TOTAL PERIODS:(THEORY)30

SUGGESTED EXPERIMENTS

1. Installing and configuring the Hadoop framework. HDFS Commands.
2. Map Reduce Program to show the need of combiner.
3. Map Reduce I/O Formats – Text, Key – Value
4. Map Reduce I/O Formats – NLine – Multiline
5. Installing and Configuring Apache PIG and HIVE
6. Querying datasets using PIG LATIN Language
7. Analyse datasets using HIVEQL.
8. Sequence File Input / Output Formats

9. Distributed Cache & Map side Join, Reduce Side Join
10. Building Spark Streaming application

TOTAL PERIODS:(LAB)30

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Explain the characteristics of big data and data management strategies	K2
CO2	Develop MapReduce programs using HDFS	K3
CO3	Make use of PIG and HIVE to query and analyze large datasets	K3
CO4	Develop streaming applications using Apache Spark	K3
CO5	Build application using Big Data Frameworks in teams applying best practices	K6

TEXTBOOKS

1 Big Data Fundamentals: Concepts, Drivers & Technique, Thomas Erl, Wajid Khattak, Paul Buhler, Pearson, January 2016 (unit 1)

2 Tom White, Hadoop: The Definitive Guide, O'Reilly Media, Inc., Fourth Edition, 2015. (unit 2)

3 Beginning Apache Pig: Big Data Processing Made Easy, Balaswamy Vaddeman, Apress, 2016. (unit 3)

4 Programming Hive, Edward Capriolo, Dean Wampler, Jason Rutherglen, O'REILLY, September 2012. (unit 4)

5 Spark – The Definitive Guide: Big data processing made simple Paperback – 9 March 2018 by Bill Chambers (Author), Matei Zaharia (Author), O'REILLY (unit 5)

REFERENCE BOOKS

1 Mike Frampton "Mastering Apache Spark" – Packt Publishing 2015.

2 Adam Shook and Donald Mine, "MapReduce Design Patterns: Building Effective Algorithms and Analytics for Hadoop and Other Systems" - O'Reilly 2012.

3 Matei Zaharia, Bill Chambers, "Spark: The Definitive Guide - Big Data Processing Made Simple (Greyscale Indian Edition) 2018.

4 Jisha Mariam Jose, "Hadoop Practice Guide: SQOOP, PIG, HIVE, HBASE for Beginners", Kindle edition, 2019.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3												2	
CO2	3	2	3										2	2
CO3	3	2	3										2	2
CO4	3	2	3										2	2
CO5	3	2	3	3					3	3		2	2	2
Total	15	8	12	3					3	3		2	10	8
Score	3	2	3	3	3				3	3		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1824	EMBEDDED SOFTWARE DEVELOPMENT	3	0	0	3

OBJECTIVES

- To learn the architecture and programming of ARM processor
- To be familiar with the embedded computing platform design and analysis
- To study interfacing concepts
- To learn an embedded firmware and its designs
- To design embedded systems and to develop programs

UNIT I EMBEDDED COMPUTING AND ARM PROCESSORS 9

Embedded Computing: Complex systems and microprocessors – Embedded system design process – Formalisms for system design – Model train controller; Instruction Sets: Preliminaries – ARM processor; CPUs: Programming input and output – Supervisor mode, exceptions and traps – Co-processors – Memory system mechanisms – CPU performance – CPU power consumption.

UNIT II EMBEDDED COMPUTING PLATFORM DESIGN 9

Bus-Based Computer Systems: CPU Bus – Memory devices and systems – Designing with computing platforms – Consumer electronics architecture – Platform-level performance analysis; Program Design and Analysis: Components for embedded programs – Models of programs – Assembly, linking and loading – Compilation techniques – Program level performance analysis – Software performance optimization – Program level energy and power analysis and optimization – Analysis and optimization of program size – Program validation and testing.

UNIT III EMBEDDED C PROGRAMMING 9

Reading switches – Adding Structure to the code; Meeting Real-Time Constraints: Creating hardware delays using Timer 0 and Timer 1 – Generating a Minimum and Maximum delay- Creating a portable hardware delay – Timeout mechanisms – Creating loop timeouts – Testing loop timeouts – Hardware timeouts – Testing a hardware timeout.

UNIT IV EMBEDDED FIRMWARE 9

Reset Circuit, Brown-out Protection Circuit-Oscillator Unit – Real Time Clock-Watchdog Timer – Embedded Firmware Design Approaches and Development Languages.

UNIT V SENSOR INTERFACING WITH ARDUINO 9

Basics of hardware design and functions of basic passive components – Sensors and Actuators – Arduino code – Library file for sensor interfacing – Construction of basic applications.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Explain the architecture and programming of ARM processor.	**K2**
CO2	Make use of the concepts of embedded systems	**K3**
CO3	Make use of C programming for solving the problems in embedded systems	**K3**
CO4	Apply the system design techniques to develop firmware	**K3**
CO5	Build basic applications using peripherals and sensors.	**K5**

TEXTBOOKS

1 Marilyn Wolf, "Computers as Components – Principles of Embedded Computing System Design", 3rd Edition, Morgan Kaufmann Publisher (An imprint from Elsevier), 2012. (UNIT I, II)

2 Michael J Pont, "Embedded C", 2nd Edition, Pearson Education, 2008. (UNIT V)

REFERENCE BOOKS

1 Shibu K V, "Introduction to Embedded Systems", McGraw Hill, 2014.

2 Jonathan W Valvano, "Embedded Microcomputer Systems Real Time Interfacing", 3rd Edition Cengage Learning, 2012. (UNIT III)

3 Raj Kamal, "Embedded Systems-Architecture, Programming and Design", 3rd edition, TMH, 2015. (UNIT IV)

4 Lyla, "Embedded Systems", Pearson, 2013.

5 J. M. Hughes, "Arduino: A Technical Reference", O'Reilly Media, 2016

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	3													
CO3	3	3								3			2	3
CO4	3	2											2	
CO5	3	3	3		3							2	2	3
Total	15	10	3		3					3		2	6	6
Score	3	3	3		3					2		2	2	3

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1825	SOFTWARE PROJECT MANAGEMENT	3	0	0	3

OBJECTIVES

- To learn key aspects of Software Project Management and Costing
- To understand the process models and lifecycles in Software Engineering
- To assess, identify and analyze risks in Software Project Management
- To develop various metrics for measure of Software Project Development
- To use latest tools in Software Project Management

UNIT I PROJECT MANAGEMENT & COSTING 9

Software Project Management approaches – Project Acquisition – Initiation – Planning – PERT Execution and Control – CPM – Change Management – Project Closure – Agile SPM Problems in Software Estimation – Algorithmic Cost Estimation Process, Function Points, COCOMO II (Constructive Cost Model) – Estimating Web Application Development – Concepts of Finance, Activity Based Costing and Economic Value Added (EVA) – Balanced Score Card.

UNIT II PROCESS MODELS & LIFECYCLE MANAGEMENT 9

Software Engineering Process Models - Adaptive Software Development (ASD) - DSDM - SCRUM – Crystal -Feature Driven Development (FDD) - ISO 9000: 2000 - SPICE – SIX SIGMA – CMMI. SLIM (Software Life cycle Management) – PLM (Product Lifecycle Management) – PDM (Product Data Management) - PLM, PDM Applications – Pre-PLM Environment – Change Management.

UNIT III RISK MANAGEMENT 9

Perspectives of Risk Management - Risk Definition – Risk Categories – Risk Assessment: Approaches, techniques, and good practices – Risk Identification / Analysis / Prioritization – Risk Control (Planning / Resolution / Monitoring) – Risk Retention – Risk Transfer - Failure Mode and Effects Analysis (FMEA) – Operational Risks – Supply Chain Risk Management.

UNIT IV METRICS 9

Need for Software Metrics – scope – basics – framework for software measurement - Classification of Software Metrics: Product Metrics (Size Metrics, Complexity Metrics, Halstead's Product Metrics, Quality Metrics), and Process metrics (Empirical Models, Statistical Models, Theory-based Models, Composite Models, and Reliability Models) – measuring internal and external product attributes.

UNIT V PEOPLE & TOOLS IN PROJECT MANAGEMENT 9

Leadership styles – Developing Leadership skills – Team building – Delegation – Art of Interviewing People - Team Management – Client Relationship Management; Project Management Platforms: JIRA and Microsoft Project, Visual Representation of Project Schedules: Gantt charts; Task Management: Kanban Boards; Risk Management: RiskyProject; Document Management: Google Drive; Issue Tracking Systems: GitHub Issues; Reporting and Analytics: Power BI.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Identify the various elements of software management and costing	**K3**
CO2	Compare various software process models and explain lifecycle management processes.	**K3**
CO3	Identify existing risks and perform a risk assessment	**K3**
CO4	Design a software metric for software project management	**K6**
CO5	Make use of latest tools in Project Management	**K3**

TEXTBOOKS

1. Murali Chemuturi, Thomas M. Cagley: Mastering Software Project Management: Best Practices, Tools and Techniques, J. Ross Publishing, 2010 (Unit I to IV)
2. Stark, John, ―Decision Engineering: Product Lifecycle Management:21st Century Paradigm for Product Realisation,2nd Edition, Springer London, 2011. (Unit II)
3. Antonio Borghesi, Barbara Gaudenzi: Risk Management: How to Assess, Transfer and Communicate Critical Risks: Perspectives in Business Culture, Illustrated Edition, Springer, 2012. (Unit III)
4. Norman Fenton, James Bieman: Software Metrics: A Rigorous and Practical Approach, 3rd edition, CRC Press, 2015. (Unit IV)

REFERENCE BOOKS

1. Project Management Institute: A Guide to the Project Management Body (PMBOK® Guide), August 2021
2. Harold Kerzner: Project Management - A Systems Approach to Planning, Scheduling, and Controlling, Sept 2017
3. Bob Hughes, Mike Cotterell and Rajib Mall: Software Project Management – Fifth Edition, 2012.
4. Erik Larson and Clifford Gray, Project Management -The Managerial Process, 6th Edition (SIE), July 2017
5. Adrienne Watt: Project Management - 2nd Edition, ISBN: 978-1-77420-012-4

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2		2				3	3	3	2	2	
CO2	3	2	2		2				3	3	3	2		2
CO3	3	2											2	
CO4	3	2			2						3		2	
CO5	3	2	2		2					2	3	2		2
Total	15	10	6		8				6	8	12	6	6	4
Score	3	2	2		2				3	3	3	2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1826	EDGE ANALYTICS	3	0	0	3

OBJECTIVES

- To understand the various computing paradigms and challenges of edge computing environment.
- To explore the various hardware needed for edge architecture.
- To learn about federated learning techniques and inferences at edge systems.
- To understand the technologies and components used to create an edge analytics application.
- To learn different applications of edge computing.

UNIT I INTRODUCTION TO NEW COMPUTING PARADIGMS 9

Introduction - Relevant Technologies - Fog and Edge Computing - Hierarchy of Fog and Edge Computing. Edge computing characteristics: Compute in context -- Capability oriented -- Centralized management, distributed computer -- Secured -- Heterogeneity; Edge computing scenarios -- IoT scenarios -- Hardware as a service -- Hybrid scenarios -- 5G scenarios.

UNIT II EDGE COMPUTING HARDWARE & SIMULATORS 9

Edge Computing Architecture: Edge Devices -- Edge Server-Cluster -- Cloud Server; Background Essentials: IoT Devices -- Sensors -- Actuators; Networking Architecture- Network Management and Control -- Orchestration; Edge Computing State-of-the-Art. Edge Computing Simulators: PureEdgeSim -- IoTSim-Edge -- iFogSim -- EdgeCloudSim.

UNIT III ARTIFICIAL INTELLIGENCE FOR EDGE COMPUTING 9

Artificial Intelligence Training at Edge: Distributed Training at Edge -- Vanilla Federated Learning (FL) at Edge -- Communication-Efficient FL -- Resource--Optimized FL -- Security-Enhanced FL;

Artificial Intelligence Inference in Edge: Optimization of AI Models in Edge -- Segmentation of AI Models -- Early Exit of Inference (EEoI) -- Sharing of AI Computation.

UNIT IV ANALYTICS AT EDGE 9

Edge Data Analysis: Challenge and Needs -- Combination of Big Data and Edge Data Process -- Architecture for Edge Data Process; Communication and Computation Modes for Edge: Integral Offloading -- Partial Offloading -- Vertical Collaboration -- Horizontal Collaboration. Working with Microsoft Azure IoT Hub -- Using the Raspberry Pi with Azure IoT Edge; Types of attacks against our edge analytics applications -- Protecting our edge analytics applications -- Monitoring and auditing our edge analytics applications.

UNIT V EDGE COMPUTING APPLICATIONS 9

Industrial Internet of Things (IIoT) Applications of Edge and Fog Computing: A Review and Future Directions - Leveraging Edge Computing for Mobile Augmented Reality.

Real-time Video Analytic - Autonomous Internet of Vehicles (IoVs) - Intelligent Manufacturing - Smart Home and City.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Describe the fundamentals and characteristics of edge computing.	**K2**
CO2	Apply the features of edge simulators and different hardware components to solve applications.	**K3**
CO3	Apply the advanced concepts and frameworks of edge AI.	**K3**
CO4	Apply the technologies used for edge analytics and developing solutions.	**K3**
CO5	Develop applications to solve real world problems using edge architecture and evaluate their performance.	**K5**

TEXTBOOKS

1. Rajkumar Buyya and Satish Narayana Srirama, Fog and Edge Computing Principles and Paradigms, Wiley, 2019. (Units 1- First half)
2. K. Anitha Kumari G. Sudha Sadasivam D. Dharani M. Niranjanamurthy, Edge Computing Fundamentals, Advances and Applications, CRC Press, 2022. (Units: 2)
3. Haishi Bai and Boris Scholl, Edge Computing and Capability-Oriented Architecture Taylor & Francis Group, CRC Press, First Edition 2022. (Unit 1 – Second Half)
4. Xiaofei Wang, Yiwen Han, Victor C.M.Leung, Dusit Niyato, Xueqiang Yan, Xu Chen Edge, AI Convergence of Edge Computing and Artificial Intelligence, Springer, 2020. (Units: 3, 4- first half, 5 – second half)
5. Wei Chang, Jie Wu Fog, Edge Computing for Security, Privacy, and Applications, Springer, 2021. (Unit 5 – first half)

REFERENCE BOOKS

1. Colin Dow, Hands-On Edge Analytics with Azure IoT- Design and develop IoT applications with edge analytical solutions including Azure IoT Edge, Packt Publishing, 2020. (Unit 4 – second half)
2. Atakan Aral, Vincenzo DeMaio, Edge Computing: Models, Technologies and Applications, December 2020, DOI: 10.1049/PBPC033E_ch14, Publisher: IET.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	2									2	3	
CO2	3	3											2	2
CO3	3	2								2		2	2	
CO4	3	2			2							2	2	
CO5	3	2	2									2	2	2
Total	15	12	4		2					2		8	11	4
Score	3	3	2		2					2		2	3	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1827	PRINCIPLES OF BLOCKCHAIN TECHNOLOGY	3	0	0	3

OBJECTIVES

- To Introduce basics of Block chain, structure and Merkle trees.
- To understand the process involved in mining and consensus.
- To learn about Hyper ledger framework and Ethereum.
- To introduce Bit coin network.
- To become familiar with Block chain use cases.

UNIT I INTRODUCTION TO BLOCKCHAIN 9

History of Blockchain, Types of Blockchain; Structure of block - block header-block identifiers-The Genesis block-linking blocks in the block chain - Merkle trees.

UNIT II MINING AND CONSENSUS 9

Introduction - Decentralized Consensus – Independent verification of transactions – Mining nodes - Aggregating transactions in to blocks - constructing the block header - Mining the block - Validating a new block.

UNIT III HYPERLEDGER FABRIC AND ETHEREUM 9

Hyperledger frameworks- Tools and Building blocks – Hyperledger fabric component design- Hyperledger fabric-The journey of a sample transaction- Hyperledger explored; Introduction to Ethereum - Ethereum Network - Components of Ethereum.

UNIT IV THE BITCOIN NETWORK 9

Peer to peer Network Architecture - Node types and roles – The extended Bitcoin Network – Network Discovery – Full nodes – Exchanging Inventory- Simplified payment verification nodes- Bloom filters – Bloom filters and Inventory updates – Transaction pools – Alert messages. Transaction Lifecycle, Transaction Structure, Transaction Outputs and Inputs, Transaction Fees, Adding Fees to Transactions, Transaction Chaining and Orphan Transactions.

UNIT V BLOCKCHAIN APPLICATIONS 9

Digital identity verification-Digital art: Blockchain attestation services – Notary - Intellectual Property protection – Key considerations and challenges in applying blockchain in government system - Internet of Things (IoT) technology - managing medical records.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Explain the basics of Blockchain, structure and Merkle trees.	**K2**
CO2	Apply mining and consensus to construct block chain	**K3**
CO3	Apply Hyperledger framework and Ethereum to build a blockchain.	**K3**
CO4	Experiment block chain in Bitcoin network.	**K3**
CO5	Justify the application of Blockchain to various use cases.	**K5**

TEXTBOOKS

1 Andreas Antonopoulos, “Mastering Bitcoin: Unlocking Digital Cryptocurrencies”, O'Reilly Media,2014.(Unit 1: Chapter 7; Unit II: Chapter 8; Unit IV: Chapter 5, 6)

2 Melanie Swan, O’Reilly “Blockchain - Blue print for a New Economy”,O'Reilly Media, 2015. (Unit 5: Chapter 3)

3 Salman A. Baset, Luc Desrosiers, Nitin Gaur, Petr Novotny, Anthony O'Dowd, Venkatraman Ramakrishna, “Hands-On Blockchain with Hyperledger Building Decentralized Applications with Hyperledger Fabric and Composer”, Packt Publishing, 2018. (Unit III: Chapter 2)

4 Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained”, Second Edition, Packt Publishing, 2018. (Unit 1: Chapter 1) (Unit III: Chapter 9,10)

REFERENCE BOOKS

1 Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldfeder, “Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction”, Princeton University Press, 2016.

2 Antonopoulos and G. Wood, “Mastering Ethereum: Building Smart Contracts and Dapps”, O’Reilly Publishing, 2018.

3 Daniel Drescher, " Blockchain Basics a Non-Technical Introduction in 25 Steps”. Apress, 2017.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO1 1**	**PO12**	**PSO 1**	**PSO2**
CO1	3													
CO2	3													
CO3	3	2			2									
CO4	3	2				2							2	
CO5	3	2	2			2				2		2	2	2
Total	15	6	2		2	4				2		2	4	2
Score	3	2	2		2	2				2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1863	PENETRATION TESTING AND VULNERABILITY ANALYSIS (TCP)	2	0	2	3

OBJECTIVES

- Understand the concepts of penetration testing as a means of securing systems.
- Know the working process to gather information and scan the target.
- Know the working process of exploitation and social engineering on the target.
- Learn how web application vulnerability assessment can be carried out by using tools.
- Learn to set security posture in an organization.

UNIT I INTRODUCTION TO PENETRATION TESTING 6

Defining Security Assessments - Overview of Penetration Testing Methodologies - Penetration Testing Steps - Overview of the Pen-Test Legal Framework - Automated Penetration Testing Tools - Overview of the Pen-Test Deliverables; Phases of a penetration test; penetration testing tools.

UNIT II RECONNAISSANCE AND SCANNING 6

Reconnaissance - HTTRACK website copier- Google directives practicing your google-Fu - attack of the drones; Scanning - pings and ping sweeps- port scanning - NMAP; vulnerability scanning.

UNIT III EXPLOITATION AND SOCIAL ENGINEERING 6

Exploitation - MEDUSA - METASPLOIT - Remote password cracking - LINUX password cracking - Wireshark; Social engineering - the basics of set - website attack vectors - QR Code through SET; Web hacking - NIKTO - W3AF.

UNIT IV WEB APPLICATION VULNERABILITIES 6

Approaches to Code Review - Black-Box Versus White-Box Testing - Code Review Methodology; Signatures of Common Vulnerabilities; Web Vulnerability Scanners - Burp suite.

UNIT V SECURITY POSTURE FOR ORGANIZATION 6

Setting Up - Monitor Mode - Capturing Packets - Open Wireless - Wired Equivalent Privacy; Wi-Fi Protected Access-The Enterprise Connection Process-The Personal Connection Process-The Four-Way Handshake-Cracking WPA/WPA2 Keys.

TOTAL PERIODS: 30

SUGGESTED EXPERIMENTS:

1. Perform Threat Modeling with Attack Trees and generated Rist Assessment Report
2. Carry out Penetration Test using various tools & Report with Mitigations
3. Perform Vulnerability Scanning for an organization.
4. Perform Exploitation for the systems and report.
5. Software Engineering Attacks
6. Password Cracking
7. Web Privacy and Anonymity

TOTAL PERIODS: 30

TOTAL PERIODS: 60

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Experiment with the different penetration testing tools.	**K3**
CO2	Apply various scanning techniques to collect information.	**K3**
CO3	Apply the various platform to gather knowledge on penetration testing	**K3**
CO4	Compare the web application vulnerability assessment.	**K5**
CO5	Explain to set security posture management for an organization.	**K2**

TEXTBOOKS

1. Patrick Engebretson, "The Basics of Hacking and Penetration Testing – Ethical Hacking and Penetration Testing Made Easy", Syngress Media, Second Revised Edition, Elsevier, 2013. ISBN :978-0-12-411644-3. (Unit 1,2,3)
2. Georgia Weidman, "Penetration testing A Hands-On Introduction to Hacking", San Francisco, 2014. (Unit 1,5)

REFERENCE BOOKS

1. Dafydd Stuttard& Marcus Pinto," The Web Application Hacker's Handbook, Finding and Exploiting Security Flaws Second Edition, ISBN: 978-1-118-02647-2. (unit 4).
2. Kimberly Graves, "CEH Official Certified Ethical Hacker Review Guide", Wiley publisher, 2007 (Unit 1)
3. Rafay Baloch, Ethical Hacking and Penetration Testing Guide, CRC Press, 2015. ISBN: 78-1-4822-3161-8.
4. Bugcrowd, "The Ultimate Guide to Penetration Testing", 2020 edition.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO1 1	PO12	PSO1	PSO2
CO1	3	2			2								2	
CO2	3	2			2								2	
CO3	3	2			2								2	
CO4	3	3	3		3	2				2		2	2	2
CO5	3												2	
Total	15	9	3		9					2		2	10	2
Score	3	2	2		2	2				2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1864	ADVANCED AI(TCP)	2	0	2	3

OBJECTIVES

- To recollect the concepts of Artificial Intelligence (AI), Machine Learning (ML), Deep Learning (DL) and Natural Language Processing (NLP) and its terminologies.
- To introduce the concept of generative modeling and AI, its framework, language models and applications.
- To familiarize concepts related to Explainable Artificial Intelligence (XAI) and interpretable methods, with emphasis on how to build a trustworthy AI system using XAI techniques.

UNIT 1 INTRODUCTION 6

Introduction: Artificial Intelligence (AI) - Understanding Machine Learning (ML) and Deep Learning (DL) - Types of Machine Learning: Supervised, Unsupervised, and Reinforcement Learning - Key concepts: Data sets, Algorithms, Model Training and Testing.

UNIT 2 GENERATIVE MODELING: BASICS AND FRAMEWORK 6

Generative Modeling: Generative Versus Discriminative Modeling - The Rise of Generative Modeling - Generative Modeling and AI- The Generative Modeling Framework - Generative Model Taxonomy - The Generative Deep Learning Codebase: Cloning the Repository- Using Docker - Running on a GPU.

UNIT 3 GENERATIVE AI LANGUAGE MODELS & APPLICATIONS 6

Generative AI Language Models: Rule-based, Statistical, and Neural Networks; Transformers: Introduction – GPT- Other Transformers: ChatGPT; The Current State of Generative AI: Large Language Models (LLM) - Text-to-Code Models (OR) Text-to-Image Models.

UNIT 4 EXPLAINABLE AI (XAI) 6

Introduction: Explainable AI - Need for and importance of XAI - Challenges in Explainability - Evaluating Explainability – Usage of Explainability: DARPA Uses Explainable AI to Build “Third-Wave AI”; Overview of Explainability: Explanations - Interpretability and Explainability Types of Explanations: Premodeling Explainability, Intrinsic Versus Post Hoc Explainability, Local, Cohort, and Global Explanations, Attributions, Counterfactual, and Example-Based Explanation.

UNIT 5 XAI TECHNIQUES 6

XAI Techniques: Tabular Model, Image Model and Text Model; LIME: LIME Working - Implementing LIME for Image data and Text data; SHAP (SHapley Additive exPlanations): Shapley Values - Visualizing Local Feature Attributions - Visualizing Global Feature Attributions - Interpreting Feature Attributions from Shapley Values; Explaining Tree-Based Models: From Decision Trees to Tree Ensembles - SHAP’s TreeExplainer.

TOTAL PERIODS(THEORY):30

SUGGESTED EXPERIMENTS

1. Implementation of ML models using the Datasets of UCI ML repository using scilkit learn libraries.
2. Synthesizing medical data for ML datasets using Generative AI.
3. Design and implementation of Chatbot using ChatGPT.
4. Generate a portfolio using appropriate LLM tool
5. Study of Existing XAI techniques and applying for Tabular Data
6. Implementation of appropriate ML models and Validation of Predicted outcome using LIME for two types of data: Image or Text
7. Implementation of appropriate ML models and Validation of Predicted outcome using SHAP LIME for Tabular Data.
8. Mini project using a combination of Generative AI with XAI (Teamwork)

TOTAL PERIODS(LAB):30

COURSE OUTCOMES

At the end of this course, student will be able to:

1. Explain the concepts of Artificial Intelligence (AI), Machine Learning (ML), Deep Learning (DL), Natural Language Processing (NLP) and its terminologies (K2)
2. Identify the need of Generative Modeling framework in AI (K3)
3. Analyze different types of Generative AI Language Models and apply to develop an application (K4)
4. Experiment the methods and terminologies involved in Explainable AI for small datasets (K3)
5. Choose the suitable techniques of XAI to develop use cases using XAI for real time applications (K5)

TEXTBOOKS

1. David Foster, Generative Deep Learning, 2nd Edition, May 2023, Publisher(s): O'Reilly Media, Inc. ISBN: 9781098134181 (Units 2,3)

2. Michael Munn, David Pitman, Explainable AI for Practitioners, October 2022, Publisher(s): O'Reilly Media, Inc., ISBN: 9781098119133 (Units 4, 5)

REFERENCE BOOKS

1. Uday Kamath and John Liu, Explainable Artificial Intelligence: An Introduction to Interpretable Machine Learning, Springer, ISBN 9783030833558, 2021
2. Tim Miller, Explanation in Artificial Intelligence: Insights from Social Science, https://arxiv.org/abs/1706.07269, 2019, Research paper
3. Explainable AI: A Review of Machine Learning Interpretability Methods, https://www.mdpi.com/1099-4300/23/1/18 4, 2021, Research paper

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2											2	
CO2	3	2	2	3									2	
CO3	3	2	3	3	2			3	3	3		3	2	2
CO4	3	2	2	3									2	
CO5	3	3	3	3	2			3	3	3		3	2	2
Total	15	11	10	12	4			6	6	6		6	10	4
Score	3	3	2	3	2			3	3	3		3	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1828	ROBOTICS	3	0	0	3

OBJECTIVES

- To introduce the fundamentals of robot programming
- To explain the fundamentals of Embedded programming
- To acquire knowledge for selection and calibration of sensors, actuator and how to interface with Robot
- To understand the Robot operating system fundamentals
- To understand the integration of Hardware controllers with ROS

UNIT I ROBOT FUNDAMENTALS 9

Robot Anatomy: Robot Configurations, Motions, Joint Notation; Work Volume – Robot Drive systems – Control Systems – Movement – End Effectors.

UNIT II EMBEDDED PROGRAMMING 9

Basic Embedded File system – hex files - Simulators and Emulators - Integrated development environments - commonly used IDE. Basics of Embedded C for Robot Programming.

UNIT III ROBOT PROGRAMMING INTERFACE 9

Sensor- Principle of sensors - Analog signal - Digital signal - I/O of Sensors – Calibration of sensors – Interfacing -Serial - I2C. Actuator – Types – I/O of Actuator, Direct control, and speed control, PWM, analog control. Programming and interfacing of sensors. Programming and interfacing of actuators.

UNIT IV ROBOT OPERATING SYSTEM 9

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

UNIT V BUILDING THE ROBOTS 9

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

TOTAL PERIODS:45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Explain the robot anatomy and robot building system.	**K2**
CO2	Develop basic embedded programs for robot.	**K3**
CO3	Build the robot with the sensor signal calibration, and actuator control.	**K3**
CO4	DevelopROS workspace to embed robotic programs.	**K3**
CO5	Construct a robot for its intelligent operation.	**K6**

TEXTBOOKS

1. Mikell P. Groover, "Industrial Robotics", McGraw Hill, 2nd edition, 2012. (Unit 1)
2. Lentin Joseph, Robot Operating System (ROS) for Absolute Beginners: Robotics Programming Made Easy, 1st Edition, APress, 2018. (Unit 4, 5)
3. Mark Siegesmund, “Embedded C Programming Techniques and Applications of C and PIC® MCUS”, Newnes, 2014 (Unit 2,3)

REFERENCE BOOKS

1. Jonathan Cacace; Lentin Joseph, Mastering ROS for Robotics Programming: Design, build, and simulate complex robots using the Robot Operating System, 2nd Edition, Packt Publishing, 2018.
2. John J. Craig, “Introduction to Robotics”, 3rd Edition, Addison Wesley, ISE 2008.
3. Jacob Fraden, “Handbook of Modern Sensors”, Springer 2016
4. W. Bolton, “Mechatronics”, Pearson, 2018

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2											2	
CO2	3	2											2	
CO3	3	2											2	
CO4	3	2											2	
CO5	3	2	3									2	2	2
Total	15	10	3		2							2	10	2
Score	3	2	3		2							2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1829	INFORMATION RETRIEVAL TECHNIQUES	3	0	0	3

OBJECTIVES

- To understand the basics of information retrieval with pertinence to modeling
- To understand various components of IR system
- To understand machine learning techniques for text classification and clustering
- To explore various IR applications.

UNIT I INTRODUCTION TO IRT AND VARIOUS MODELS 9

Basic Concepts: Retrieval process – Architecture – Boolean retrieval; IR Models: Taxonomy and characterization of IR models – Classical IR models – Alternative algebraic models – Models for Browsing – Retrieval Evaluation; LEMUR.

UNIT II INDEXING, QUERYING AND WEB LANGUAGES 9

Indexing: Inverted indices – Suffix trees – Suffix arrays – Compression; Querying: Query languages; Query Operations: Relevance feedback and query expansion; Semantic Web Technologies – Structured Web Documents – Describing Web Resources – Applications and Challenges – Rule Interchange Format (RIF) – SPARQL -Web Ontology Language – OWL.

UNIT III SEARCHING 9

Searching: Sequential searching – Pattern matching; Searching the Web: Characterizing the Web – Search engines – Browsing – Searching using hyperlinks. Search Engine Architectures: Search Engine Ranking – Simple Ranking Functions – Learning to Rank – Evaluations - Search Engine User Interaction – Browsing – Applications of a Web Crawler – Evaluation- INDRI SEARCH ENGINE.

UNIT IV TEXT CLASSIFICATION AND CLUSTERING 9

Text classification and Naive Bayes: The text classification problem - Naive Bayes text classification - The Bernoulli model - Properties of Naive Bayes - Feature selection - Evaluation of text classification. Vector space classification: Rocchio classification - SVM based text classification - Extensions to the SVM model: Flat and Hierarchical clustering for text; Matrix decompositions and latent semantic indexing.

UNIT V APPLICATIONS OF IR 9

XML Retrieval – Multimedia IR – Parallel and Distributed IR – Digital Libraries – Social Media Retrieval – Content-based Image Retrieval – Online Public Access Catalogs (OPACs).

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Apply the IR modeling techniques for the document retrieval problem and measure the performance of IR systems by making use of IR evaluation metrics.	**K3**
CO2	Construct the basic components of an IR system namely indexing and querying	**K3**

CO3	Explain the searching techniques for IR and Web	**K2**
CO4	Analyze machine learning techniques used in text classification and clustering for efficient Information Retrieval	**K4**
CO5	Demonstrate the use of IR applications in different domains	**K2**

TEXTBOOKS

1 Christopher D. Manning, Prabhakar Raghavan, Hinrich Schutze, "Introduction to Information Retrieval, Cambridge University Press, First South Asian Edition, 2008. (Unit-I, IV)

2 Ricardo Baeza-Yates, Berthier Ribeiro-Neto, "Modern Information Retrieval: The concepts and Technology behind Search ", (ACM Press Books), Second Edition, 2011. (Unit- II, III, V)

REFERENCE BOOKS

1 Crestani F,Mizzaro S, Scagnetto I," Mobile Information Retrieval" Germany : Springer International Publishing, 2017.

2 Stefan Buttcher, Charles L. A. Clarke, Gordon V. Cormack, "Information Retrieval: Implementing and Evaluating Search Engines, The MIT Press, Cambridge, Massachusetts London, England, 2016.

3 David A. Grossman, Ophir Frieder, Information Retrieval: Algorithms and Heuristics, Springer, 2nd edition, 2012.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2		2							2	2	
CO2	3	2		2									2	
CO3	3			2	2							2	2	2
CO4	3	2		2						2		2	2	2
CO5	2	2	2	2	2			2		2		2	2	2
Score	14	8	4	8	6			2		4		8	10	6
Course Mapping	3	2	2	2	2			2		2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1831	VIDEO PROCESSING AND ANALYTICS	3	0	0	3

OBJECTIVES

- To have a better knowledge about video representation and its formats.
- To know the fundamental concepts of data science and analytics.
- To familiarize with video processing tools for analytics.
- To understand data analytics for processing video content.
- To expose to emerging trends in video analytics.

UNIT I FUNDAMENTALS OF VIDEO PROCESSING 9

Basic Concepts and Terminology – Analog Video Standards – Digital Video Basics – Analog to Digital Conversion – Color Representation and Chroma Sub Sampling – Video Sampling Rate and Standards Conversion – Digital Video Formats – Video Features – Colour, Shape and Textural features.

UNIT II MOTION ESTIMATION 9

Fundamentals of Motion Estimation – Optical Flow – 2D and 3D Motion Estimation – Block Based Point Correspondences – Gradient Based Intensity Matching – Feature Matching – Frequency Domain Motion Estimation – 3D Motion and Structure Estimation

UNIT III VIDEO SEGMENTATION AND ANALYTICS 9

Video Segmentation – Video Shot Boundary Detection – Model Based Annotation – Video Mining – Multimodal Approach to Image and Video Data Mining – Probabilistic Semantic Mode.

UNIT IV VIDEO ANALYTICS USING DEEP LEARNING 9

Video Processing – Use cases of video analytics – Vanishing Gradient and exploding gradient problem – ResNet Architecture – ResNet and skip connections - Inception network – GoogleNet Architecture – Improvement in Inception v2 - Video Analytics: ResNet and Inception v3/v4.

UNIT V EMERGING TRENDS IN VIDEO PROCESSING 9

Affective Video Content Analysis – Parsing a Video into Semantic Segments – Video Indexing - Video Abstraction – Automatic Video Trailer Generation– Video in painting– Forensic Video Analysis.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Illustrate the basic video processing functions.	**K2**
CO2	Apply various motion estimation techniques.	**K3**
CO3	Apply video segmentation techniques	**K3**
CO4	Develop applications on video analytics using deep learning.	**K5**
CO5	Demonstrate video content analysis and indexing techniques.	**K3**

TEXTBOOKS

1. A. Murat Tekalp, “Digital Video Processing”, Second Edition, Prentice Hall, 2015.(Unit 1, 2,3)
2. Vaibhav Verdhan, “Computer Vision using Deep learning Neural network Architectures with Python and Keras”, Apress, 2021(Unit 4)
3. Alan Hanjalić, Content-Based Analysis of Digital Video, Springer, 2013 (Unit 5)

REFERENCE BOOKS

1. Oges Marques, “Practical Image and Video Processing Using MATLAB”, Wiley and Sons (IEEE Press), 2011. (Unit 1)
2. Caifeng Shan, Fatih Porikli, Tao Xiang, Shaogang Gong, Video Analytics for Business Intelligence, Springer, 2012.
3. Milan Sonka, Vaclav Hlavac, Roger Boyle, “Image Processing, Analysis and Machine Vision” 4th Edition, Thomson Learning, 2013

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2											2	
CO2	3	2											2	
CO3	3													
CO4	3	2	2	3	2				3	2				
CO5	3											2	2	2
Total	15	6	2	3	2				3	2		2	6	2
Score	3	2	2	3	2				3	2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1865	MOBILE APPLICATION DEVELOPMENT(TCP)	2	0	2	3

OBJECTIVES

- To facilitate students to understand mobile application design patterns.
- To help students to gain a basic understanding of Android application development.
- To inculcate working knowledge of Android Studio development environment.
- To understand the basis of iOS Programming

UNIT I Mobile Application Design Patterns 6

Introduction to Mobile Design Patterns; Navigation Patterns, Input and Content Patterns, Social and Collaboration Patterns

UNIT II Android Application Basis 6

First Android Application: Creating an Android Project, Navigating in Android Studio, Laying Out the User Interface, Wiring Up Widgets, setting listeners, Running on the Emulator; Activity, Intents, Layouts, Wigdets, UI fragments and arguments.

UNIT III Databases, Mutlithreading and Location services 6

SQLite Databases, Assets, Audio Playback with SoundPool, HTTP & Background Tasks, Location and Libraries.

UNIT IV iOS Programming Basics 6

A Simple iOS Application: Creating an Xcode Project, Interface Builder, Building the Interface, Model Layer, Building the Finished Application; Swift Language, Views, Views hierarchy, Working with text input.

UNIT V iOS UIControls and ViewController Containers 6

View Controllers, Programmatic Views,UITableView and UITableViewController, Editing UITableView, Stack Views, UINavigation Controller.

TOTAL PERIODS:(THEORY)30

SUGGESTED EXPERIMENTS:

1. Develop an application to simulate a keyboard.
2. Create an application that uses graphical primitives.
3. Develop an application that makes use of databases.
4. Develop a native application that uses GPS location information.
5. Implement an application that writes data to the SD card.
6. Implement an application that sends an SMS.
7. Create an alert upon receiving the SMS.
8. Develop an application to build an alarm clock.
9. Develop an application using Views, Views hierarchy.
10. Develop an application that uses UINavigation Controller.

TOTAL PERIODS:(LAB)30

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Identify various concepts of mobile application design patterns.	**K3**
CO2	Develop android mobile applications using layouts and widgets.	**K2**
CO3	Design mobile applications using database and other services.	**K6**
CO4	Develop simple mobile applications for the iOS that use basic concepts.	**K3**
CO5	Develop iOS mobile applications using UIControls and ViewController Containers.	**K3**

TEXTBOOKS

1. Neil, Theresa. Mobile design pattern gallery: UI patterns for smartphone apps. " O'Reilly Media, Inc.", 2014. (Unit 1)
2. Ranch, Big Nerd. "Android Programming: The Big Nerd Ranch Guide." (2015). (Unit 2,3)
3. Keur, Christian, and Aaron Hillegass. *iOS programming: the Big Nerd Ranch guide*. Pearson Technology Group, 2016. (Units 4, 5)

REFERENCE BOOKS

1. Reto Meier, “Professional Android 2 Application Development”, Wiley India Pvt Ltd
2. Mark L Murphy, “Beginning Android”, Wiley India Pvt Ltd
3. Android Application Development All in one for Dummies by Barry Burd, Edition: 1

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2											2	
CO2	3	2											2	
CO3	3	2	3	3	2					3		2	2	2
CO4	3	2											2	
CO5	3	2											2	
Total	15	10	3	3	2					3		2	10	2
Score	3	2	3	3	2					3		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1921	CYBER SECURITY	3	0	0	3

OBJECTIVES

- To know the cyber security principles, as well as the issues, policy and standards.
- To understand the difference between threat, risk, attack and vulnerability and how threats materialize into attacks.
- To be familiar with the typical threats, attacks and exploits and the motivations behind them.
- To study the defensive techniques against these attacks.
- To describe remedies for various existing cyber security breaches and to show the methodologies required to make future systems less prone to security failures.

UNIT I INTRODUCTION TO CYBER SECURITY 9

Basic Cyber Security Concepts, layers of security, Vulnerability, Threat, Harmful acts, Internet Governance - Controls - Authentication -Access Control and Cryptography – Challenges and Constraints, Computer Criminals, CIA Triad, Motive of Attackers, Taxonomy of various attacks, IP spoofing, Methods of defense, Security Models, risk management, Types of Cyber Threats.

UNIT II SECURITY IN OPERATING SYSTEMS & NETWORKS 9

Security in Operating Systems - Security in the Design of Operating Systems -Rootkit – Network Security Attack- Threats to Network Communications - Wireless Network Security - Denial of Service - Distributed Denial-of-Service.

UNIT III DEFENCES: SECURITY COUNTERMEASURES 9

Cryptography in Network Security - Firewalls - Intrusion Detection and Prevention Systems - Network Management - Databases - Security Requirements of Databases - Reliability and Integrity - Database Disclosure - Data Mining and Big Data. Cloud Security Tools & Techniques.

UNIT IV PRIVACY IN CYBERSPACE 9

Privacy Concepts -Privacy Principles and Policies -Authentication and Privacy - Data Mining - Privacy on the Web - Email Security - Privacy Impacts of Emerging Technologies - Where the Field Is Headed.

UNIT V MANAGEMENT AND INCIDENTS 9

Comprehensive Cyber Security Policy Security Planning - Business Continuity Planning – Handling Incidents - Risk Analysis - Dealing with Disaster - Emerging Technologies - The Internet of Things - Economics - Electronic Voting - Cyber Warfare- Cyberspace and the Law - International Laws - Cyber-crime - Cyber Warfare and Homeland Security.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Discuss the broad set of technical, social & political aspects of Cyber Security	**K2**
CO2	Identify the security aspects in OS and networks	**K3**
CO3	Identify and assess intrusions and possible mitigation solutions using firewall and intrusion detection system	**K3**
CO4	Identify the privacy issues and its impact in cyberspace	**K3**
CO5	Examine the risks and provide a comprehensive solution to build robust systems.	**K5**

TEXTBOOKS

1. Charles P. Pfleeger Shari Lawrence Pfleeger Jonathan Margulies, Security in Computing, 5th Edition, Pearson Education, 2018 (Unit I, II III, IV,V)
2. Nina Godbole, Sunit Belapure, "Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Wiley India Pvt. Ltd., 2011 (Unit IV, V)

REFERENCE BOOKS

1. B. B. Gupta, D. P. Agrawal, Haoxiang Wang, Computer and Cyber Security: Principles, Algorithms, Applications, and Perspectives, CRC Press, 2018.
2. George K.Kostopoulos, Cyber Space and Cyber Security, CRC Press, 2013.
3. Martti Lehto, Pekka Neittaanmäki, Cyber Security: Analytics, Technology and Automation, Springer International Publishing Switzerland 2015.
4. Chwan-Hwa (John) Wu, J. David Irwin, Introduction to Computer Networks and Cyber security, CRC Press T&F Group, 2013.
5. James Graham, Richard Howard and Ryan Otson, Cyber Security Essentials, CRC Press T&F Group, 2011

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12	PSO1	PSO 2
CO1	3												2	
CO2	3	2			2								2	
CO3	3	2		3	2								2	
CO4	3				2								2	
CO5	3	2	2		2	2				2		2	2	2
Total	15	6	2	3	8	2				2		2	10	2
Score	3	2	2	2	2	2				2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1921	MALWARE ANALYSIS (TCP)	2	0	2	3

OBJECTIVES

- To introduce the fundamentals of malware, types and its effects
- To enable to identify and analyse various malware types by static analysis
- To enable to identify and analyse various malware types by dynamic analysis
- To deal with detection, analysis, understanding, controlling, and eradication of malware

UNIT I INTRODUCTION AND BASIC ANALYSIS 6

Goals of Malware Analysis- AV Scanning, Hashing, Finding Strings, Packing and Obfuscation, PE file format, Static, Linked Libraries and Functions, Static Analysis tools, Virtual Machines and their usage in malware analysis, Sandboxing, Basic dynamic analysis, Malware execution, Process Monitoring, viewing processes, Registry snapshots, Creating fake networks.

UNIT II ADVANCED STATIC ANALYSIS 9

X86 Architecture- Main Memory, Instructions, Opcodes and Endianness, Operands, Registers, Simple Instructions, The Stack, Conditionals, Branching, Rep Instructions, Disassembly, Global and local variables, Arithmetic operations, Loops, Function Call Conventions, C Main Method and Offsets. Portable Executable File Format, The PE File Headers and Sections, IDA Pro, Function analysis, Graphing, The Structure of a Virtual Machine, Analyzing Windows programs, Anti-static analysis techniques, obfuscation, packing, metamorphism, polymorphism.

UNIT III ADVANCED DYNAMIC ANALYSIS 5

Live malware analysis, dead malware analysis, analyzing traces of malware, system calls, api calls, registries, network activities. Anti-dynamic analysis techniques, VM detection techniques, Evasion techniques, Malware Sandbox, Monitoring with Process Monitor, Packet Sniffing with Wireshark, Kernel vs. User-Mode Debugging, OllyDbg, Breakpoints, Tracing, Exception Handling, Patching,

UNIT IV MALWARE FUNCTIONALITY 5

Downloaders and Launchers, Backdoors, Credential Stealers, Persistence Mechanisms, Handles, Mutexes, Privilege Escalation, Covert malware launching- Launchers, Process Injection, Process Replacement, Hook Injection, Detours, APC injection, YARA rule-based detection.

UNIT V ANDROID MALWARE ANALYSIS 5

Android Malware Analysis: Android architecture, App development cycle, APKTool, APKInspector, Dex2Jar, JD-GUI, Static and Dynamic Analysis, Case studies.

TOTAL PERIODS:(THEORY)30

SUGGESTED EXPERIMENTS

1. Experimentation on Initial Infection Vectors and Malware Discovery
2. Implementation on Sandboxing Malware and Gathering Information from Runtime Analysis uisng IDA Pro, Cuckoo Sandbox
3. Implementation on Portable Executable (PE32) File Format uisng PE Explorer, OllyDBg
4. Implementation on Executable Metadata and Executable Packers
5. Experimentation on Malware Self - Defense, Compression, and

Obfuscation Techniques
6. Experimentation on Malware behaviour analysis using Procmon
7. Experimentation on analyzing Malicious Microsoft Office and Adobe PDF Documents
8. Experimentation on Mobile malware analysis uisng Androguard, MSTG, Dex2Jar
9. Experimentation on Packing and Unpacking of malware using UPX
10. Experimentation on Rootkit AntiForensics and Covert Channels uisng Autopsy tool
11. Experimentation on Modern Rootkit Analysis using GMER
12. Experimentation on Malware traffic analysis using wireshark

TOTAL PERIODS:(LAB)30

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Understand the various concept of malware analysis and their technologies used	**K2**
CO2	Apply independent analysis of modern malware samples using both static and dynamic analysis techniques	**K3**
CO3	Apply the methods and techniques used by professional malware analysts	**K3**
CO4	To be able to safely analyze, debug, and disassemble any malicious software by malware analysis	**K3**
CO5	Understand the concept of Android malware analysis their architecture, and App development	**K3**

TEXTBOOKS

1 Michael Sikorski and Andrew Honig, “Practical Malware Analysis” by No Starch Press, 2012, ISBN: 9781593272906 (Unit I, II, III,IV)

2 Ken Dunham, Shane Hartman, Manu Quintans, Jose Andre Morales, Tim Strazzere, "Android Malware and Analysis",CRC Press, Taylor & Francis Group, 2015, ISBN: 9781482252194 (Unit V)

REFERENCE BOOKS

1 Bill Blunden, “The Rootkit Arsenal: Escape and Evasion in the Dark Corners of the System”, Second Edition,Jones& Bartlett Publishers, 2009.

2 Jamie Butler and Greg Hoglund, “Rootkits: Subverting the Windows Kernel” by 2005, Addison-Wesley Professional, ISBN:978-0-321-29431-9

3 Bruce Dang, Alexandre Gazet, Elias Bachaalany, SébastienJosse, "Practical Reverse Engineering: x86, x64, ARM, Windows Kernel, Reversing Tools, and Obfuscation", 2014, ISBN: 978-1-118-78731-1.

4 Victor Marak, "Windows Malware Analysis Essentials" Packt Publishing, O’Reilly, 2015, ISBN: 9781785281518

5 Windows Malware Analysis Essentials by Victor Marak, Packt Publishing, 2015.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2		2	2				2		2	2	
CO2	3	2		3	2							2	2	
CO3	3	2			2							2	2	
CO4	3	2											2	
CO5	3	2											2	2
Total	15	10											2	
Score	3	2	2	3	2	2				2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1962	FINANCIAL DATA ANALYTICS	2	0	2	3

OBJECTIVES

- To understand the basics of finance data
- To learn about assets and volatility
- To understand the characteristics of high frequency finance data and its risks
- To learn estimation of stochastic models
- To learn about financial forensics

UNIT I INTRODUCTION TO FINANCIAL ANALYTICS 6

Introduction to Financial Analytics: Definition - relevance and scope - recent trends; Financial Time Series and Their Characteristics: Asset Returns - Distributional Properties of Returns - Review of Statistical Distributions - properties of financial time series

UNIT II ASSET VOLATILITY AND VOLATILITY MODELS 6

Characteristics of Volatility - Model Building - Testing for ARCH Effect - ARCH model - GARCH model - GARCH-M model - Exponential GARCH model.

UNIT III HIGH FREQUENCY FINANCIAL DATA ANALYSIS AND RISK 6

High-Frequency Data Analysis: Nonsynchronous Trading - Bid–Ask Spread of trading Prices - Empirical Characteristics of Trading Data - Models for Price Changes - Duration Models -Risk Measure and Coherence - Risk Metrics

UNIT IV ESTIMATION OF STOCHASTIC MODELS FOR FINANCE 6

Derivative Pricing: Issues regarding derivative markets - Brownian motion - Short-term interest rates models - Exponential Levy model - Black-Sholes model - Modeling derivative prices

UNIT V FINANCIAL FORENSICS AND ALGORITHMIC TRADING 6

Overview of common financial crimes and fraud schemes, Statistical methods for fraud detection (z-score, Benford's Law) and Machine learning approaches (Isolation Forest, Local Outlier Factor), Overview of financial algorithms - Moving Average Convergence Divergence (MACD), Arbitrage Algorithms, Algorithmic trading of high frequency data

TOTAL PERIODS:(THEORY)30

SUGGESTED EXPERIMENTS

1. Visualization of financial data and Implementation of linear time series – Prediction of Weekly Regular Gasoline Price
2. Asset Portfolio construction from BSE
3. Modeling Stock market volatility using ARCH/GARCH models.
4. Visualizing Empirical Characteristics of Trading Data
5. VaR estimation for IBM stocks
6. Estimation of Sectoral Index derivative

7. Anamoly detection in financial transactions
8. Mean Reversion Strategy in Algorithmic Trading

TOTAL PERIODS:(LAB)30

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Demonstrate knowledge on financial data and its characteristics	**K2**
CO2	Apply volatility models and understand risks in high frequency financial data	**K3**
CO3	Implement stochastic models on finance data for estimation	**K3**
CO4	Evaluate stochastic models for finance data.	**K5**
CO5	Analyze various financial algorithms and understand algorithmic trading	**K4**

TEXTBOOKS

1 Ruey S Tsay, Analysis of Financial Time Series, 3rd Edition,Wiley, 2010 (Unit 1,2,3)

2 Yves Hilpisch, Python for Finance (Mastering Data Driven Finance), 2nd Edition, Oreilly, 2018 (Unit 4)

3 Darrell D. Dorrell and Gregory A. Gadawski , Financial Forensics Body of Knowledge, Wiley, 1st Edition, 2012 (Unit 5)

REFERENCE BOOKS

1 Bernhard Pfaff , “Financial risk modelling and portfolio optimization with R”, Wiley, ISBN 978-0-470-97870, 2013

2 John L. Teall, "Financial Trading and Investing" 3rd Edition, Elsiever, 2022.

3 Cairns, A.J. G , “Interest Rate Models: An Introduction”, Princeton University Press, ISBN: 9780691118949, 2004

4 Argimiro Arratia, “Computational Finance an Introductory Course with R”, Atlantis Press, ISBN 978-94-6239-069-0, 2014

5 Duffie, D. and Singleton, K.J, “Credit Risk: Pricing, Measurement, and Management”, Princeton University Press, ISBN: 9780691090467, 2003

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2										2	
CO2	3	2	2	2	2							2	2	2
CO3	3	2		2	2					2		2	2	2
CO4	3	2	2	2	2					2		2	2	2
CO5	3	2	2	2									2	
Score	15	11	8	8	6					4		6	10	6
Course Mapping	3	3	2	2	2					2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1963	CLOUD COMPUTING	2	0	2	3

OBJECTIVES

- To understand the principles of cloud architecture, models and infrastructure.
- To understand the concepts of virtualization and virtual machines.
- To gain knowledge about virtualization Infrastructure.
- To explore and experiment with various Cloud deployment environments.
- To learn about the security issues in the cloud environment.

UNIT I CLOUD ARCHITECTURE AND MODELS 6

Cloud Architecture: System Models for Distributed and Cloud Computing – NIST Cloud Computing Reference Architecture – Cloud Characteristics – Cloud deployment models – Cloud service models – Pros and Cons of Cloud; Cloud Infrastructure: Architectural Design of Compute and Storage Clouds – Design Challenges

UNIT II INTRODUCTION TO VIRTUALIZATION 6

Basics of Virtualization – Virtualization Types – Implementation Levels of Virtualization – Virtualization Structures / Tools and Mechanisms – Virtualization of CPU, Memory, I/O Devices – Virtual Clusters and Resource management -Taxonomy of Virtual Machines.

UNIT III VIRTUALIZATION INFRASTRUCTURE AND DOCKER 7

Desktop Virtualization – Network Virtualization – Storage Virtualization – System-level of Operating Virtualization – Application Virtualization – Virtual clusters and Resource Management – Containers vs. Virtual Machines – Introduction to Docker – Docker Components – Docker Container – Docker Images and Repositories.

UNIT IV CLOUD DEPLOYMENT ENVIRONMENT 6

Google App Engine – Amazon AWS – Microsoft Azure; Cloud Software Environments – Eucalyptus – OpenStack.

UNIT V CLOUD SECURITY 5

Virtualization System-Specific Attacks: Guest hopping – VM migration attack – hyperjacking. Data Security and Storage; Identity and Access Management (IAM) - IAM Challenges - IAM Architecture and Practice.

TOTAL PERIODS (THEORY):30

SUGGESTED EXPERIMENTS

1. Install Virtualbox/VMware/ Equivalent open-source cloud Workstation with different flavours of Linux or Windows OS on top of windows 8 and above.
2. Install a C compiler in the virtual machine created using a virtual box and execute Simple Programs
3. Install Google App Engine. Create a Hello World app and other simple web applications using python/java.
4. Use the GAE launcher to launch the web applications.

5. Simulate a cloud scenario using CloudSim and run a scheduling algorithm that is not present in CloudSim.
6. Find a procedure to transfer the files from one virtual machine to another virtual machine.
7. Install Hadoop single node cluster and run simple applications like wordcount.
8. Creating and Executing Your First Container Using Docker.
9. Run a Container from Docker Hub

TOTAL PERIODS:(LAB)30

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Design, Develop & Demonstrate real-world applications from the Cloud Computing	K3
CO2	Apply the concept of virtualization and analyze its types	K3
CO3	Experiment with virtualization of hardware resources and Docker.	K5
CO4	Build the cloud environment to deploy the infrastructure and platform as a service.	K6
CO5	Describe the security management models in cloud	K2

TEXTBOOKS

1 Kai Hwang, Geoffrey Fox, Jack J. Dongarra, Morgan Kaufmann, "Distributed and Cloud Computing: From Parallel Processing to the Internet of Things," 1st Edition, 2011. (Unit 1,2)

2 George Recse, "Cloud Application Architectures: Building Application and Infrastructure in the Cloud", O' Reilly Media, First Edition, 2009.

3 Tim Mather, Subra Kumaraswamy, Shahed Latif, "Cloud Security and Privacy: an enterprise perspective on risks and compliance", O'Reilly Media, 2009. (Unit V)

REFERENCE BOOKS

1 James Turnbull, "The Docker Book", O'Reilly Publishers, 2014.

2 Rajkumar Buyya, James Broberg, Andrzej Goscinski, "Cloud Computing Principles and Paradigms", John Wiley & Sons, 2011.

3 John Rhoton and Risto Haukiojal, "Cloud Computing Architectured : Solution Design Handbook", Recursive Press, 2013.

4 Krutz, R. L., Vines, R. D, "Cloud security. A Comprehensive Guide to Secure Cloud Computing", Wiley Publishing, 2010.

5 Samee. U. Khan, Albert. Y. Zomaya, "Handbook on Data Centers", Springer, 2015.

6 Kris Jamsa, "Cloud Computing", Jones & Barlett Learning, 2013.

7 Srinivasan A, Suresh J, "Cloud Computing: A practical Approach for Learning and Implementation", Pearson Education India, 2014.

8 James E Smith, Ravi Nair, "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO1 1	PO12	PSO 1	PSO2
CO1	3	2												
CO2	3	2											2	
CO3	3	3	2	2	2				2	2			2	
CO4	3	3	2	2	2				2	2			2	2
CO5	3	2										2		2
Total	15	12	4	4	4				4	4		2	6	4
Score	3	2	2	2	2				2	2		2	2	2

COURSE CODE	COURSETITLE	L	T	P	E	C
ICS1964	GAME PROGRAMMING	2	0	2	0	3

OBJECTIVES

- To know the basics of 2D and 3D graphics for game development
- To know the stages of game development.
- To understand the basics of a game engine.
- To survey the gaming development environment and tool kits.
- To learn and develop simple games.

UNIT I 3D GRAPHICS FOR GAME DESIGN 6

Genres of Games, Basics of 2D and 3D Graphics for Game Avatar, Game Components – 2D and 3D Transformations – Projections – Color Models – Illumination and Shader Models – Animation – Controller Based Animation.

UNIT II GAME DESIGN PRINCIPLES 6

Character Development, Storyboard Development for Gaming – Script Design – Script Narration, Game Balancing, Core Mechanics, Principles of Level Design – Proposals – Writing for Preproduction, Production and Post – Production.

UNIT III GAME ENGINE DESIGN 6

Rendering Concept – Software Rendering – Hardware Rendering – Spatial Sorting Algorithms – Algorithms for Game Engine– Collision Detection – Game Logic – Game AI – Pathfinding.

UNIT IV OVERVIEW OF GAMING PLATFORMS AND FRAMEWORKS 6

Pygame Game development – Unity – Unity Scripts –Mobile Gaming, Game Studio, Unity Single player and multi-Player games.

UNIT V GAME DEVELOPMENT USING PYGAME 6

Developing 2D and 3D interactive games using Pygame – Avatar Creation – 2D and 3D Graphics Programming – Incorporating music and sound – Asset Creations – Game Physics algorithms Development – Device Handling in Pygame – Overview of Isometric and Tile Based arcade Games– Puzzle Games.

TOTAL PERIODS:(THEORY)30

SUGGESTED EXPERIMENTS

1. Installation of a game engine, e.g., Unity, Unreal Engine, familiarization of the GUI. Conceptualize the theme for a 2D game.
2. Character design, sprites, movement, and character control
3. Level design: design of the world in the form of tiles along with interactive and collectible objects.

4. Design of interaction between the player and the world, optionally using the physics engine.
5. Developing a 2D interactive using Pygame
6. Developing a Puzzle game
7. Design of menus and user interaction in mobile platforms.
8. Developing a 3D Game using Unreal
9.Developing a Multiplayer game using unity

TOTAL PERIODS:(LAB)30

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Explain the concepts of 2D and 3D Graphics.	**K3**
CO2	Design the game design documents.	**K3**
CO3	Build the gaming engines	**K5**
CO4	Survey gaming environments and frameworks.	**K3**
CO5	Build simple games using gaming softwares	**K6**

TEXTBOOKS

1 Sanjay Madhav, "Game Programming Algorithms and Techniques: A Platform Agnostic Approach", Addison Wesley,2013. (Unit-4)

2 Will McGugan, "Beginning Game Development with Python and Pygame: From Novice to Professional", Apress,2007. (Unit-5)

REFERENCE BOOKS

1 Paul Craven, "Python Arcade games", Apress Publishers,2016

2 David H. Eberly, "3D Game Engine Design: A Practical Approach to Real-Time Computer Graphics", Second Edition, CRC Press,2006. (Unit-2,3)

3 Jung Hyun Han, "3D Graphics for Game Programming", Chapman and Hall/CRC, 2011. (Unit-1,2)

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	3	2												
CO3	3	3	2	2	2				2	2			2	2
CO4	3	3												
CO5	3	2	2	2	2				2	2		2	2	2
Total	15	12	4	4	4				4	4		2	4	4
Score	3	2	2	2	2				2	2		2	2	2

COURSE CODE	COURSETITLE	L	T	P	C
ICS1922	BIOINFORMATICS	3	0	0	3

OBJECTIVES

- Understand the concept and need of Bioinformatics.
- Transform biological data into knowledge and perform data analysis.
- Learn the machine learning algorithms for bioinformatics.
- Learn hidden Markov modeling and probabilistic modeling.
- Know the importance of microarray data analysis.

UNIT I INTRODUCTION 9

Introduction to Bioinformatics: Need for Bioinformatics technologies – Overview of Bioinformatics technologies; Overview of structural bioinformatics: Organization of Structural bioinformatics – Primary resource: protein data bank – Secondary resources and applications.

UNIT II DATAWAREHOUSING AND DATAMINING IN BIOINFORMATICS 9

Data warehousing in Bioinformatics: Bioinformatics data – Transforming data to knowledge – Data warehousing architecture – Data quality; Data mining for Bioinformatics: Biomedical data analysis – DNA data analysis – Protein data analysis.

UNIT III MACHINE LEARNING IN BIOINFORMATICS 9

Machine learning in Bioinformatics: Artificial Neural network – Neural network architecture and applications – Genetic algorithm – Fuzzy system.

UNIT IV MODELING FOR BIOINFORMATICS 9

Modeling for Bioinformatics: Hidden Markov modeling for biological data analysis – Comparative modeling – Probabilistic modeling – Molecular modeling.

UNIT V MICROARRAY DATA ANALYSIS 9

Microarray Data Analysis: Microarray technology for genome expression study – Image analysis for data extraction – Data Analysis for Pattern Discovery.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Explain the concept and need of bioinformatics	**K2**
CO2	Experiment the importance of genome and protein data using data mining techniques	**K3**
CO3	Apply machine learning algorithms on bioinformatics data	**K3**
CO4	Apply Hidden Markov Modeling and probabilistic modeling for bioinformatics data	**K3**
CO5	Analyse the importance of microarray technology using Gene Expression Data	**K4**

TEXTBOOKS

1 Yi-Ping Phoebe Chen (Ed), “Bioinformatics Technologies”, First Indian Reprint, Springer Verlag, 2007.

REFERENCES

1 Arthur M Lesk, “Introduction to Bioinformatics”, Fourth Edition, Oxford University Press,2008

2 Rui Jiang, Xuegong Zhang, Michael Q Zhang, “Basics of Bioinformatics”, Tsinghua University Press, Springer, 2013

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11		PO12	PSO1	PSO2
CO1	3														
CO2	3	2	2											2	
CO3	3	2	2											2	2
CO4	3	2	2											2	
CO5	3	2	2											2	2
Total	15	8	8		2								2	8	4
Score	3	2	2		2								2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1923	REALTIME SYSTEMS	3	0	0	3

OBJECTIVES

- To understand the real time environment and model
- To explore the concepts of real time communication and operating system
- To build systems for real time use cases

UNIT I REAL TIME ENVIRONMENT 9

Introduction to Real-Time Systems - Functional Requirements - Temporal Requirements - Dependability Requirements - Classification of Real-Time Systems - The Real Time systems Market – Examples of Real Time Systems

UNIT II REAL TIME MODEL AND TEMPORAL RELATIONS 9

Model Outline - Component State - The Message Concept - Component Interfaces - Gateway Component - Linking Interface Specification - Component Integration - Temporal Relations:Real-Time Entities - Observations - Real-Time Images and Real-Time Objects - Temporal Accuracy - Permanence and Idempotency - Determinism

UNIT III REAL TIME COMMUNICATION AND OPERATING SYSTEM 9

Requirements - Design Issues - Event-Triggered Communication - Rate-Constrained Communication - Time-Triggered Communication - Inter-Component Communication - Task Management - The Dual Role of Time - Inter-task Interactions - Process Input and Output

UNIT IV REAL TIME SCHEDULING 9

The Scheduling Problem - Worst-Case Execution Time of Simple Tasks and Complex tasks - Static Scheduling - Dynamic Scheduling of dependent and independent tasks - Alternative Scheduling Strategies

UNIT IV SYSTEM DESIGN 9

System Design - Design Phases - Design Styles - Design of Safety-Critical Systems - Design Diversity - Design for Maintainability.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Explain real time environment	**K2**
CO2	Apply temporal models for real time use cases	**K3**
CO3	Solve challenges in real time communication and OS	**K3**
CO4	Analyse worst case execution time for real time scheduling examples	**K4**
CO5	Design system models for real time use-cases	**K5**

TEXTBOOKS

1 Hermann Kopetz, “Real-Time Systems - Design Principles for Distributed Embedded Applications, Third Edition”, Springer, 2022 (All the Units)
2 C.M. Krishna, K.G. Shin, “Real-Time Systems”, McGraw Hill, 2017 (Unit 4)

REFERENCE BOOKS

1 Jim Cooling, “The Complete Edition - Software Engineering for Real-Time Systems”, Packt publishing, 2019

2 Rajib Mall, “Real Time Systems”, Pearson, 2006

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO 1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
CO1	3	2												
CO2	3	2												
CO3	3	2											2	
CO4	3	2											2	
CO5	3	3	2							2			2	2
Score	15	10	2							2			6	2
	3	2	2							2			2	2

COURSECODE	COURSETITLE	L	T	P	E	C
ICS1924	NETWORK AND SERVER SECURITY	3	0	0	0	3

OBJECTIVES

- To study about the essentials of computer security
- To acquire knowledge on TCP/IP security, firewalls, IPSec, Virtual Private Networks, and intrusion detection systems
- To understand how various security mechanisms work and correlate these security mechanisms with security principles.
- To learn the security aspects of data center
- To learn the security protocols and technologies with respect to infrastructure.

UNITI INTRODUCTION 9

ComputerSecurityConcepts–SecurityAttacks–SecurityServices-SecurityMechanisms-AModel forNetworkSecurity-Standards.AttackonPublicKeyCryptography–PublicKeyCertificates: X.509Authenticationservices–Attacks on PKI–Types of Digital Certificates.

UNIT II SECURITYPRACTICES &SYSTEMSECURITY 9

Internet Firewalls for Trusted System: Roles of Firewalls – Types of Firewalls – Net filter – Iptables FirewalldesignPrinciples–DNSAttacks–CachePoisoning–SET(SecureElectronicTransaction) for E-Commerce Transactions. Intruder – Intrusion detection system – Virus and related threats – Countermeasures.

UNIT III IP &WEB SECURITY 9

IP Security: Overview of IPsec – IP and IPv6 – Authentication Header – Encapsulation Security Payload (ESP) – Internet Key Exchange; Web Security: SSL/TLS Basic Protocol – Computing the keys – Client authentication – PKI as deployed by SSL Attacks fixed in v3 – Exportability-Encoding - SET.

UNIT IV DATACENTERSECURITYOVERVIEW 9

Data center security overview: Need for a secure data center – Vulnerabilities and common attacks; Network Security Infrastructure; Security Fundamentals; Datacenter security frame- works: Security policies – Security lifecycle; Secure Management Framework.

UNI TV SECURITYPROTOCOLSANDTECHNOLOGIES 9

Security Protocols and Technologies: Cryptography – PKI – Transport Security – Authentication Protocols and Technologies; Network management security; Integrating security into the infrastructure: Defining security zone – Internet Edge – Intranet Server Farm – Server-Farm Design Alternative – Management Network.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Summarize the essentials of computer security	K2
CO2	Experiment the security practices available in system security	K3
CO3	Determine the security practices followed in email, IP and web security	K5
CO4	Select the security aspects in designing a data center	K3
CO5	Design the security protocols for the infrastructure	K3

TEXTBOOKS

1. William Stallings, "Network Security Essentials: Applications and Standards", Sixth Edition, Pearson, 2017.
2. Mauricio Arregoces, Maurizio Portolani,"DataCenterFundamentals", CiscoPress, 2003.

REFERENCES

1. Charlie Kaufman, RadiaPerlmanandMikeSpeciner,"NetworkSecurity:Private Communication in a Public World", Second Edition, Pearson Education, 2017.
2. WenliangDu, "ComputerSecurity:AHands-onApproach",CreateSpaceIndependent Publishing Platform, First Edition, 2017.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2											2	
CO2	3	2											2	
CO3	3	2											2	
CO4	3	2											2	
CO5	3	2											2	
Total	15	10											10	
Score	3	2											2	

COURSE CODE	COURSETITLE	L	T	P	C
ICS1925	PRIVACY AND SECURITY IN IOT	3	0	0	3

OBJECTIVES

- To be familiar with the state-of-the-art methodologies in Cyber Physical system
- To study the crypto foundations required in Internet of Things (IoT)
- To explore the Privacy Preservation for Internet of Things (IoT)
- To explore Trust Models in Internet of Things (IoT)
- To apply the concept of Internet of Things Security in the real-world scenarios

UNIT I CYBER PHYSICAL SYSTEMS AND INTERCONNECTION OF THREATS 9

IoT and cyber-physical systems – IoT security (vulnerabilities, attacks, and countermeasures): security engineering for IoT development – IoT security lifecycle; Network Robustness of Internet of Things – Sybil Attack Detection in Vehicular Networks – Malware Propagation and Control in Internet of Things – Solution-Based Analysis of Attack Vectors on Smart Home Systems.

UNIT II PRIVACY PRESERVATION FOR IOT 9

Privacy Preservation Data Dissemination – Privacy Preservation Data Dissemination – Social Features for Location Privacy Enhancement in Internet of Vehicles – Lightweight and Robust Schemes for Privacy Protection in Key Personal IoT Applications: Mobile WBSN and Participatory Sensing

UNIT III TRUST MODELS FOR IOT 9

Authentication in IoT – Computational Security for the IoT – Privacy-Preserving Time Series Data Aggregation – Secure Path Generation Scheme for Real-Time Green Internet of Things – Security Protocols for IoT Access Networks – Framework for Privacy and Trust in IoT – Policy-Based Approach for Informed Consent in Internet of Things.

UNIT IV INTERNET OF THINGS SECURITY 9

Security and Impact of the Internet of Things (IoT) on Mobile Networks – Networking Function Security-IoT Networking Protocols, Secure IoT Lower Layers – Secure IoT Higher Layers –Secure Communication Links in IoTs – Back-end Security – Secure Resource Management –Secure IoT Databases – Security Products-Existing Test bed on Security and Privacy of IoTs –Commercialized Products.

UNIT V SOCIAL AWARENESS 9

User-Centric Decentralised Governance Framework for Privacy and Trust in IoT: Social Security Framework- Device-Centric Enablers for Privacy and Trust; Policy-Based Approach
for Informed Consent IoT: Dynamic and context-aware approach - Policy-based framework-Application of the SecKit framework; Security and Impact of the Internet of Things (IoT) on Mobile Networks

TOTAL PERIODS: 45

COURSE OUTCOMES

CO1	Summarize the areas of cyber security for the Internet of Things	**K2**
CO2	Make use of privacy preservation methods for IoT	**K3**
CO3	Make use of privacy protection in IoT application	**K3**
CO4	Build an IoT model for real-time data	**K5**
CO5	Solve IoT security problems using light weight cryptography	**K3**

TEXTBOOKS

1. Hu Fei, Security, and privacy in Internet of things (IoTs): Models, Algorithms, and Implementations, 1st edition, CRC Press, 2016. (Unit I - V)
2. Russell, Brian, and Drew Van Duren, Practical Internet of Things Security, 1st edition, Packt Publishing Ltd, 2016.

REFERENCE BOOKS

1. Whitehouse O, Security of things: An implementers' guide to cyber-security for internet of things devices and beyond, 1st edition, NCC Group, 2014.
2. DaCosta, Francis, and Byron Henderson, Rethinking the Internet of Things: a scalable approach to connecting everything, 1st edition, Springer Nature, 2013.
3. Zaigham Mahmood, Security, Privacy and Trust in the IoT Environment, Springer, ISBN: 9783030180744, 2019.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	3													
CO3	3	3				2				3			2	3
CO4	3	2											2	
CO5	3	3	3		3							2	2	3
Total	15	10	3		3	2				3		2	6	6
Score	3	3	3		3	2				2		2	2	3

COURSE CODE	COURSETITLE	L	T	P	C
ICS1965	EXPLORATORY DATA ANALYSIS(TCP)	2	0	2	3

OBJECTIVES

- To outline an overview of exploratory data analysis
- To perform univariate and bivariate data exploration and analysis
- To use data exploration and visualization techniques for multivariate and time series data
- To gain meaningful insights from raw data to support decision-making, identify patterns, and extract valuable information.

UNIT I FUNDAMENTALS OF EXPLORATORY DATA ANALYSIS 6

Exploratory Data Analysis (EDA) Fundamentals: Significance of EDA - Making sense of data – Software tools for EDA; Visual Aids for EDA: Scatter plot, Bubble chart, Area plot, stacked plot, table chart, Polar chart, Lollipop chart, Choosing the best chart.

UNIT II UNIVARIATE ANALYSIS 6

Introduction to Single Variables: Summaries of levels and spread – Choosing between measures – Individual and aggregate level data; Scaling and Standardizing.

UNIT III BIVARIATE ANALYSIS 6

Relationship between two Variables: Percentage Tables - Analyzing Contingency Tables - Handling Several Batches: Multiple boxplots -T-test.

UNIT IV MULTIVARIATE ANALYSIS 6

Causal Explanations – Three-variable Contingency Tables: Trust and reciprocity – Controlling for a prior variable – Causal path models for three variables – logistic regression models – More complex model-Going beyond three variables – Estimating a more complex model with interactions.

UNIT V TIME-SERIES ANALYSIS 6

Understanding Time-series Dataset – Time-series Analysis with Open Power System Data: Data Cleaning – Time-based indexing – Visualizing – Grouping – Resampling; Introduction to Data Visualization Tool: Tableau.

TOTAL PERIODS:(THEORY)30

SUGGESTIVE EXPERIMENTS

1. Perform EDA on simple datasets using plots and charts (E.g., Boston Housing dataset, Online Retail dataset)
2. Conduct EDA to analyze the data patterns and the behavior of data (Analyzing email data to find out the usage patterns and communication behaviors)
3. Generate percentage tables and contingency tables for real time scenarios (Any customer-product dataset analyzing the relationship between two variables)
4. Demonstrate simple problems showing how a third variable controls the relationship between two variables (Identify the relationship among multiple variables for Titanic dataset)

5. Visualizing time series data (E.g., Open Power System Dataset).
6. Perform EDA on a sample dataset and generate report using any data visualization tool. (E.g., Wine Quality Data Set).

TOTAL PERIODS:(LAB)30

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Apply visual aids for exploratory data analysis and demonstrate the fundamentals of EDA.	**K3**
CO2	Apply univariate data exploration techniques for analyzing the data.	**K3**
CO3	Make use of bivariate data exploration techniques for data analysis.	**K3**
CO4	Apply multivariate analysis techniques to demonstrate the causal dependence among the variables.	**K3**
CO5	Analyze the time-series data by applying exploratory analysis techniques.	**K4**

TEXTBOOKS

1 Suresh Kumar Mukhiya, Usman Ahmed, “Hands-On Exploratory Data Analysis with Python”, Packt Publishing, 2020. (Unit 1,5)

2 Catherine Marsh, Jane Elliott, “Exploring Data: An Introduction to Data Analysis for Social Scientists”, Wiley Publications, 2nd Edition, 2008. (Unit 2,3,4)

REFERENCE BOOKS

1 Jake Vander Plas, "Python Data Science Handbook: Essential Tools for Working with Data", First Edition, O Reilly, 2017

2 Ayodele Oluleye, “Exploratory Data Analysis with Python Cookbook", Packt Publishing, 2023

3 Eric Pimpler, “Data Visualization and Exploration with R”, GeoSpatial Training service, 2017.

4 Claus O. Wilke, “Fundamentals of Data Visualization”, O’reilly publications, 2019

5 Daniel G Murray, Tableau your Data! Fast and Easy Visual Analysis with Tableau Software, Wiley, second edition, 2016 (Unit 5)

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2											2	
CO2	3	2	2		2					2			2	
CO3	3	2											2	
CO4	3	2											2	
CO5	3	2	3	2	2					2		2	2	2
Total	15	10	5	2	4					4		2	10	2
Score	3	2	3	2	2					2		2	2	2

COURSE CODE	COURSETITLE	L	T	P	C
ICS1926	MULTIVARIATE STATISTICAL ANALYSIS	3	0	0	3

OBJECTIVES:

- To understand the basic concepts of random vectors and matrices.
- To represent a model for multivariate data.
- To develop different inference methods, such as Multivariate Analysis of Variance (MANOVA).
- To predict the value of one dependent variable based on two or more independent variables using Multiple linear regression model.
- To represent the directions of the data that explain a maximal amount of variance

UNIT 1: MATRICES AND RANDOM VECTORS 9

Basics of Matrices – Positive Definite Matrices – Square Root Matrices - Random vectors – Mean vectors and covariance matrices – Matrix Inequalities and Maximization.

UNIT 2: MULTIVARIATE NORMAL DISTRIBUTION 9

Multivariate Normal density and its properties – Sampling from a Multivariate normal distribution and Maximum Likelihood estimation – Detecting Outliers and Cleaning Data – Transformation to near normality.

UNIT 3: COMPARISONS OF SEVERAL MULTIVARIATE MEANS 9

Comparing mean vectors from two populations – One way MANOVA (Multivariate ANOVA) Simultaneous Confidence Interval for Treatment effects – Testing for equality of Covariance Matrices.

UNIT 4: MULTIVARIATE LINEAR REGRESSION 9

Classical Linear Regression Model -Least Square Estimation-Inferences about the Regression Model – Inferences from the Estimated regression function- Multiple regression model with time dependent errors.

UNIT:5 PRINCIPAL COMPONENTS 9

Principal components – Population principal components – Principal components from standardized variables - Principal Components for covariance matrices – Summarizing sample variation by Principal Components – Graphing the Principal Components.

TOTAL PERIODS (THEORY): 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Builds the foundation for the statistical analysis of multivariate data.	**K3**
CO2	apply the properties of the multivariate normal distribution and apply in various fields such as statistics, finance, and machine learning where multivariate data analysis is common.	**K3**
CO3	Examine for statistical differences on multiple continuous dependent variables by an independent grouping variable.	**K3**
CO4	apply the basics of classical linear regression modeling, estimation,	**K3**

	inferences, and their extension to multivariate settings and time-dependent data.	
CO5	Analyze data for principal components and perform dimension reduction	**K4**

TEXTBOOKS:

1. Johnson, R.A. & Wichern, D.W., Applied Multivariate Statistical Analysis (6th ed.), Pearson Prentice Hall, 2007.
2. I.T. Jolliffe, Principal component analysis: A beginner's guide - I. Introduction and application, 1990.

REFERENCE BOOKS

1. Gupta S. C., Kapoor V. K., Fundamentals of Mathematical Statistics, Sultan and Sons, New Delhi, 2001.
2. Richard A. Johnson and Dean W. Wichern, Applied Multivariate Statistical Analysis, Pearson Education, Asia, 5 Edition, 2002.
3. Giri, N.C., Multivariate Statistical Analysis (2nd ed., Revised and Expanded), Marcel Dekker, 2004.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										
CO2	3	2										1
CO3	3	2										1
CO4	3	2										
CO5	3	2										1
Total	15	10										3
Score	3	2										1

COURSE CODE	COURSETITLE	L	T	P	C
ICS1927	PRINCIPLES OF REINFORCEMENT LEARNING	3	0	0	3

OBJECTIVES

- To understand the basics of reinforcement learning techniques
- To explore various methods used in reinforcement learning
- To apply reinforcement learning techniques for solving real-world problems

UNIT I INTRODUCTION 9

Reinforcement Learning – Elements of Reinforcement Learning – Tic-Tac-Toe; Multi-armed Bandits: k-armed Bandit problem – Action value methods – 10-armed testbed – Simple Bandit algorithm – Gradient Bandit algorithm; Finite Markov Decision Processes: Agent-environment interface – Goals, rewards, returns and episodes – Policies and value functions - Optimal policies and optimal value functions.

UNIT II TABULAR SOLUTION METHODS 10

Dynamic Programming: Policy evaluation – Policy improvement – Policy iteration – Value iteration; Monte Carlo Methods: Prediction – Estimation of action values – Control – Off-policy Prediction – Incremental Implementation; Temporal-Difference (TD) Learning: TD prediction and its advantages – Optimality of TD (0) – Sarsa – Q-learning.

UNIT III APPROXIMATE SOLUTION METHODS 10

On-policy Prediction with Approximation: Value-function approximation – Prediction objective – Stochastic gradient – Linear methods; On-policy Control with Approximation: Episodic semi-gradient control - n-step Semi-gradient Sarsa - Average reward; Policy Gradient Methods: Policy approximation - Policy gradient theorem.

UNIT IV TRANSFER IN REINFORCEMENT LEARNING 8

Framework and Taxonomy for Transfer in Reinforcement Learning: Transfer framework – Taxonomy - Methods for transfer across tasks with a fixed and different state-action spaces.

UNIT V APPLICATIONS 8

TD-Gammon; Watson's Daily-Double Wagering; Optimizing Memory Control; Human-levelVideo Game Play.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Illustrate the basics of reinforcement learning problem	**K2**
CO2	Solve various problems using tabular solution methods	**K3**
CO3	Apply approximate solution methods for larger state space problems	**K3**
CO4	Apply transfer learning methods for various problem solutions	**K3**
CO5	Analyze the use of reinforcement learning techniques for different applications	**K4**

TEXTBOOKS

1. Richard S. Sutton & Andrew G. Barto, “Reinforcement Learning: An Introduction”, The MIT Press, 2nd Edition, 2018. (Units: I, II, III, V)
2. Marco Wiering & Martijn van Otterlo, “Reinforcement Learning State-of-the-Art”, Springer, 2012. (Unit: IV)

REFERENCE BOOKS

1. Boris Belousov, Hany Abdulsamad, Pascal Klink, Simone Parisi & Jan Peters, “Reinforcement Learning Algorithms: Analysis and Applications”, Springer, 1st edition,2021.
2. Micheal Lanham, “Hands-On Reinforcement Learning for Games”, Packt Publishing Ltd., 2020.
3. Taweh Beysolow II, “Applied Reinforcement Learning with Python”, Apress, 2019.
4. Dimitri Bertsekas, “Reinforcement Learning and Optimal Control”, Athena Scientific, 2019.
5. HM Schwartz , “Multi-Agent Machine Learning - A Reinforcement Approach”, John Wiley & Sons Inc, 1st edition, 2014

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2
CO1	3	2											2	
CO2	3	2	2		2					2			2	
CO3	3	2											2	
CO4	3	2											2	
CO5	3	2	3	3	2					2		2	2	2
Total	15	10	5	3	4					4		2	10	2
Score	3	2	3	3	2					2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1967	3D MODELING AND ANIMATION	1	0	4	3

OBJECTIVES

- To understand the basics of 3D object creation.
- To use a 3D modeling tool to create basic and complex objects
- To apply lighting, textures, and visual effects to a scene
- To create animations and render scenes with special effects

UNIT I INTRODUCTION TO 3D MODELING 3

Introduction to 3D modeling and animation - Overview of popular 3D modeling software (e.g., Blender, Autodesk Maya) - Installation and basic interface navigation - Understanding basic geometric shapes - Introduction to modeling tools (extrude, bevel, etc.) - Introduction to more complex modeling techniques (subdivision surfaces, Boolean operations).

UNIT II TEXTURING AND MATERIALS 3

Texturing: Understanding UV mapping - Basic texture creation and application. Materials and Shading: Introduction to materials and shaders - Applying realistic materials to 3D objects

UNIT III ANIMATION BASICS 3

Animation Fundamentals: Introduction to keyframes and timeline - Basic animation principles (e.g., squash and stretch, anticipation). Rigging Basics: Introduction to rigging - Basics of skeletal and character rigging

UNIT IV ADVANCED ANIMATION 3

Character Animation: Advanced character animation techniques - Walk cycles, expressions, and emotions. Dynamics and Simulations: Introduction to physics-based animation - Simulating cloth, particles, and fluids

UNIT V RENDERING AND OUTPUT 3

Rendering Basics: Introduction to rendering settings - Lighting and camera techniques. Output and Export: Exporting 3D models and animations - File formats and settings.

LECTURE PERIODS: 15

SUGGESTED EXPERIMENTS

1. Create simple objects - Model a simple room with furniture. Apply basic modeling tools to create walls, floors, and furniture using cubes, cylinders, and other basic shapes.
2. Practice creating more detailed 3D objects - Design a futuristic building or object. Experiment with subdivision surfaces and Boolean operations to create a more complex and intricate 3D model.
3. Apply texturing on a simple 3D model - Texture a wooden crate or a simple prop. Practice UV mapping and apply a texture to simulate realistic materials like wood.

4. Create and apply materials - Create a scene with varied materials. Apply different materials to objects in a scene, considering factors like reflectivity, transparency, and surface properties.
5. Create a simple animation - Animate a bouncing ball.Apply principles like squash and stretch to make the animation more dynamic and visually interesting.
6. Apply rigging on a simple character and animate a walk cycle to understand character movement.
7. Create a character animation - Animate a character expressing emotions.Use advanced character animation techniques to create a short scene where a character expresses various emotions.
8. Simulate a dynamic scene - Simulate a dynamic scene like a falling object or a cloth draped over an object.Explore Blender's physics-based animation by simulating dynamics in a scene.
9. Render a scene with realistic lighting.Experiment with different lighting setups and render a scene with attention to shadows, reflections, and overall visual aesthetics.

LAB PERIODS: 60

Project: Animated Short Film

Project Overview:
Students will be working in teams to create a project applying the concepts of 3D modeling, texturing, animation, and rendering skills.The project allows the participants to engage in a holistic 3D modeling and animation experience, from concept to final presentation.

Sample Project: - "The Journey of a Robot"
Create a short, animated film that tells the story of a robot's journey through different environments.

Conceptualization and Storyboarding: Brainstorm the narrative for the animated short. Create a storyboard outlining key scenes and actions.
3D Modeling - Robot Design and Environments: Model the main character, the robot, with attention to detail. Model key elements of the environments the robot will traverse.
Texturing and Shading: Apply textures to the robot model, considering material properties.Texture the environments to establish a cohesive visual style.
Rigging and Character Animation: Rig the robot character for movement. Animate the robot's movements through the different scenes, ensuring fluid motion.
Environment Animation: Animate elements in the environments (e.g., moving clouds, swaying trees). Refine the overall flow of the animated journey.
Lighting and Camera Setup: Set up lighting to enhance the mood of each scene. Experiment with camera angles and movement to enhance storytelling.
Dynamics and Special Effects: Integrate dynamics or simulations for specific scenes (e.g., a waterfall, dust clouds). Add special effects to enhance visual appeal.
Sound Design and Music Integration: Source or create sound effects for the robot's movements and environmental sounds. Integrate background music that complements the narrative.
Rendering Optimization: Optimize scenes for rendering efficiency. Adjust rendering settings for the desired visual quality.
Post-Processing and Editing: Apply post-processing effects to enhance the final look. Edit the animated sequences into a cohesive short film.
Feedback and Iteration: Review the animated short film as a group. Provide constructive feedback and make necessary adjustments.

Finalization and Rendering: Finalize the project based on feedback. Render the complete animated short film.
Exporting and Deliverables: Export the animated short film in a suitable format. Prepare any additional deliverables (e.g., project documentation).
Showcase and Reflection: Showcase the animated short film to the group. Reflect on the project, discussing challenges, successes, and lessons learned.

Rubrics for evaluating the project:

Assessment tool	**Project Execution**	**Viva-Voce**	**Project Report**
Review 1 - Modeling and Texturing	40% Showcasing the 3D models and environments created. Enhancing the models with texturing and shading	10%	50% Description of the project statement with story board layout and object definitions
Review 2 - Animation and Cinematography	80% Use of Character and environment animation, lighting effects	10%	10% Generation of Keyframes and inbetweening
End semester Evaluation - Integration and Presentation	80% Dynamics and special effects integration, Sound design integration. Final presentation and delivery	10%	10% Screenshots of keyframes with learning outcomes

STUDIO PERIODS: 30

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Design and develop 3D models in animation with materials and textures	K6
CO2	Create keyframes and apply rigging and character animations	K6
CO3	Apply lighting andvarious camera parameters to add visual realism to the scene	K3
CO4	Apply dynamics and special effects to render the scene	K3
CO5	Work in teams to develop modules and integrate them.	
CO6	Communicate effectively through reflections, reports, and presentations.	

TEXTBOOKS

1. Roland Hess, “Blender Foundations”, Focal Press, 2nd edition, 2017. (All units)
2. Jason van Gumster, “Blender for Dummies”, For Dummies, 4th Edition, 2020.

REFERENCE BOOKS

1. Oscar Baechler, Xury Greer, “Blender 3D By Example”, Packt Publishing, 2nd Edition, 2020.
2. John M. Blain, “The Complete Guide to Blender Graphics: Computer Modeling and Animation”, Taylor & Francis Ltd, 7th Edition, 2022.

3 Ben Simonds, “Blender Master Class: A Hands-On Guide to Modeling, Sculpting, Materials, and Rendering”, No Starch Press, 1st Edition, 2013.
4 Lance Flavell, “Beginning Blender: Open-Source 3D Modeling, Animation, and Game Design”, Apress, 2010

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	2							2	2	2
CO2	3	2	2	3	2							2	2	2
CO3	3	2	2	3	2							2	2	2
CO4	3	2	2	3	2							2	2	2
CO5									3	2				
CO6									3	2				
Total	12	8	8	12	8				6	4		8	8	8
Score	3	2	2	3	2				3	2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1966	SOFTWARE VERIFICATION & VALIDATION(TCP)	2	0	2	3

OBJECTIVES

- Identify the different techniques for verification and validation.
- Use available traceability analysis tools on sample requirements.
- Modify existing coverage analyzers in terms of functionality or features used.
- Design system test cases.
- Use test case generators and test management tools

UNIT I INTRODUCTION 6

Principles Of Verification and Validation – Software Architecture Frameworks – Model Driven Architecture – UML – Systems Modeling Language – Verification, Validation and Accreditation.

UNIT II SOFTWARE VERIFICATION 6

Verification and Validation Life Cycle – Traceability Analysis – Interface Analysis – Design and Code Verification – Test Analysis – Reviews – Inspections – Walkthroughs – Audits – Tracing – Formal Proofs – Model Based Verification and Validation.

UNIT III TESTING STRATEGIES 6

Stages of Testing: Test Planning – Test Design – Test Case Definition – Test Procedure – Test Reporting – Unit Testing: White Box, Black Box and Performance Testing; System Testing: Function, Performance, Interface, Operations, Resource, Security, Portability, Reliability, Maintainability, Safety, Regression and Stress Testing.

UNIT IV TOOLS 6

Tools For Verification and Validation: Static Analyser – Configuration Management Tools– Reverse Engineering Tools – Tracing Tools – Tools for Formal Analysis.

UNIT V ACCESSIBLE SOFTWARE VERIFICATION WITH DAFNY 6

Dafny: Language, Verifier, and IDEs - Verifying an Imperative Procedure - Integers - Ghost vs. Compiled - Stating and Proving a Lemma

TOTAL PERIODS :(THEORY)30

SUGGESTED EXPERIMENT

1. Develop the UML diagram for a given problem statement.
2. Develop the code and use the agile platform to store the code.
3. Apply the configuration techniques in agile platform.
4. Apply the black box and white box testing using the automated tools.
5. Test the precondition and post conditions using automated testing platform.
6. Perform testing to prove the partial correctness of this program.
7. Apply validation tool, a given problem statement to perform validation testing.
   Eg1. Check that a surname is always entered into each record in a database of addresses
8. Demonstrate the traceability in software testing.

Eg1. Login is ability to trace tests forward and backward through the development lifecycle.
Eg2. Identify and fix the bug.

9. Demonstrate the data flow testing

TOTAL PERIODS :(LAB)30

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Develop software systems using principles and practices of Software Engineering.	**K6**
CO2	Analyze verification techniques using appropriate techniques.	**K3**
CO3	Use the strategies in testing and provide appropriate solutions needed as per requirements	**K3**
CO4	Examine verification and validation skills using automated tools for improving the testing activities	**K3**
CO5	Explain effectively and technically the verification process using a framework.	**K2**

TEXTBOOKS

1 Mourad Debbabi, Hassaine F, Jarrya Y., Soeanu A., Alawneh L., "Verification and Validation in Systems Engineering", Springer, 2010. (Unit 1)

2 ESA Board for Software Standardization and Control (BSSC), "Guide to Software verification and Validation", European Space Agency ESA PSS05-10 Issue 1 Revision 1, 1995. (Unit 2,3,4)

REFERENCE BOOKS

1 K. R. M. Leino, "Accessible Software Verification with Dafny," in IEEE Software, vol. 34, no. 6, pp. 94-97, 2017. (Unit 5)

2 Aditya Mathur, "Foundations of Software Testing", Pearson Education, 2008.

3 Marcus S. Fisher, "Software Verification and Validation: An Engineering and Scientific Approach", Springer, 2007.

4 Avner Engel, "Verification, Validation & Testing of Engineered Systems", Wiley series in systems Engineering and Management, 2010.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO1 1**	**PO12**	**PSO 1**	**PSO2**
CO1	3	3	3	3	3					2		2	2	2
CO2	3	2			2								2	
CO3	3	2			2								2	
CO4	3	3			3								2	
CO5	3								2	2			2	2
Total	15	10	3	3	10				2	2		2	10	2
Score	3	2	2	2	2				2	2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1928	WEARABLE COMPUTING	2	0	2	3

OBJECTIVES

- To explore and understand the building blocks of Wearable Computing
- To enumerate the details of Body Sensor Networks (BSN).
- To understand the features of various types of BSNs.
- To Integrate Wearable and Cloud Computing.
- To explore different software tools required and develop BSN applications.

UNIT I IINTRODUCTION TO WEARABLE COMPONENTS AND BUILDING BLOCKS 6

History - Internet of Things and Wearables - Wearables' Mass Market Enablers - Human Computer Interface and Human Computer Relationship.Bluetooth Low Energy (BLE) - Embedded Software Programming - Sensors for Wearables - Android Wear: Notification Settings and Control, Wear Network - Android Wear API: DataItem – DataMapItem – DataMap - Google Fit API

UNIT II BODY SENSOR NETWORKS 6

Typical m-Health System Architecture - Hardware Architecture of a Sensor Node - Communication Medium - Power Consumption Considerations - Communication Standards - Network Topologies - Commercial Sensor Node Platforms - Bio-physiological Signals and Sensors - BSN Application Domains - Developing BSN Applications

UNIT III AUTONOMIC AND AGENT - ORIENTED BODY SENSOR NETWORKS 6

Task-Oriented Programming in BSNs - SPINE framework - Task-Based Autonomic Architecture - Autonomic Physical Activity Recognition - Agent-Oriented Computing and Wireless Sensor Networks - Mobile Agent Platform for SUN SPOT (MAPS) - Agent-Based Modeling and Implementation of BSNs - Reference Architecture for Collaborative BSNs

UNIT IV INTEGRATION OF WEARABLE AND CLOUD COMPUTING 6

Background - Motivations and Challenges- Reference Architecture for Cloud-Assisted BSNs - BodyCloud: A Cloud-based Platform for Community BSN Applications - Engineering Body Cloud Applications - SPINE Based Design Methodology

UNIT V SPINE-BASED BODY SENSOR NETWORK APPLICATIONS 6

Introduction - SPINE1.x - Install SPINE 1.x - Use SPINE - Run a Simple Desktop Application Using SPINE1.3 - SPINE Logging Capabilities - SPINE2 - Install SPINE2 - Use the SPINE2 API - Run a Simple Application Using SPINE2, Physical Activity Recognition - Step Counter - Emotion Recognition - Handshake Detection

TOTAL PERIODS: 30

SUGGESTED EXERCISES:

1. Introduction to wearable development platforms (Hardware and Software).
2. Data acquisition from accelerometer and gyroscope and visualization in real-time.
3. Integration of heart rate monitor and data analysis.
4. Integration of temperature and pressure sensors.
5. ECG monitoring with compact sensors.
6. Designing an effective wearable user interface.
7. Implementation of power saving strategies for energy efficient node designs.
8. Development of wearable applications (Eg: Fall detection system, Healthcare monitoring, Physical activity tracking using SPINE framework etc.)

TOTAL PERIODS: 30
TOTAL PERIODS: 60

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Explain the basics of wearable computing and its basic building blocks.	**K2**
CO2	Explain the architecture of body sensor networks and use programming frameworks for BSNs.	**K3**
CO3	Model automatic and agent-based body sensor networks.	**K3**
CO4	Use cloud environments for integrating and manage sensors and BSNs.	**K3**
CO5	Evaluate various tools and develop body sensor networks applications using required tools.	**K5**

TEXTBOOKS

1 Fortino, Giancarlo, Raffaele Gravina, and Stefano Galzarano, Wearable computing: from modelling to implementation of wearable systems based on body sensor networks, 2018, 1st edition, John Wiley & Sons, USA.

REFERENCE BOOKS

1 Sanjay M. Mishra, Wearable Android™: Android wear & Google Fit app development, 2015, 1st edition, John Wiley & Sons, USA

2 Barfield, Woodrow, ed. Fundamentals of wearable computers and augmented reality, 2015, 1st edition, CRC press, USA

3 Sandeep K.S. Gupta, Tridib Mukherjee, Krishna Kumar Venkata Subramanian, "Body AreaNetworks Safety, Security, and Sustainability," Cambridge University Press,2013.

4 Mehmet R. Yuce, Jamil Y. Khan, "Wireless Body Area Networks Technology, Implementation and Applications", Pan Stanford Publishing Pvt. Ltd, Singapore,2012.

5 Guang-Zhong Yang (Ed.), "Body Sensor Networks, "Springer,2006.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO 1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
CO1	3												2	
CO2	3	2	2		2					2		2	2	2
CO3	3	2	2		**2**								2	
CO4	3	2	2		2					2		2	2	
CO5	3	2	2		2							2	2	2
Total	15	8	8		8					4		6	10	4
Score	3	2	2		2					2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	E	C
ICS1929	APPLICATION DEVELOPMENT USING AR, VR AND MR	2	0	0	3	3

OBJECTIVES

- To impart the fundamental development principles of AR/VR/MR applications.
- To gain knowledge about VR application development with unity.
- To gain knowledge about AR application development with unity.
- To learn the scripting languages for AR/VR applications.
- To design and develop real-time AR/VR/MR applications.

UNIT I FUNDAMENTALS OF AR, VR AND MR 6

Categorizing the realities – Virtual Reality, Augmented Reality & Mixed Reality – Features and application areas of Virtual Reality, Augmented Reality & Mixed Reality - Integration of VR techniques - Contents objects and scale - Gaze- based Control - Handy Interactables - IDE setup with package files - concepts and features of VR - Working with AR techniques - compatibility with the environment - system architecture - AR terminology - application areas of AR - Integration of AR toolkits with existing IDE's.

UNIT II VR APPLICATION DEVELOPMENT 6

VR SDK'S and Frameworks – OpenVR SDK - StreamVR SDK – VRTK - Oculus SDK - Google VR SDK - VR Concept Integration: Motion Tracking – Controllers - Camera - Hardware and Software requirements - Setting up Unity with VR: Framework/SDK Integration with Unity - Debugging VR projects - Unity XR API's - Mobile VR Controller Tracking - Object Manipulation - Text optimizing and UI for VR.

UNIT III AR APPLICATION DEVELOPMENT 6

Detection of surfaces - Identifying feature points - Track virtual objects in real world - Face and object tracking - SLAM Algorithm (Simultaneous Localization and Mapping) - Understanding uncertain spatial relationship - Loop detection and Loop closing - Unity AR concepts: Pose tracking - Environmental detection - Raycasting and physics for AR - Light estimation, Occlusion – ARCore – ARToolkit – Vuforia.

UNIT IV PROGRAMMING LANGUAGES FOR AR & VR APPLICATIONS 6

C# with Unity – Classes in C# - Setting up visual studio or code editor for C# - 3D models compatibility with C# - C# for AR and VR C++ with Unreal Engine – Building and compiling C++ programs with unreal engine - Variables and memory - Looping and if else structures with unreal Engine - Functions and macros - Adding actors to the scene - Dynamic memory allocations.

UNIT V USE CASES FOR AR, VR AND MR 6

Gaming and Entertainment: Immersive video/Cinematic VR - Architecture and Construction: Artificial Spaces - Science and Engineering: Automotive Engineering - Health and Medicine: Training and Treatment - Aerospace and Defense: Flight Simulation and Training – Education: Tangible Skills Education - Telerobotics and Telepresence - Human Factors Considerations - Legal and Social Considerations.

TOTAL PERIODS: 30

SUGGESTED PROJECTS
:

Develop a virtual science lab for performing experiments.

1. Develop a virtual tour of a home with 2 rooms.
2. Develop a marker based augmented reality learning application for kids.
3. Develop an interior design application for planning and organizing the furniture.
4. Develop a QR code-based index retrieval system for library.

TOTAL PERIODS: 30

TOTAL: 60 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Explain the basics of AR, VR and MR.	**K2**
CO2	Develop VR applications using various toolkits in Unity.	**K3**
CO3	Develop AR applications using various toolkits in Unity.	**K3**
CO4	Apply scripting languages to objects for interacting in AR/VR/MR environment.	**K3**
CO5	Design and develop VR applications by using different tools and technologies of VR programming	**K6**

TEXTBOOKS

1 Jesse Glover, Jonathan Linowes – Complete Virtual Reality and Augmented Reality Development with Unity: Leverage the power of Unity and become a pro at creating mixed reality applications. Packt publishing, 17th April 2019. ISBN -13 : 978-1838648183 (Unit 1, 2 and 3)

2 William Sherif- Learning C++ by Creating Games with UE4, Packt Publishing, 2015, ISBN 978-1-78439-657-2 (Unit 4)

3 Steve Aukstakalnis- Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR, Addison-Wesley Professional, September 2016, ISBN: 9780134094328 (Unit 5)

REFERENCE BOOKS

1 Allan Fowler- Beginning iOS AR Game Development Developing Augmented Reality Apps with Unity and C#, 1st Edition, Apress Publications, 2018, ISBN 978-1484236178.

2 Jonathan Linowes, Krystian Babilinski – Augmented Reality for Developers: Build practical augmented reality applications with Unity, ARCore, ARKit, and Vuforia. Packt publishing, 9th October 2017. ISBN-13: 978-1787286436

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2	3	2	2		2					2		2	2	
CO3	3	2	2		**2**					2		2	2	2
CO4	3	2											2	
CO5	3	2	2		2					2		2	2	2
Total	15	8	6		6					6		6	8	4
Score	3	2	2		2					2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1931	DATABASE TUNING	3	0	0	3

OBJECTIVE

- To comprehend the basic principles of database tuning
- To understand the basics of indexing and Relational Systems tuning.
- To understand the principles of E-commerce applications.
- To understand the principles of Datawarehouse tuning and Column Family Database.
- To understand document databases and Graph Database Design.

UNIT I PRINCIPLES OF TUNING 8

Basic principles – Tuning the Guts: Lock and Concurrency Control Tuning – Tuning the Recovery subsystem- Operating Systems Considerations – Hardware Tuning.

UNIT II INDEX TUNING AND RELATIONAL SYSTEMS TUNING 10

Types of Queries and Keys- Data structures for in-memory database - Sparse versus Dense Indexes- Clustered and non-clustered Indexes – Joins, Foreign Key Constraints, and Indexes - Tuning Relational Systems: Normalization – Denormalization – Clustering Two Tables – Aggregate Maintenance – Record Layout – Query Tuning – Trigger Performance.

UNIT III APPLICATION INTERFACE AND E-COMMERCE APPLICATIONS TUNING 9

Client Server Mechanisms – Objects - Application Tools and Performance – Tuning the Application Interface – Bulk Loading Data – E-Commerce Architecture – Tuning E-Commerce Architecture – Case Study – Shop comparison Portal.

UNIT IV DATA WAREHOUSE TUNING AND COLUMN FAMILY DATABASE DESIGN 9

DBMS Subsystems – Data Warehousing Tuning – Technology for Data warehousing – Tuning for customer relationship Management systems - Federated Data Warehouse Tuning - Designing for Column Family Databases - Guidelines for Designing Tables- Guidelines for Indexing

UNIT V DOCUMENT DATABASES AND GRAPH DATABASE DESIGN 9

Document Databases: Designing for Document Databases- Denormalization – Planning for Mutable Documents- Indexes and modelling Common Relations; Graph Databases: Designing for Graph Databases- Graph design for social Network graph database - Tips and Traps of Graph Database Design.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Explain the database tuning principles and apply for a database Systems	**K3**
CO2	Apply suitable indexing technique, normalization technique for schema refinement and query optimization technique to optimize queries	**K3**

CO3	Apply suitable techniques to tune E-Commerce	**K3**
CO4	Apply suitable techniques to tune Data Warehouse and Column Family Database	**K3**
CO5	Apply suitable techniques to tune the document and Graph database design	**K3**

TEXTBOOKS

1. Dennis Shasha and Philippe Bonnet, "Database Tuning, Principles, Experiments, and Troubleshooting Techniques", Morgan Kaufmann, An Imprint of Elsevier, Revised Edition, 2004. (Units 1- 4)
2. Dan Sullivan, "NoSQL for Mere Mortals", Addison- Wesley-2015 (unit 5)

REFERENCE BOOKS

1. C.J. Date," Database Systems", Addison Wesley 2004
2. Thomas Connoly and Carlolyn Begg, "Database Systems, A Practical Approach to Design, Implementation and Management", Third Edition, Pearson Education, 2003.
3. M.TamerOzsu, Patrick Valduriez and S.Sridhar, "Principles of Distributed Database Systems", Pearson Education, 2007.
4. Hector Garcia – Molina, Jeffrey D. Ullman, Jennifer Widom, "Database Systems: The Complete Book", Prentice Hall, 2008

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO1 1**	**PO12**	**PSO 1**	**PSO2**
CO1	3												2	
CO2	3	2	3										2	
CO3	3	2	3									2	2	2
CO4	3	2	3							2		2	2	2
CO5	3	2	3							2		2	2	2
Total	15	8	15							4		6	10	6
Score	3	2	3							2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1932	SEMANTIC WEB	3	0	0	3

OBJECTIVE

- To learn the basics of Semantic Web and structured web documents
- To understand describing web resources in RDF
- To learn web ontology language
- To learn querying ontology
- To learn ontology reasoning

UNIT I INTRODUCTION TO SEMATIC WEB 9

Current web vs Semantic Web - Semantic Web Technologies - A layered approach; Structured Web Documents in XML: XML - Structuring - Namespaces - Addressing and querying XML document - Processing.

UNIT II DESCRIBING WEB RESOURCES 9

RDF: Data Model - XML-Based Syntax - RDF semantics - RDF Schema – An axiomatic semantics for RDF and RDF schema – A direct inference system for RDF.

UNIT III WEB ONTOLOGY LANGUAGE 9

OWL2 - Requirements for Ontology Language - Compatibility of OWL2 with RDF/RDFS - The OWL Language - OWL2 Profiles.

UNIT IV QUERYING THE SEMANTIC WEB 9

SPARQL Infrastructure - Basics: Matching Patterns – Filters - Constructs for Dealing with an Open World - Organizing Result Sets - Other Forms of SPARQL Queries - Querying Schema

UNIT V ONTOLOGY REASONING 9

Introduction to logics and reasoning - Monotonic Rules: Examples – Syntax – Semantics - OWL2 RL: Description Logic Meets Rules - Rule Interchange Format: RIF - Semantic Web Rules Language (SWRL) - Rules in SPARQL: SPIN

TOTAL PERIODS: 45

COURSE OUTCOMES:

On successful completion of this course, the student will be able to:

CO1	Explain structured web documents	**K2**
CO2	Apply Resource Description Framework RDF to represent semantic web	**K3**
CO3	Make use of web ontology language OWL for knowledge representation	**K3**
CO4	Make use of SPARQL for querying ontology	**K3**
CO5	Create an ontology for any domain and infer knowledge from the ontology.	**K6**

TEXTBOOKS

1 Grigoris Antoniou, Paul Groth, Frank van Harmelen and Rinke Hoekstra, A Semantic Web Primer, The MIT - Press Cambridge – 3rd edition – 2012. (All 5 units)

2 James Hendler, Fabien Gandon, Dean Allemang, Semantic Web for the Working Ontologist: Effective Modeling for Linked Data, RDFS, and OWL, Association of Computing Machinery (ACM), U.S., 3rd edition, 2020.

REFERENCE BOOKS

1 Pascal Hitzler, Markus and Sebastian, Foundations of Semantic Web Technologies, Chapman and Hall/CRC; 1st edition, 2009.

2 Franz Baader, Ian Horrocks, Carsten Lutz, Uli Sattler, An Introduction to Description Logic, Cambridge University Press; 1st edition 2017.

3 C Maria Keet, An Introduction to Ontology Engineering, College Publications, 2018.

4 Lamy Jean-Baptiste, Ontologies with Python: Programming OWL 2.0 Ontologies with Python and Owlready2, APress; 1st ed. Edition, 2020.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO1 1**	**PO12**	**PSO1**	**PSO2**
CO1	3		3										2	
CO2	3	2	3										2	
CO3	3	2	3									2	2	2
CO4	3	2	3							2		2	2	2
CO5	3	2	3							2		2	2	2
Total	15	8	15							4		6	10	6
Score	3	2	3							2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1933	QUANTUM COMPUTING	3	0	0	3

OBJECTIVES

- Understand about quantum computing and quantum mechanics.
- Analyze the Quantum Circuits.
- Utilize Open-source Qi skit for quantum programming.
- Learn about quantum algorithms.
- Learn the quantum cryptography algorithms.

UNIT I INTRODUCTION TO QUANTUM COMPUTING 9

Need for Quantum Computing and fundamental concepts- Complex Numbers, Vector Space, and Dirac Notation- Basics
of Quantum Mechanics - Matrices and Operators – Quantum Information Processing: Quantum Computation, The Quantum Bit and Its Representations, Superposition in Quantum Systems, Quantum Register

UNIT II QUANTUM GATES AND CIRCUITS 9

Universal logic gates - Basic single qubit gates - Multiple qubit gates - Circuit development - Quantum error correction. Programming concepts in Qi skit- Analysis of Qi skit- Exploring Qi skit- Programming in quantum.

UNIT III QUANTUM ALGORITHMS 9

Deutsch's Algorithm, Deutsch–Jozsa Algorithm, Grover's Search Algorithm, Shor's Factoring Algorithm.

UNIT IV QUANTUM INFORMATION THEORY 9

Classical noise and Markov processes- Quantum operations - Examples of quantum noise and quantum operations - Applications of quantum operations - Limitations of the quantum operations formalism- Distance measures for quantum information

UNIT V QUANTUM CRYPTOGRAPHY 9

Principles of Information Security - One-Time Pad - Public Key Cryptography - RSA Coding Scheme - Quantum Cryptography - Quantum Key Distribution - BB84 - Ekart 91.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Identify the need of quantum computing and quantum information processing	**K3**
CO2	Model the circuits using quantum computation environments and framework.	**K3**

CO3	Compare and analyze the different quantum algorithms.	**K4**
CO4	Explain the Quantum noise and quantum operations.	**K2**
CO5	Apply the quantum cryptographic algorithms.	**K3**

TEXTBOOKS

1. Parag K Lala, Mc Graw Hill Education, Quantum Computing, A Beginners Introduction, First edition (1 November 2020). (Units:1, 2, 3, 5)
2. MichaelA. Nielsen and Issac L. Chuang," Quantum Computation and Information, Cambridge, 2010. (Unit:4)

REFERENCE BOOKS

1. Mikio Nakahara and Tetsuo Ohmi,"Quantum Computing", CRC Press, 2008
2. N. David Mermin,"Quantum Computer Science", Cambridge, 2007
3. https://qiskit.org/ (Unit: 2)
4. An Introduction to Quantum Computing. P. Kaye, R. Laflamme, and M. Mosca, Oxford University Press, New York
5. Lala, P.K., Quantum Computing: A Beginner's Introduction. McGraw-Hill Education. 2019.
6. Presskil Lecture notes: Available online: http://www.theory.caltech.edu/~preskill/ph229/

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2											2	
CO2	3	2											2	
CO3	3	2	2		2					2		2	2	2
CO4	3	2											2	
CO5	3	2											2	
Total	15	10	2		2					2		2	10	2
Score	3	2	2		2					2		2	2	2

COURSE CODE	COURSE TITLE	L	T	P	C
ICS1934	SOCIAL NETWORK ANALYSIS	3	0	0	3

OBJECTIVES

- To understand the social network measures and various models.
- To understand patterns of relationships and similarity of the actors in social network.
- To identify communities in the social network.
- To analyze and predict links using link predictions methods.
- To understand the visualization techniques and applications of social networks.

UNIT I SOCIAL NETWORK MEASURES AND MODELS 9

Social Network Perspective, Fundamentals concepts in Network Analysis – Introduction to Network Data - Types of Networks – Centrality of Prestige: Prominence – Directional Relations – Non-Directional Relations - Properties of Real-World Networks – Random Network Model – Ring Lattice Network Model – Watts-Strogatz Model – Preferential Attachment Model – Price's Model - Local Network – Network model with accelerating growth.

UNIT II STRUCTURAL BALANCE AND STRUCTURAL EQUIVALENCE 9

Structural Balance: Clusterability Theorems, Clustering Coefficient and Transitivity. Structural Equivalence: Definition, Positional Analysis, Measuring Structural Equivalence, Representation of Network Positions - Block Models: Building Block Models, Interpretations.

UNIT III COMMUNITY STRUCTURE IN SOCIAL NETWORK 9

Applications of Community Detection – Types of Communities – Community Detection Methods Disjoint Community Detection – Overlapping Community Detection – Local Community Detection Community Detection Vs Community Search – Evaluation of Community detection methods.

UNIT IV LINK ANALYSIS AND LINK PREDICTION 9

Link Analysis: Applications – Signed Networks – strong and Weak Ties – Link Analysis Algorithms: PageRank – Div Rank – Sim Rank – Link Prediction Concepts - Temporal Changes in a Network – evaluating link Prediction Methods – Heuristics Models – Probabilistic Models – Supervised Random Walk – Information- theoretic Model – Advanced Link Prediction Techniques.

UNIT V VISUALIZATION AND APPLICATIONS 9

Visualization: Node-Edge Diagrams, Matrix Representation – Visualizing Online Social Network - Fundamentals of Gephi - A Network Graph Framework - Selecting the Layout - Network Patterns - Working with Filters - Graph Statistics – Introduction to applications of Social Network Analysis: Introduction, Organizational Issues, Recommendation and E-commerce Systems, Covert Networks, Web Applications, Community Neworks, Collaboration Networks, Co-Citation Networks.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to:

CO1	Illustrate social network measures and various models.	**K2**
CO2	Identify patterns of relationships and structural equivalence in social network.	**K3**
CO3	Make use of Community detection techniques in social networks.	**K3**
CO4	Apply link prediction algorithms to social networks.	**K3**
CO5	Design a real-world social network using social network visualization tool and analyze with social network measures.	**K6**

TEXTBOOKS

1 Stanley Wasserman, Katherine Faust, "Social Network Analysis Methods and Applications", 1st Edition, Cambridge University Press, 1994. (Unit 1)

2 Social Network Analysis, Tanmoy Chakraborty, Wiley,2021 (Unit 1, 2, 3, 4)

3 Mastering Gephi Network Visualization, Ken Cherven Packt Publishing Ltd, 2015 (unit 5)

4 BorkoFurht, "Handbook of Social Network Technologies andApplications",1st Edition, Springer, 2010. (Unit 5)

REFERENCE BOOKS

1 Peter Mika, "Social Networks and the Semantic Web", 1st Edition, Springer,2007.

2 Maksim Tsvetkova and Alexander Kouznetsov, "Social Network Analysis for Startups", O'Reilly, 2011.

3 John Scott, Social Network Analysis, 4th Edition, 2017.

4 Maksim Tsvetkova, Alexander Kouznetsov, "Social Network Analysis for Start-ups: Finding connections on the social web", O'Reilly, 2015.

5 Stephen P Borgatti, Martin G Everett, Jeffrey C Johnson, "Analyzing Social Networks" 2nd Edition, 2018.

COURSE OUTCOMES (CO) MAPPED TO PROGRAMME OUTCOMES (PO) AND PROGRAM SPECIFIC OUTCOMES (PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												2	
CO2	3	2											2	3
CO3	3	2											2	3
CO4	3	2											2	3
CO5	3	2	2	2	2			2		2			2	3
Total	15	8	2	2	2			2		2			10	12
Score	3	2	2	2	2			2		2		2	2	2