CURRICULUM STRUCTURE

THIRD YEAR UG: B.E

ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

REVISION: FRCRCE-2-25

Effective from Academic Year 2025-26
Board of Studies Approval: 28/02/2025
Academic Council Approval: 14/02/2025 & 08/03/2025

Dr. DEEPAK BHOIR
Dean Academics

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Principal

Preamble:

Greetings and congratulations to all the education partners Fr Conceicao Rodrigues College of Engineering for getting autonomous status to the college from the year 2024-25. University Grant Commission vide letter No. F. 2-10/2023(AC-Policy) dated 23rd Nov 2023 conferred the autonomous status to Fr. Conceicao Rodrigues College of Engineering, Fr. Agnel Ashram, Bandstand, Bandra (West), Mumbai 400050 affiliated to University of Mumbai for a period of 10 years from the academic year 2024-2025 to 2033-2034 as per clause 7.5 of the UGC (Conferment of Autonomous Status Upon Colleges and Measures for Maintenance of Standards in Autonomous Colleges) Regulations,2023. We look towards autonomy as a great opportunity to design and implement curriculum sensitive to needs of Learner, Indian Society and Industries.

Government of Maharashtra has also directed Autonomous Colleges to revise their curriculum in line with National Education Policy (NEP) 2020 through Government Resolution dated 4th July 2023. We commit to ourselves to the effective implementation of UGC Regulations and NEP 2020 in its spirit.

Based on recent recommendations of the GR, we are pleased to offer our holistic curriculum for 2024-28, a "**H-Tree Model"** of Engineering Education. A unique **"H-Tree Model"** of Engineering Education Curriculum is carefully designed to systematically develop IQ (Intelligence Quotient), PQ (Physical Quotient), EQ (Emotional Quotient) and SQ (Spiritual Quotient) of a learner. This curriculum aims at the development of an **all-rounded** personality with **holistic** approach to education in which learner receives **25% teacher-led learning, 25% peer learning, 25% self-learning and 25% experiential learning**. The curriculum model is outcome based that focuses on learning by doing. Curriculum is designed to provide multiple learning opportunities for students to acquire and demonstrate competencies for rewarding careers. It ensures multiple choices to leaner acquiring skills through systematic planning. It has 7 verticals aligned to GR recommendations with strong science, and mathematics foundation and program core, sequel of electives, Multidisciplinary Minor courses, humanities & management courses and sufficient experiential learning through projects and semester-long industry / research internship along with employable skill-based courses. Learner gets an opportunity to acquire skills through NSDC aligned courses during summer vacations. Learner also gets additional option to choose the kind of degree i.e. Honors or Double Minor or Honors with Research.

Various steps are taken to transform teaching learning process to make learning a joyful experience for students. We believe that this curriculum will raise the bar of academic standards with the active involvement and cooperation from students, academic and administrative units.

Curriculum Structure for UG Programs at Fr CRCE w.e.f. A.Y. 2025-26

Nomenclature of the courses in the curriculum	
Abbreviation	**Title**
BSESC	Basic Science & Engineering Science Courses
PCPEC	Program Core and Program Elective Courses
MDC	Multidisciplinary Courses
SC	Skill Courses
HSSM	Humanities, Social Sciences and Management
EL	Experiential Learning
LLC	Liberal Learning Courses
BSC	Basic Science Courses
ESC	Engineering Science Courses
PCC	Program Core Courses
PEC	Program Elective Courses
MDM	Multidisciplinary Minor
OE	Open Elective
VSEC	Vocational and Skill Enhancement Course
VSC	Vocational Skill Courses
SEC	Skill Enhancement Courses
AEC	Ability Enhancement Course
EEMC	Entrepreneurship, Economics and Management Course
IKS	Indian Knowledge System
VEC	Value Education
RM	Research Methodologies
CEFP	Community Engagement or Field Project
ELC	Experiential Learning Courses
PRJ	Project
INT	Internship
CC	Cocurricular Courses
HMM	Honors and Multidisciplinary Minor
DM	Double Minor
BC	Bridge Course

Credit Specification:

- Theory: 1 credit=13 to 15 hrs of teaching
- Lab: 1 Credit=26 to 30 hrs of lab work
- Studio Activities: 1 Credit= 26 to 30 hrs of creative activities
- Workshop Based Activities: 1 Credit=26 to 30 hrs of hands-on activities related to vocation/professional practice/skill based
- Seminar/Group Discussion: 1 Credit=13 to 15 hrs of participation
- Internship: 1 Credit=Per 2 weeks OR 36 to 40 hrs of engagement

- Field Based Learning/Practices: 1 Credit=26 to 30 hrs of learning activities
- Community Engagement Projects: 1 Credit=26 to 30 hrs of contact time along with 13 to 15 hrs of activities preparation, report writing, independent reading etc.

Credit requirements for different options of the Degrees:

Degree/SEM	I	II	III	IV	V	VI	VII	VIII	Total
B.E	18	20	22+4#	23+5#	20	20	20	20	163+9#=172
B.E with Honors/Minors	18	20	22+4#	23+5#	20+4*	20+4*	20+6*	20+4*	163+9#+18*=190

 # Bridge courses
**Optional Credits*

1. Learners who earn a minimum of total **172 credits** will be awarded "**Bachelor of Engineering**" degree.

2. Learners will have the following options to earn **B. E. in ……(regular) Engineering with Honours/Minor in …….. (specialization)**

Sr. No.	Honors/Minor degree programs	Programs who can offer this Honours Degree Program	Programs who can offer this as Minor Degree program
1	Internet of Things	1. Computer Engineering 2. Artificial Intelligence & Data Science 3. Electronics and Computer Science 4. Mechanical Engineering	--
2	Artificial Intelligence and Machine Learning	1. Computer Engineering 2. Electronics and Computer Science	Mechanical Engineering
3	Data Science	1. Computer Engineering 2. Electronics and Computer Science 3. Mechanical Engineering	
4	Blockchain	1. Computer Engineering 2. Artificial Intelligence & Data Science 3. Electronics and Computer Science	Mechanical Engineering
5	Cyber Security	1. Computer Engineering 2. Artificial Intelligence & Data Science 3. Electronics and Computer Science	Mechanical Engineering
6	Robotics	Mechanical Engineering	1. Computer Engineering 2. Artificial Intelligence & Data Science 3. Electronics and Computer Science
7	3D Printing	Mechanical Engineering	1. Computer Engineering 2. Artificial Intelligence & Data Science 3. Electronics and Computer Science

3. **Honours and Minor Degree Eligibility Criteria for Students:**

i. Following is the eligibility criteria for students opting the Honours/ Minor Degree program:

a. Students with no backlog in semester I, II, and III

b. The CGPI (based on semester I, II, and III) of the students must be 6.75 and above

c. For direct second year (DSE) admitted students - No backlog in semester III and CGPI must be 6.75 and above

ii) Each eligible student can opt for maximum one Honour's or one Minor Programs at any time.

iii) However, it is optional for learners to take Honours/Minor degree program.

iv) The Honours/ Minor degree program can be opted only during regular engineering studies

v) The student shall complete the Honours/ Minor degree program in stipulated four semesters only.

4. Courses offered during internship semester shall be in online mode

5. Learner can earn additional credits by enrolling to skill courses offered in summer. College shall explore feasibility to offer NSDC aligned skill-based courses to the learners

6. Technical support team for registration of Academic Bank of Credits (ABC), registration of elective/optional courses, registration of online courses, registration for degree options etc. under supervision of Dean Academics.

Salient Features of Curriculum:

- ✓ Framed as per Government Resolution dated 4th July 2023 in line with National Education Policy (NEP) 2020.
- ✓ Minimum 172 choice-based credit structure with options of Degrees earning additional credits
- ✓ Unique 'H-Tree' Model of Curriculum: Hybrid model for holistic development with happy learning environment having bridge connecting verticals providing unique path for each learner for 3-dimensional growth, Life Long Learning, bridge courses, inclusive model indicating equal distribution of central resources
- ✓ More emphasis on laboratory based and experiential learning
- ✓ More weightage to continuous assessment to reduce examination stress
- ✓ Mandatory Semester-long internship, courses with emotional & spiritual learning and skill-based learning aligned with NSDC framework
- ✓ Well balanced curriculum to attain Program Outcomes and skills of 21st century learner

- ✓ Curriculum is designed to create excitement among learners for education through stories, activities, collaboration, hackathon, contest, case studies, creative art etc.
- ✓ Curriculum is designed to make graduates responsible citizens of country with future ready skills to handle challenges of 21st Century

SEMESTERWISE CURRICULUM STRUCTURE

UG Artificial Intelligence and Data Science Program:

SEM-V													
Course Code	Course Vertical	Sub-Vertical	Course Name		Contact Hours	Examination Marks (1 Credit=50 Marks)					Credits	
						ISE1	MSE	ISE2	ESE	Total	Points	Total
25PCC13CS11	PCPEC	PCC	Operating System	TH	2	20	30	20	30	100	2	3
				PR	2	20	-	30	-	50	1	
25PCC13CS12	PCPEC	PCC	Computer Network	TH	2	20	30	20	30	100	2	3
				PR	2	20	-	30	-	50	1	
25PCC13CS13	PCPEC	PCC	Artificial Intelligence	TH	2	20	30	20	30	100	2	3
				PR	2	20	-	30	-	50	1	
25PCC13CS14	PCPEC	PCC	Machine Learning	PR	2	20	-	30	-	50	1	1
25PCC13CS15	PCPEC	PCC	Theoretical Computer Science	TH	2	20	30	20	30	100	2	3
				TU	1	20	-	30	-	50	1	
25PEC1CSXX	PCPEC	PEC	Program Elective Course	TH	2	20	30	20	30	100	2	3
				PR	2	20	-	30	-	50	1	
25MDM03X	MDC	MDM	1. Health, Wellness and Psychology 2. Emotional and Spiritual Intelligence	TH	2	50	-	50	-	100	2	2
25OECS3X	MDC	OE	Open Elective-4	TH	1	10	15	10	15	50	1	2
				PR	2	20	-	30	-	50	1	
25HXXXC501	HMM/DM	HMM/DM	Honors/Minor Degree Course	TH	4	20	30	20	30	100	4	4*
				Total	**TH:TU:PR 13:1:12=26**			-	-	**1000**	-	**20**

SEM-VI												
Course Code	Course Vertical	Sub-Vertical	Course Name		Contact Hours	Examination Marks (1 Credit=50 Marks)					Credits	
						ISE1	MSE	ISE2	ESE	Total	Points	Total
25PCC13CS16	PCPEC	PCC	Cryptography and Computer Security	TH	2	20	30	20	30	100	2	3
				PR	2	20	-	30	-	50	1	
25PCC13CS17	PCPEC	PCC	Data Warehousing and Mining	TH	2	20	30	20	30	100	2	3
				PR	2	20	-	30	-	50	1	
25PCC13CS18	PCPEC	PCC	Cloud Computing	PR	2	20	-	30	-	50	1	1
25PCC13CS19	PCPEC	PCC	Deep Learning	TH	2	20	30	20	30	100	2	3
				PR	2	20	-	30	-	50	1	
25PEC2CSXX	PCPEC	PEC	Program Elective Course	TH	2	20	30	20	30	100	2	3
				TU	1	20	-	30	-	50	1	
25PEC3CSXX	PCPEC	PEC	Program Elective Course	TH	2	20	30	20	30	100	2	3
				TU	1	20	-	30	-	50	1	
25PECL2CSXX	PCPEC	PEC	Program Elective Lab	PR	2	20	-	30	-	50	1	1
25PCC13CS20	PCPEC	PCC	Software Testing Lab	PR	2	20	-	30	-	50	1	1
25MDM04	MDC	MDM	Public Relations and Corporate Communication	TH	2	50	-	50	-	100	2	2
25HXXXC601	HMM/DM	HMM/DM	Honors/Minor Degree Course	TH	4	20	30	20	30	100	4	4*
				Total	**TH:TU:PR 12:2:12=26**			-	-	**1000**	-	**20**

List of Program Elective Courses:

Track-1:

SEM-V: **25PEC1CS11:** Big Data Analytics

SEM-VI: **25PEC2CS11:** Social Media Analytics

25PEC3CS12: Graph Data Science

SEM-VI: Lab:

25PECL2CS11: knowledge Representation and Ontology Lab

Track-2:

SEM-V: **25PEC1CS21:** Blockchain

SEM-VI: **25PEC2CS21:** AI in Cyber Security

25PEC3CS22: FinTech

SEM-VI: Lab:

25PECL2CS21: Generative AI Lab

Track-3:

SEM-V: **25PEC1CS31:** Image Processing

SEM-VI: **25PEC2CS31:** UI/UX Design
25PEC3CS32: Computer Vision
SEM-VI: Lab:
25PECL2CS31: Soft Computing Lab

Open Electives offered to AI&DS students:

SEM-V Any one: Embedded Systems OR IoT OR E-Vehicle OR Supply Chain Management OR Design of Experiments OR 3D Printing OR High-Performance Computing

Honor Degree Offered to AI&DS Students from SEM-V to SEM-VIII:

A. Name: **Internet of Things**

1. SEM-V: HIoTC501: IoT Sensor Technologies
2. SEM VI: HIoTC601: IoT System Design
3. SEM VII: HIoTC701: Dynamic Paradigm in IoT
4. SEM VIII: HIoTSBL701: Interfacing & Programming with IoT Lab (SBL)
5. SEM VIII: HIoTC801: Industrial IoT

B. Name: Blockchain

1. SEM-V: HBCC501: Bit coin and Crypto currency
2. SEM VI: HBCC601: Blockchain Platform
3. SEM VII: HBCC701: Blockchain Development
4. SEM VIII: HBCSBL701: Private Blockchain Setup Lab (SBL)
5. SEM VIII: HBCC801: DeFi (Decentralized Finance)

C. Name: Cyber Security

1. SEM-V: HCSC501: Ethical Hacking
2. SEM VI: HCSC601: Digital Forensic
3. SEM VII: HCSC701: Security Information Management
4. SEM VIII: HCSSBL601: Vulnerability Assessment Penetration Testing (VAPT) Lab
5. SEM VIII: HCSC801: Application Security

Minor Degree Offered to Artificial Intelligence & Data Science Students from SEM-V to SEM-VIII:

A. Name: **Robotics**

1. SEM-V: HRBC501: Industrial Robotics
2. SEM VI: HRBC601: Mechatronics & IoT
3. SEM VII: HRBC701: Artificial Intelligence & Data Analysis
4. SEM VIII: HRBSBL701: Robotics and Automation Lab
5. SEM VIII: HRBC801: Autonomous Vehicle Systems

B. Name:3D Printing

1. SEM-V: H3DPC501: Introduction to CAD
2. SEM VI: H3DPC601: 3D Printing: Introduction & Processes
3. SEM VII: H3DPC701: Applications of 3D Printing
4. SEM VIII: H3DPSBL701: Skill Based Lab– Digital Fabrication
5. SEM VIII: H3DPC801: 3D Printing in Medical Technology

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
		2	--	2	2	--	1	3
25PCC13CS11	Operating System	Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	30	100	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes	Discrete Maths, Programming Fundamentals, Data structure	
Course Outcomes	CO1	Comprehend the primitive concepts of Operating System functionality and services.
	CO2	Apply concurrency and synchronization techniques in software development.
	CO3	Implement algorithms for memory management.
	CO4	Evaluate various algorithms of File Storage & I/O management.
	CO5	Analyze advanced operating system architectures and functionalities through case studies of modern systems.

Module No.	Unit No.	Topics	Ref	Hrs
1	1	**Overview of Operating Systems-** Role, functions, and evolution of operating systems, Types of OS, OS Architecture, Components of an OS- Kernel, Shell, and File System, Processes- Definition, lifecycle, and Process Control Block (PCB), Threads vs. Processes.	1,2, 3, 4	2
2	2	**Process Management** CPU Scheduling- Goals, criteria, and types of scheduling, Scheduling algorithms, Process Synchronization- Critical sections and race conditions, Semaphores, Monitors, and Mutex, Deadlock Handling, IPC Mechanism.	1,2,3 ,4	8
3	3	**Memory Management** Contiguous and Non-Contiguous Allocation, Paging and Segmentation, Page replacement algorithms, Virtual Memory Memory Allocation Techniques-Fixed, Variable Partitioning, and Buddy System.	1,2,3 ,4	7
4	4	**File Systems and I/O Management** File Systems - File attributes, directory structures, and access methods, File allocation techniques: Contiguous, Linked, and Indexed, Disk Scheduling- FCFS, SSTF, SCAN, C-SCAN, I/O Management-Device drivers, interrupts, and buffering.	1,2,3 ,4	5

5	**5**	**Advances in Modern Operating Systems** Case Studies- Cloud and Mobile OS, Real-Time and Edge OS, AI and OS, Modern Linux-Based Systems, Experimental OS, Communication in Distributed Systems, Synchronization in Distributed Systems, Security in distributed systems	5,6,7,8,9,10	4
			Total	**26**

Module No.	Sr. no	Suggested List of experiments (Any 8 experiments can be conducted)	Ref	Hrs
2	**1**	Implement basic scheduling algorithms	1,2,3,4	2
2	**2**	Simulate producer-consumer synchronization.	1,2,3,4	2
2	**3**	Simulate a system with processes and resources to detect and resolve deadlocks using a resource allocation graph.	1,2,3,4	2
3	**4**	Write a program to simulate page replacement algorithms	1,2,3,4	2
3	**5**	Write a program to simulate memory allocation techniques.	1,2,3,4	2
4	**6**	Simulate file allocation techniques	1,2,3,4	2
4	**7**	Implement disk scheduling algorithms.	1,2,3,4	2
4	**8**	Implement buffering techniques for a simulated I/O device to manage data streams efficiently.	1,2,3,4	2
5	**9**	Analyze Linux kernel logs for specific events (scheduling, I/O operations) using tools like dmesg or syslog.	9	2
5	**10**	Explore OS vulnerabilities using a controlled virtual environment. Analyze patching or mitigation strategies.	5,6,7,8,9	2
5	**11**	Simulator based experiments (EduMIPS64, GAIL (General Algorithm Interactive Learning) ,NS-3	10	2

Course Assessment:

Theory:

ISE1:
Activity: Quiz and assignments 20 Marks

ISE2: 20 Marks
Activity: Article Discussion, Quiz and Assignments

MSE: 30 Marks 90 minutes written examination based on 50% syllabus

ESE: 30 Marks 90 Minutes written examination based on remaining syllabus after MSE

Lab:

ISE1 will be conducted for four or 50% of experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.

ISE2

a. Remaining Four experiments or 50% of experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.
b. Simulation using modern tools to solve the given problem statement for 10 marks

Recommended Books:

1. Silberschatz A., Galvin P., Gagne G. "Operating Systems Principles", Willey Eight edition
2. Achyut S. Godbole , Atul Kahate "Operating Systems" McGraw Hill Third Edition
3. "Operating System-Internal & Design Principles", William Stallings, Pearson
4. Andrew S. Tanenbaum, "Modern Operating System", Prentice Hall.
5. "Cloud Computing: Concepts, Technology & Architecture" by Thomas Erl, Ricardo Puttini, and Zaigham Mahmood
6. "Mobile Operating Systems: Concepts and Practices" by Dr. R. Latha and S. Pavithra
7. "Embedded and Real-Time Operating Systems" by K.C. Wang
8. "Quantum Computing: A Gentle Introduction" by Eleanor Rieffel and Wolfgang Polak
9. "Linux Kernel Development" by Robert Love
10. Official Website of GAIL on GitHub,NS-3 Official Website,EduMIPS64 Official Website

Online Resources:

1. http://www.nptelvideos.in/2012/11/compiler-design.html
2. https://www.coursera.org/lecture/nand2tetris2/unit-4-1-syntax-analysis-5pC2Z
3. https://onlinecourses.nptel.ac.in/noc21_cs72/preview
4. https://www.scaler.com/topics/course/free-operating-system-course/

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PCC13CS12	Computer Network	L	T	P	L	T	P	Total
		2	--	2	2	--	1	3
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	30	100	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes	Programming Fundamentals, Data structure	
Course Outcomes	CO1	Interpret the basic network structure and analyze utilization of communication devices.
	CO2	Illustrate the impact of transmission media, multiplexing techniques and switching techniques in computer network.
	CO3	Use various functionalities of MAC & LLC sublayer.
	CO4	Classify Functionalities of static & dynamic routing protocol.
	CO5	Analyze Transport layer protocols and its impact on quality of service.
	CO6	Design network architecture using various network protocol in real time environment.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	**Introduction to Computer Networks** Definition of a Computer Network; Components of a computer network: Classification of networks, network types, Network topologies, networking devices (Hub, Switch, Routers, Firewall, Gateway, NIC, Repeater).	1,3	3
	1.2	Basic Communication System, Switching Techniques, Multiplexing.		
	1.3	OSI Reference Model, Introduction to TCP/IP Protocol Suite, Comparison between OSI & TCP/IP Protocol Suite.		
2	2.1	**Data Link Layer** Introduction To Data Link Layer, Error Detection and Correction (Hamming Code, CRC, Checksum).	1,3	6
	2.2	Elementary Data Link Protocol, Sliding Window Protocol, MAC & LLC Sublayers.		
	2.3	Channel Allocation, Multiple Access Protocol: Aloha, CSMA/CD, Collision Free Protocol, Ethernet Protocols, ARP, RARP, 802.X		
3	3.1	**Network Layer**	1,3	7

		Introduction to Network Layer, Design issues of Network layer.		
	3.2	Addressing: Physical Address, Logical Address, Port Address, And Application Specific Address. Introduction to Interface & Services, Introduction to IPV4 Address: Classful Address, Classless Addressing, Special Address, NAT: Address Translation & translation table.		
	3.3	Routing Algorithm: Shortest Path Routing, Dijkstra Algorithm, Flooding, Link State Routing, Count to Infinity problem, Congestion Control Algorithm, Quality of Services: Leaky Bucket Algorithm, Token Bucket Algorithm.		
4	**4.1**	**Transport Layer** Introduction of Transport layer Services: Relationship between transport layer & network layer, Multiplexing & Demultiplexing, Connectionless Transport.	4	5
	4.2	Transport layer protocol: Go-Back-N, Selective Repeat Protocol, Piggybacking.		
	4.3	Connection-Oriented Transport, Principal of congestion control, TCP congestion control.		
5	**5.1**	**Application Layer** Introduction of Application layer, principal of network application	1,2,3 ,4	5
	5.2	Web & HTTP, FTP, SMTP, DHCP, DNS: The internet Directory Services		
	5.3	Peer to Peer Application, Socket programming with UDP & TCP		
			Total	**26**

Module No.	Sr.no	Suggested List of experiments
1	**1**	Case Study-Classify various types of cabling used in networking
	2	Illustrate various networking devices using Packet Tracer
2	**3**	Use CRC/ Hamming code for error detection and correction
	4	Analyze various Networking Operations and Troubleshooting using command.
3	**5**	Use IP addressing, Subnet and Subnet Mask for given problem statement
	6	Create a local area network using Static & Dynamic Routing Protocols in network infrastructure.
4	**7**	Illustrate Socket programming using TCP and Remote Login using Telnet/SSH
	8	Illustrate VLAN in network infrastructure
5	**9**	Build DHCP Functionality in network infrastructure

	10	Perform Remote login using Telnet server
		Mini project-Build Network Architecture for a given problem Statement.

Course Assessment:

Theory:

ISE1:

Activity: Quiz and assignments 20 Marks

ISE2: Two hours 20 Marks

Activity: Article Discussion, Quiz and Assignments

Outcome: Reflective Journal

MSE: 30 Marks 90 minutes written examination based on 50% syllabus

ESE: 30 Marks 90 Minutes written examination based on remaining syllabus after MSE

Lab:

ISE1 will be conducted for four or 50% of experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.

ISE2

a. Remaining Four experiments or 50% of experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.

b. Simulation using modern tools to solve the given problem statement for 10 marks/Mini project

Recommended Books:

1. A.S. Tanenbaum, "Computer Networks", Pearson Education, 5th Edition.
2. B.A. Forouzan, "Data Communications and Networking", 5th edition, McGraw Hill
3. James F. Kurose, Keith W. Ross, "Computer Networking, A Top-Down Approach
   a. Featuring the Internet",6th edition, Addison Wesley
4. B.A. Forouzan, "TCP/IP Protocol Suite", 4th edition, McGraw Hill

Online Resources:

1. NPTEL, https://nptel.ac.in/courses/106105081/
2. Stanford University, https://lagunita.stanford.edu/courses/Engineering/Networking-SP/SelfPaced/about
3. www.tutorialpoint.com, https://www.tutorialspoint.com/computer_fundamentals/computer_networking

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PCC13CS13	Artificial Intelligence	L	T	P	L	T	P	Total
		2	--	2	2	--	1	3
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	30	100	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes	Programming Fundamentals, Data structure, Object oriented programming with JAVA	
Course Outcomes	CO1	Identify the suitable agent architecture for a given problem.
	CO2	Solve basic AI problems using appropriate searching technique.
	CO3	Solve constraint satisfaction problem using appropriate AI technique.
	CO4	Apply appropriate knowledge representation and inference methods to given AI problems.
	CO5	Use suitable AI methods to find solution of given planning and learning problems.
	CO6	Apply communication and perception methods to given AI problems.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Artificial Intelligence and Intelligent Agents**	1	3
	1.1	Definition of AI, Philosophy of AI- thinking and acting humanly, thinking and acting rationally		
	1.2	The nature of environments- fully and partially observable environment, single and multi-agent, deterministic and stochastic, episodic and sequential, static and dynamic, discrete and continuous		
	1.3	Structure of agents- agent programs and types of agent programs- simple reflex agent, model-based agent, goal-based agent, utility-based agent		
2		**Problem Solving by Searching**	1,2	8
	2.1	Problem solving agents, problem formulation and example problems		
	2.2	Uninformed search strategies- BFS, Uniform Cost Search, DFS, Depth Limited, Iterative Deepening DFS, Bidirectional Search		
	2.3	Informed search strategies- Heuristic function, Greedy Best First Search, A* Search		

	2.4	Local search strategies- Hill Climbing Search, Simulated Annealing, Local Beam Search, Genetic Algorithm		
	2.5	Adversarial Search- Minimax algorithm, alpha-beta pruning		
3		**Constraint Satisfaction Problems (CSP)**	1,2	3
	3.1	Defining CSP, Inference in CSPs		
	3.2	Backtracking search in CSPs		
	3.3	Local search for CSPs		
4		**Knowledge Representation and Reasoning**	1,2	7
	4.1	Knowledge representation systems, syntax and semantics using FOPL		
	4.2	Inference using forward chaining, backward chaining and resolution		
	4.3	Reasoning under uncertainty- Basics of probability and Bayes Theorem		
	4.4	Inference using Bayesian Networks		
5		**Planning and Learning**	1,2	3
	5.1	Planning process, components of planning system, total and partial order planning, hierarchical planning		
	5.2	What is learning? types of learning- supervised, unsupervised, semi-supervised, ensemble and reinforcement learning		
6		**Communication and Perception**	2	2
	6.1	Introduction to Natural Language Processing- Steps in the process including morphological analysis, syntactic analysis, semantic analysis, discourse integration, pragmatic analysis		
	6.2	Perception- vision, speech recognition		
			Total	**26**

Exp. No.	**Suggested List of experiments**
1.	Design of an AI agent specifying PEAS description, type of environment in which the agent performs the task and block diagram of the agent for given problem statement.
2.	To solve trivial AI problems using Prolog.
3.	To solve given AI problem using informed and uninformed search. Compare the performance of both the techniques.
4.	To solve given AI problem using adversarial search technique.
5.	To solve given Constraint Satisfaction Problem using appropriate AI technique.
6.	Apply SAT solvers like DPLL, WalkSAT algorithms to solve given problem using appropriate knowledge representation scheme.

7.	Use Bayesian network to infer from the given knowledge base in uncertain environment.
8.	To solve a given planning problem using appropriate technique.
9.	Mini Project covering areas of AI like communication, perception, learning etc. It is recommended to make group of 2-3 students and make them solve real world problem.

Course Assessment:

Theory:

ISE1:

a. Quiz on module1 for 10 marks.
b. Group-based real-world problem-solving assignment for 10 marks based on module 2. Recommended group size (2-3 students in a group). The assignment should develop skills of comparing different methods and take an informed decision about suitable approach to solve a given problem.

ISE2:

a. Quiz on module 5 for 10 marks.
b. E-Poster design for a real-world problem given as a group assignment for 10 marks on module 5. Recommended group size (2-3 students in a group). This activity should focus on developing skills like problem solving by application of relevant concept, designing a solution and visual presentation of the same in appropriate format.

MSE: 30 Marks 90 minutes written examination based on 50% syllabus
ESE: 30 Marks 90 Minutes written examination based on remaining syllabus after MSE

Lab:

ISE1 will be conducted for experiments 1-5. Continuous pre-defined rubrics-based evaluation for 20 marks.

ISE2

a. Experiments 6-8. Continuous pre-defined rubrics-based evaluation for 10 marks.
b. Mini Project- Rubrics-based evaluation for 20 marks

Recommended Books:

1. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Prentice Hall, 3rd Edition.
2. Elain Rich, Kevin Knight, and Shivashankar Nair, "Artificial Intelligence", McGraw Hill Education, 3rd Edition.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc22_cs56/
2. https://ocw.mit.edu/courses/6-034-artificial-intelligence-fall-2010/

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
25PCC13CS14	Machine Learning	--	--	2	--	--	1	1

Examination Scheme					
	ISE1	MSE	ISE2	ESE	Total
Theory	--	--	--	--	--
Lab	20	--	30	--	50

Pre-requisite Course Codes	Programming Fundamentals, Data analytics and Visualization, Statistics	
	On successful completion of the course learner will be able to	
Course Outcomes	CO1	Comprehend basics of machine learning.
	CO2	Apply preprocessing techniques on dataset.
	CO3	Apply suitable machine learning models for a given problem
	CO4	Implement neural network-based models
	CO5	Apply dimensionality reduction technique

Module No.	Suggested List of Experiments
1	**Introduction to machine Learning** • **Theory:** o Introduction to Machine Learning, Application of Machine Learning, Steps of developing a Machine Learning Application. Supervised and Unsupervised Learning: o Statistical Description of Data; Data Visualization • **Suggested Experiments:** o Set up Python environment with libraries (NumPy, pandas, scikit-learn, matplotlib, seaborn, tensorflow, keras,) o Exploratory Data Analysis (EDA) on a sample dataset.
2	**Data Preprocessing** • **Theory:** o Why Preprocessing? o Data Cleaning; Handling missing values, inconsistent data and outlier. o Data Reduction, Sampling, Data Transformation, Data Discretization, Normalization, Binning. • **Suggested Experiment:** o Data preprocessing (handling missing values, data discretization, data normalization and standardization) on a real-world dataset.
3	**Supervised Learning** • **Theory:**

	○ Classification: Decision tree, Bayesian Classification: Naïve Bayes‟ Classifier, KNN classifier, Accuracy and Error measures, Precision, Recall • **Suggested Experiments:** ○ Implement Naïve Bayes Classification Algorithm. ○ Implement decision tree classifier ○ Implement Support vector machine
4	**Unsupervised Learning** • **Theory:** ○ Clustering: Introduction to clustering, k-Means, K-medoid, Hebbian Learning rule, Expectation -Maximization algorithm for clustering • **Suggested Experiments:** ○ Implementation of k-Means clustering algorithm ○ Implementation of Hebbian Learning rule, Expectation - Maximization algorithm for clustering.
5	**Neural Networks** • **Theory:** ○ Introduction, Fundamental concept, Evolution of Neural Networks, Biological Neuron, Artificial Neural Networks, NN architecture, McCulloch-Pitts Model. ○ Designing a simple network, non-separable patterns, Perceptron model with Bias. Activation functions, Binary, Bipolar, continuous, Ramp ○ Neural Networks and Backpropagation. • **Suggested Experiments:** ○ Implementation of McCulloch Pitts Model. ○ Building a neural network with single-layer perception ○ Implementation of error back propagation training algorithm
6	**Dimensionality Reduction** • **Theory:** ○ Dimensionality Reduction, Curse of Dimensionality, Feature Selection and Feature Extraction. Dimensionality Reduction Techniques, Principal Component Analysis. • **Suggested Experiments:** ○ Principal Component Analysis. ○ Dimensionality Reduction using attribute selection measure.

Course Assessment:

ISE1: will be conducted for (40-50%) experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.

ISE2: will be conducted for remaining experiments. Continuous pre-defined rubrics-based evaluation for 20 marks, Implementation of small communication project – 10 Marks

Text Books:

1. Nathalie Japkowicz and Mohak Shah, "Evaluating Learning Algorithms: A Classification Perspective", 1st edition, Cambridge
2. Samir Roy and Chakraborty, "Introduction to Soft Computing", 1st edition, Pearson Education
3. Ethem Alpaydın, "Introduction to Machine Learning",1st edition, MIT Press
4. Peter Flach, "Machine Learning,"1st edition, Cambridge University Press.

Reference Books:

1. Tom M. Mitchell, "Machine Learning", 1st edition, McGraw Hill.
2. Kevin P. Murphy, "Machine Learning — A Probabilistic Perspective", 1st edition, MIT Press
3. Stephen Marsland, "Machine Learning an Algorithmic Perspective,", 2nd edition, CRC Press
4. Shai Shalev-Shwartz, Shai Ben-David, "Understanding Machine Learning", 1st edition, Cambridge University Press
5. Peter Harrington, "Machine Learning in Action", 1st edition, Dream Tech Press Drives

Online References:

1. https://www.learndatasci.com/out/edx-columbia-machine-learning/
2. https://www.learndatasci.com/out/oreilly-hands-machine-learning-scikit-learn-kerasand-ten sorflow-2nd-edition/
3. https://www.learndatasci.com/out/google-machine-learning-crash-course/

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PCC13CS15	Theoretical Computer Science	L	T	P	L	T	P	Total
		2	1	--	2	1	--	3
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	30	100	
		Tutorial	20	--	30	--	50	

Pre-requisite Course Codes	Discrete Maths	
Course Outcomes	CO1	Design DFA, NFA, Moore, and Mealy machines, demonstrating their equivalence and computational efficiency.
	CO2	Derive the equivalence of languages described by finite automata and regular expressions.
	CO3	Apply grammar principles to address ambiguity, and perform conversions and simplifications of CFGs into Normal Forms.
	CO4	Analyze Pushdown Automata and their equivalence to context-free grammars and languages.
	CO5	Analyze Turing Machines, their variants, and advanced concepts to evaluate computational problems and un-decidability.
	CO6	Apply regular expressions, parsing techniques, and recursive functions to model and solve computational problems in NLP.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	**Introduction to Theory of Computation and Finite Automata** Core concepts including automata, alphabets, symbols, strings, and formal languages; Deterministic Finite Automata (DFA), Non-Deterministic Finite Automata (NFA), and their equivalence; NFA with ε-transitions, its conversion to standard NFA, and Automata minimization.	1,2,3	05
	1.2	**Finite Automata with Output** Finite Automata with Output: Moore Machine, Mealy Machine, Equivalence of Moore and Mealy Machines	1,2,3	02
2	2.1	**Regular Languages** Regular Expressions, Conversion between RE and FA, Introduction to Algebraic Laws of Regular Languages, Pumping Lemma for proving non-regularity, Closure Properties of Regular Languages including Union, Concatenation, Complement, Intersection, and Kleene Star.	1,2	03

3	**3.1**	**Grammar** Chomsky Hierarchy, Context free Grammar, Derivation Trees and Ambiguity, Regular Grammars - Right Linear And Left Linear Grammars, Conversion of FA to Regular Grammar and Regular Grammar to FA	1,3	03
	3.2	**Normal Forms** Simplification of CFG, Normal Forms - Chomsky Normal Form (CNF), Greibach Normal Form (GNF),	1,3	03
4.	**4.1**	**Push Down Automata (PDA)** Mathematical Framework of PDA, Transition Diagrams, Functions and Tables, Deterministic Push- Down Automata (DPDA) - Definition, Nondeterministic Pushdown Automata (NPDA), Equivalence Of Context Free Grammars And PDA, Properties Of Context Free Languages.	1,2	04
5.	**5.1**	**Turing Machines** Mathematical Framework of TM, Language Acceptability of Turing Machines, Turing Machine Construction	1,2	02
	5.2	**Variants and Advanced Concepts** Composite, iterative, multi-tape, multi-stack, and multi-track Turing machines. Universal Turing machines, Church's thesis, Post Correspondence Problem (PCP), Halting problem.	1,2	02
6	**6.1**	**Applications** Regular expressions for lexical analysis, text editing, and pattern searching; parsing techniques using leftmost and rightmost derivations; recursive functions and recursive and recursively enumerable languages to model computational aspects of natural language.	1,2,4	02
			Total	**26**

Sr. No	Suggested list of Tutorials
1	Design DFA accepting the given language.
	DFA Minimization Using Myhill-Nerode theorem (State Equivalence Algorithm), Table-Filling Method
2	Design Finite Automata with output (Moore and Mealy Machine), NFA to DFA conversion practice problems.
3	Understand how Finite Automata (FA) and Regular Expressions (RE) are connected, with a focus on designing FA from RE, creating RE for specific patterns, and converting between FA and RE.
4	Simplification of CFG, Normal Forms
5	Design/ Construct PDA accepting given language/grammar
6	Design a Turing machine to accept the given language.

7	Exploring Regular Expressions, Context-Free Grammar, Advanced Parsing Strategies, Recursive Functions, and a Gateway to NLP Applications in Modern Computing

Course Assessment:

Theory:

ISE1:
Activity: Tutorial, Quiz and assignments 20 Marks
ISE2:
Activity: Tutorials, Quiz and Assignments 20 Marks

MSE: 30 Marks 90 minutes written examination based on 50% syllabus
ESE: 30 Marks 90 Minutes written examination based on remaining syllabus after MSE

Tutorial:

ISE1:
20 marks based on first three tutorials as per the predefined rubrics.
ISE2:
30 marks based on remaining four tutorials as per the predefined rubric.

Recommended Books:

1. K.L.P. Mishra and N. Chandrasekaran, "Theory of Computer Science: Automata, Languages, and Computation", 2nd Edition, PHI Learning.
2. John E. Hopcroft, Rajeev Motwani, and Jeffrey D. Ullman, "Automata Theory, Languages, and Computation", 3rd Edition, Pearson.
3. Vivek Kulkarni, "Theory of Computation", Oxford Higher Education.
4. Michael Sipser, "Introduction to the Theory of Computation", Cengage Learning.
5. Peter Linz, "An Introduction to Formal Languages and Automata", Jones & Bartlett Learning.
6. Daniel A. Cohen, "Introduction to Computer Theory", Wiley Publication.
7. John C. Martin, "Introduction to Languages and the Theory of Computation", McGraw Hill.
8. E.V. Krishnamurthy, "Theory of Computer Science", EWP Publication.

Online Resources:

1. https://www.youtube.com/playlist?list=PL85CF9F4A047C7BF7
2. https://nptel.ac.in/courses/106104028

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PEC1CS11	Big Data Analytics	L	T	P	L	T	P	Total
		2	--	2	2	--	1	3
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	30	100	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes	Data base management system	
Course Outcomes	CO1	Explain building blocks of Big Data Analytics.
	CO2	Apply fundamental enabling techniques like Hadoop and MapReduce in solving real world problems.
	CO3	Understand different NoSQL systems and how it handles big data.
	CO4	Apply advanced techniques for emerging applications like stream analytics.
	CO5	Achieve adequate perspectives of big data analytics in various applications like recommender systems, social media applications, etc.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Big Data and Hadoop**	1,3	4
	1.1	Introduction to Big Data - Big Data characteristics and Types of Big Data -5 V's, Semi-structured and Structured, Sources of data, working with unstructured data, Big Data Analysis Life Cycle, Case Study of Big Data Solutions		
	1.2	Concept of Hadoop, Core Hadoop Components; Hadoop Ecosystem		
2		**Hadoop HDFS and MapReduce**	2	6
	2.1	Distributed File Systems: Physical Organization of Compute Nodes, Large Scale File-System Organization		
	2.2	MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping with Node Failures, Algorithms Using MapReduce: Matrix-Vector Multiplication by MapReduce, Computing Selections by MapReduce, Computing Projections by MapReduce, Union, Intersection, and Difference by MapReduce		
	2.3	Hadoop Technology Stack: Hive, Pig, Zookeeper, Swoop, oozie, flume etc., Hadoop Limitations		
3		**NoSQL**	2,3	6

	3.1	Introduction to NoSQL, NoSQL Business Drivers		
	3.2	NoSQL Data Architecture Patterns: Key-value stores, Graph stores, Column family (Bigtable) stores, Document stores, Variations of NoSQL architectural patterns, NoSQL Case Study		
	3.3	NoSQL solution for big data, Analyzing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer; Big data for E-Commerce Big data for blogs, Case Studies MongoDB and Cassandra, Graph Databases-Neo4j.		
4		**Mining Data Streams**	1,3	6
	4.1	The Stream Data Model: A Data-Stream-Management System, Examples of Stream Sources, Stream Queries, Issues in Stream Processing. Sampling Data techniques in a Stream		
	4.2	Filtering Streams: Bloom Filter with Analysis, Counting Distinct Elements in a Stream, Count Distinct Problem, Flajolet-Martin Algorithm, Combining Estimates, Space Requirements, Real time Analytics Platform (RTAP) applications		
	4.3	Counting Ones in a Window: The Cost of Exact Counts, The Datar- Gionis-Indyk-Motwani Algorithm, Query Answering in the DGIM Algorithm, Decaying Windows, Case Studies as Spark, Kafka.		
5		**Real-Time Big Data Models**	1,3	4
	5.1	A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering, Case Study: Product Recommendation		
	5.2	Social Networks as Graphs, Clustering of Social-Network Graphs, Direct Discovery of Communities in a social graph		
			Total	**26**

Module No.	Sr.no	Suggested List of experiments
1	**1**	Case Study-on big data and big data analysis (Walmart, Uber, Netflix, eBay, Zomato etc.)
2	**2**	Install Hadoop and Implement the following file management tasks in Hadoop: Adding files and directories Retrieving files Deleting files and directories.
2	**3**	• Develop a MapReduce program to implement Matrix Multiplication

		• Develop a Map Reduce program that mines weather data and displays appropriate messages indicating the weather conditions of the day.
2	**4**	• Develop a MapReduce program to find the tags associated with each movie by analyzing movie lens data. • Implement a word count program in Hadoop and Spark. • Use Hive to create, alter, and drop databases, tables, views, functions, and indexes.
3	**5**	Implement Functions: Count – Sort – Limit – Skip – Aggregate using MongoDB
	6	Case Studies on Cassandra or Graph Databases-Neo4j
4	**7**	• Implementation of Matrix algorithms in Spark Sql programming, • Building Spark Streaming application
	8	Implement bloom filter technology
5	**9**	Finding Communities in a social network graph
	10	Build recommendation system

Course Assessment:

Theory:

ISE1: 20 Marks
Activity: Conduct any two activities (each of 10 marks) like Assignments/ quiz/ crossword/ tutorial/ case study/ programming on first 50% syllabus
ISE2: 20 Marks
Activity: Conduct any two activities (each of 10 marks) like Assignments/ quiz/ crossword/ tutorial/ case study/ programming on next 50% syllabus

MSE: 30 Marks 90 minutes written examination based on 50% syllabus
ESE: 30 Marks 90 Minutes written examination based on remaining syllabus after MSE

Lab:

ISE1: will be conducted for first four experiments. Continuous pre-defined rubrics-based evaluation for 20 marks
ISE2: Rest six experiments. Continuous pre-defined rubrics-based evaluation for 30 marks.

Recommended Books:

1. Cre Anand Rajaraman and Jeff Ullman, "Mining of Massive Datasets", Cambridge University Press
2. Alex Holmes, "Hadoop in Practice", Manning Press, Dreamtech Press.

3. Dan Mcary and Ann Kelly, "Making Sense of NoSQL," A guide for managers and the rest of us, Manning Press.

Online Resources:

1. https://nptel.ac.in/courses/106104189
2. https://www.coursera.org/specializations/big-data#courses
3. https://www.digimat.in/nptel/courses/video/106106169/L01.html
4. https://www.coursera.org/learn/nosql-databases#syllabus
5. https://www.coursera.org/learn/basic-recommender-systems#syllabus

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PEC1CS21	Blockchain	L	T	P	L	T	P	Total
		2	--	2	2	--	1	3
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	30	100	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes	Python, Data structure	
Course Outcomes	CO1	Explain the Fundamental Concepts of Blockchain
	CO2	Examine Consensus Algorithms and Blockchain Security Challenges
	CO3	Analyze Cryptocurrencies and Bitcoin Mechanisms
	CO4	Evaluate Public and Private Blockchain Platforms
	CO5	Develop Smart Contracts using Solidity

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Introduction to Blockchain**		1,2	5
	1.1	What is a blockchain, Centralization vs. Decentralization, Blockchain defined- peer to peer, Distributed Ledger, Cryptographically Secure, Append-only, Updatable via consensus, The Structure of a Block, Block header, Genesis block, Mining, Rewards, Foundation of blockchain: Merkle trees		
	1.2	Components of blockchain, Types: Public,Private, and Consortium, Consensus Protocol- Proof-of-Work (PoW), Proof-of-Burn (PoB), Proof-of-Stake (PoS), and Proof-of-Elapsed Time (PoET), Limitations and Challenges of blockchain		
2	**Bitcoin and Cryptocurrency**		1,2	5
	2.1	Cryptocurrency: Bitcoin, Altcoin, and Tokens (Utility and Security), Cryptocurrency wallets: Hot and cold wallets, Cryptocurrency usage, Transactions in Blockchain, UTXO and double spending problem in Bitcoin		
	2.2	Mining difficulty, Mining pool, Private keys in Bitcoin, Public Keys in Bitcoin, Addresses in Bitcoin		
3	**Public Blockchain**		4	4
	3.1	Introduction to Public Blockchain, Ethereum and its Components, Mining in Ethereum, Ethereum Virtual Machine (EVM), Transaction, Accounts, Architecture and Workflow, Comparison between Bitcoin and		

		Ethereum		
	3.2	Types of test-networks used in Ethereum, Transferring Ethers using Metamask, Mist Wallet, Ethereum frameworks, Case study of Ganache for Ethereum blockchain. Exploring etherscan.io and ether block structure		
4	**Programming for Blockchain**		2	8
	4.1	Introduction to Smart Contracts, Types of Smart Contracts, Structure of a Smart Contract, Smart Contract Approaches, Limitations of Smart Contracts		
	4.2	Introduction to Programming: Solidity Programming – Basics, functions, Visibility and Activity Qualifiers, Address and Address Payable, Bytes and Enums, Arrays-Fixed and Dynamic Arrays, Special Arrays-Bytes and strings, Struct, Mapping, Inheritance, Error handling		
5	**Private Blockchain**		1,3,5	4
	5.1	Introduction, Key characteristics, Need of Private Blockchain, Smart Contract in a Private Environment, State Machine Replication, Consensus Algorithms for Private Blockchain - PAXOS and RAFT, Byzantine Faults: Byzantine Fault Tolerant (BFT) and Practical BFT		
	5.2	Introduction to Hyperledger, Tools and Frameworks, Hyperledger Fabric, Comparison between Hyperledger Fabric & OtherTechnologies		
	5.3	Hyperledger Fabric Architecture, Components of Hyperledger Fabric: MSP, Chain Codes, Transaction Flow, Working of Hyperledger Fabric, Creating Hyperledger Network, Case Study of Supply Chain Management using Hyperledger		
			Total	**26**

Sr. No.	Suggested List of Experiments
1	**Blockchain Implementation in Supply Chain Management** **Objective:** To analyze how blockchain enhances transparency and traceability in supply chains. **Experiments:** • Examine how blockchain is used for tracking goods in real-world supply chains (e.g., Walmart, IBM Food Trust). • Identify the advantages of using blockchain in logistics, including fraud prevention and efficiency. • Propose a simplified blockchain-based model for a supply chain and explain its working.
2	**Cryptocurrency Adoption and Financial Systems**

	Objective: To explore the role of cryptocurrencies in modern financial systems. **Experiments:** • Investigate the adoption of Bitcoin and other cryptocurrencies as legal tender (e.g., El Salvador's Bitcoin initiative). • Discuss the impact of decentralized finance (DeFi) on traditional banking. • Analyze risks such as volatility, regulatory challenges, and security issues in cryptocurrency transactions.
3	**UTXO Model and Double-Spending in Bitcoin** **Objective:** To understand the security model of Bitcoin transactions. **Experiments:** • Analyze a real-world Bitcoin transaction using blockchain explorers. • Explain how the UTXO model prevents double-spending. • Investigate historical double-spending attacks and how Bitcoin's consensus mechanism mitigates them.
4	**Smart Contract Vulnerabilities and Security Breaches** **Objective:** To study real-world smart contract failures and security risks. **Experiments:** • Examine high-profile smart contract vulnerabilities (e.g., The DAO hack, Parity wallet bug). • Identify common security issues such as reentrancy attacks and integer overflow. • Propose security best practices for developing secure smart contracts.
5	**Implementation of Private Blockchains in Enterprises** **Objective:** To explore how private blockchain networks are used in business applications. **Experiments:** • Investigate Hyperledger Fabric's role in enterprise blockchain solutions. • Compare Hyperledger Fabric with public blockchains like Ethereum in terms of security and scalability. • Analyze a real-world use case of Hyperledger Fabric in healthcare or finance.
6	**Hyperledger Fabric in Supply Chain Management** **Objective:** To understand how Hyperledger Fabric optimizes supply chain operations. **Experiments:** • Examine case studies where Hyperledger Fabric is used for tracking goods (e.g., IBM Food Trust). • Explain how smart contracts (chaincode) enforce rules in supply chain transactions. • Propose a simplified architecture for implementing Hyperledger Fabric in logistics.
7	**Future Trends in Blockchain Technology**

	Objective: To explore emerging innovations in blockchain technology. **Experiments:** • Analyze new blockchain developments such as Ethereum 2.0, Layer 2 solutions, and interoperability protocols. • Discuss the potential of quantum-safe cryptography in blockchain. • Explore the impact of blockchain on industries like IoT, AI, and digital identity management.
8	**Smart Contracts in Decentralized Finance (DeFi)** **Objective:** To analyze how smart contracts enable decentralized financial services. **Experiments:** • Study the working of DeFi platforms like Uniswap, Aave, or Compound. • Examine how smart contracts automate lending, borrowing, and trading without intermediaries. • Identify security vulnerabilities in DeFi smart contracts and suggest improvements.
9	**Ethereum's Role in NFTs and Digital Ownership** **Objective:** To explore how Ethereum powers the NFT (Non-Fungible Token) ecosystem. **Experiments:** • Analyze real-world NFT marketplaces like OpenSea and Rarible. • Explain how ERC-721 and ERC-1155 standards work for NFT creation and ownership. • Discuss challenges such as high gas fees, copyright issues, and NFT sustainability.
10	**Web3.js for Blockchain Interaction** **Objective:** To understand how Web3.js enables interaction with Ethereum smart contracts. **Experiments:** • Demonstrate how Web3.js connects a front-end application to an Ethereum smart contract. • Implement basic Web3.js functions like fetching blockchain data and executing transactions. • Explore real-world applications of Web3.js in dApps (Decentralized Applications).

Course Assessment:

Theory:

ISE1: Activity: Quiz and assignments 20 Marks
ISE2: Activity: Case studies/ Article Discussion/ Quiz/ Assignments 20 Marks
MSE: 30 Marks 90 minutes written examination based on 50% syllabus
ESE: 30 Marks 90 Minutes written examination based on remaining syllabus after MSE

Lab:

ISE1: will be conducted for four experiments. Continuous pre-defined rubrics-based evaluation for 20 marks

ISE2: Rest five experiments. Continuous pre-defined rubrics-based evaluation for 20 marks. Research paper presentation for 10 marks

Recommended Books:

1. Blockchain Technology, Chandramouli Subramanian, Asha A. George, Abhillash K. A and Meena Karthikeyen, Universities Press.
2. Mastering Ethereum, Building Smart Contract and Dapps, Andreas M. Antonopoulos Dr. Gavin Wood, O'reilly.
3. Imran Bashir, Mastering Blockchain: A deep dive into distributed ledgers, consensusprotocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more, 3rd Edition, Packt Publishing.
4. Blockchain with Hyperledger Fabric, Luc Desrosiers, Nitin Gaur, Salman A. Baset, Venkatraman Ramakrishna, Packt Publishing
5. Blockchin enabled Applications, Vikram Dhillon, DevidMetcalf, Max Hooper, Apress

Online Resources:

1. https://ethereum.org/en/
2. https://hyperledger-fabric.readthedocs.io/en/release-2.2/whatis.html
3. https://www.blockchain.com/
4. https://docs.soliditylang.org/en/v0.7.4

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
		2	--	2	2	--	1	3
25PEC1CS31	Image Processing	Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	30	100	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes		Linear algebra, Matrices
Course Outcomes	CO1	Apply Image enhancement techniques to enhance gray scale images
	CO2	Extracts discontinuities in an image using Segmentation techniques
	CO3	Demonstrate image compression techniques
	CO4	Perform operations on Image in transform domain
	CO5	Develop real world image processing application

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Digital Image Fundamentals and Enhancement**		1,4	7
	1.1	Digital Image Fundamentals: What is Digital Image Processing? Origins of Digital Image Processing, Examples of fields that use DIP, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Image Sampling and Quantization, Some Basic Relationships Between Pixels, Image File Formats: BMP, TIFF and JPEG.		
	1.2	Introduction to Image Enhancement: Gray Level Transformations, Zero Memory Point Operations, Histogram Processing, Neighborhood Processing, Spatial Filtering, Smoothing and Sharpening Filters		
2	**Image Segmentation**		1,2	5
	2.1	Segmentation based on Discontinuities (point, Line, Edge), Image Edge detection using Robert, Sobel, Previtt masks, Image Edge detection using Laplacian Mask, Edge linking		
	2.2	Region-Oriented Segmentation: Region growing by pixel Aggregation, Split and Merge		
3	**Image Compression**		1,2	6
	3.1	Introduction, Redundancy, Fidelity Criteria, Lossless Compression Techniques: Run length Coding, Arithmetic Coding, Huffman Coding		

	3.2	Lossy Compression Techniques: Improved Gray Scale Quantization, Vector Quantization		
4	**Image Transform**		3	5
	4.1	Introduction to Unitary Transforms, orthogonal transform, Discrete Fourier Transform (DFT), Inverse DFT, Properties of DFT, Fast Fourier Transform (FFT)		
	4.2	Discrete Hadamard Transform (DHT), Inverse DHT, Fast Hadamard Transform (FHT), Discrete Cosine transform (DCT), Inverse DCT, Walsh Transform, Haar transform, Basis images		
5	**Applications of Image Processing**		1,2,5	3
	5.1	Case Study on Digital Watermarking, Biometric Authentication (Face, Finger Print, Signature Recognition), Vehicle Number Plate Detection and Recognition, Object Detection using Correlation Principle, Person Tracking using DWT, Handwritten and Printed Character Recognition, Contend Based Image Retrieval, Text Compression etc.		
			Total	**26**

Suggested List of Experiments	
Sr. No.	Implementation of following methods in any programming language
1	Any two point processing image enhancement techniques
2	Histogram Equalization
3	Histogram matching
4	Spatial low pass and high pass filter
5	Edge detection using derivative filter
6	Region based edge detection
7	Lossless compression method
8	Lossy compression method
9	Generate Walsh transform of an image
10	Perform filtering in frequency domain

Course Assessment:

Theory:

ISE1: Two activities (each of 10 marks) Quiz/assignments/tutorial/ crossword/ seminar on first two module

ISE2: Two activities (each of 10 marks) Quiz/assignments/tutorial/ crossword/ seminar on next two module

MSE: 30 Marks 90 minutes written examination based on 50% syllabus

ESE: 30 Marks 90 Minutes written examination based on remaining syllabus after MSE

Lab:

ISE1: will be conducted for first five experiments. Continuous pre-defined rubrics-based evaluation for 20 marks

ISE2: Rest five experiments. Continuous pre-defined rubrics-based evaluation for 20 marks. Mini project developed on last module for 10 marks

Recommended Books:

1. R.C.Gonzalez & R.E.Woods, "Digital Image Processing", Pearson Education, 3rd edition, ISBN. 13:978-0131687288 .
2. William K. Pratt, "Digital Image Processing", John Wiley, NJ, 4th Edition,200
3. Anil K.Jain, Fundamentals of Digital Image Processing, Prentice Hall of India,2nd Edition,2004.
4. Sid Ahmed M.A., "Image Processing Theory, Algorithm and Architectures", McGraw-Hill, 1995.
5. S. Jayaraman Digital Image Processing TMH (McGraw Hill) publication, ISBN-13:978-0-07- 0144798

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25MDM031	Health, Wellness and Psychology	L	T	P	L	T	P	Total
		2	0	0	2	0	0	2
			Examination Scheme					
			ISE1	MSE	ISE2	ESE	Total	
		Theory	50	--	50	--	100	
		Lab	--	--	--	--	--	

Pre-requisite Course Codes		--
Course Outcomes	CO1	Introduce the concept of health, wellness and psychology, and understand its effectiveness in handling stress.
	CO2	Develop human strength and life-enhancement skills through recovery and goal setting.
	CO3	Apply the holistic well-being quotient for personal and professional benefits.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Psychology, Health and Wellness**		
	1.1	Understanding holistic health- Meaning, components of holistic health- components of wellbeing, Psychology of overall health-enhancing behaviors component, Types of health-compromising behaviors, Illness Management, and wellness enhancement.	1	4
	1.2	Nature and source of stress, personal and professional triggers of stress, Effects of stress, coping with stress (minimalistic yet effective exercise habits)	2	4
2		**Promoting Personal and Professional Wellness: Human Strengths & Life-Enhancement**		
	2.1	Strength: Definition, meaning; Realizing strength; Maximizing Unrealized strength Weakness: Definition, meaning; Identifying and overcoming weakness; Developing hope and optimistic approach.	2,3	4
	2.2	Recovery and Goal Setting: analyzing trends in personality, Approaching Individual differences; Meaning of Goal setting, Types and effectiveness of Goal Setting. Motivation: Meaning, Theory of Needs, 4A's of coping with stress during or after goal setting.	2	4
	2.3	Eudaimonic Wellness: Meaning and characteristics; concept of defensive coping.	1,4	2
3		**Positive Approach and The Psychology of Living in The**		

		Present		
	3.1	The Psychology of Living in the Present: meaning, self-registering to the flow of positive thoughts and actions; addressing positive and negative emotions; Eliminating daily hassles, creating happiness. Responding to overthinking: Sociocultural factors and self- realization.	1,2, 4	4
	3.2	Resilience: Meaning and Nature; How to build resilience; Self-communication and self-care, reframe thoughts; channelize gratitude; practice resilience building: physical and mental exercises.	1,2, 4	4
			Total	26

Course Assessment:

ISE1:

Certification: 50 marks
NPTEL/ Swayam/any other authentic portal certification
https://archive.nptel.ac.in/courses/109/103/109103182/
https://onlinecourses.nptel.ac.in/noc23_hs06/preview

ISE2:

a. Health and Wellness: Introduce Group Happiness Project. Group work: Meet, exchange, contact, collect info, talk about why you chose this topic, brainstorm ideas, and present people's opinions in your designed PPT. 30 marks
b. Psychology of wellness or happiness: Case Study and Brief Report on : Chris Gardener in the Pursuit of Happyness (Group-specific interpretation) 20 Marks

Recommended Books:

1. Emmons, R.A., & McCullough, M.E. (2003). Counting blessings versus burdens: An experimental investigation of gratitude and subjective well-being in daily life. Journal of Personality & Social Psychology, 88, 377-389
2. Carpenter, S. (2012). Awakening to sleep. Monitor on Psychology, 44 (1), 40.
3. Emmons, R. A., & Mishra, A. (2012). Why gratitude enhances well-being: What we know, What We Need to Know.
4. Carr, A. (2004). Positive Psychology: The science of happiness and human strength UK Routledge.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
25MDM032	Emotional and Spiritual Intelligence	2	0	0	2	0	0	2
			Examination Scheme					
			ISEI	MSE	ISE2	ESE	Total	
		Theory	50	---	50	---	100	
		Lab	---	---	---	---	---	

Pre-requisite Course Codes		-----
Course Outcomes	CO1	Introduce the concept of emotional intelligence, its models, components and measures of emotional intelligence
	CO2	Understand the significance of emotional intelligence in self-growth and building effective relationships, Understand the professional impact of emotional intelligence
	CO3	Develop a wide range of work and life skills.
	CO4	Display spiritual intelligence in different roles.
	CO5	Apply the spiritual quotient for corporate benefits.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Fundamentals of Emotional Intelligence**		
	1.1	Emotion- Meaning, characteristics of emotion, components of emotion- cognitive component, physiological component, Behavioural component. Types of emotions, exposing the myths about emotion, physiological or bodily changes accompanying emotions, how emotions affect our thinking and actions	1	3
	1.2	Nature and Significance of EI, Models of emotional intelligence: Ability, Trait and Mixed, Building blocks of emotional intelligence: self-awareness, self- management, social awareness, and relationship management	2	3
2		**Personal and Social Competence**		
	2.1	Self-Awareness: Observing and recognizing one's own feelings, Knowing one's strengths and areas of development Self-Management: Managing emotions, anxiety, fear, and anger	2	3
	2.2	Social Awareness: Others' Perspectives, Empathy and Compassion Relationship Management: Effective communication, Collaboration, Teamwork, and Conflict management (professional impact)	2	3
	2.3	Strategies to develop and enhance emotional intelligence and using them effectively in professional life	1	2

3		**Background and Approach: Spiritual Intelligence and Karma Yoga**		
	3.1	• Spiritual Intelligence- Definition, need, state of presence, psychological element, Intuitive intelligence. • Foundation of Spiritual Intelligence • Types of spiritual actions • Models- SQ and SI-Growth model • Yoga of Action and Spirituality: Professionalism	6,8	3
	3.2	• Types of spiritual actions • Models- SQ and SI-Growth model • Readiness for spiritual intelligence: self-leadership, synthesize high performance, spiritual awareness, neuropsychology, and state of conscious identity.	5, 7	3
4		**Opposite Polarity in SI and Overall Impact on Personality**		
	4.1	• Twin poles of attention- subject and the object pole • Benefits of Spiritual Intelligence- personal, social and corporate • Dimensions of Spiritual Intelligence- SI and Self Esteem, SI and Restoration of confidence • SI and clarity of thoughts and speech, Personality moulding and SI.	8	4
5	**5.1**	**Spiritual Ecology and Environmental Grassroots Activism**		
		• Spiritual Stewardship and Ecology: Case studies based on making a difference in ecology through environmental grassroots activism	4	2
			Total	26

Course Assessment:

ISE1:

Certification: 50 marks
NPTEL/ Swayam/ Farmer space Certification
https://onlinecourses.swayam2.ac.in/aic22_ge23/preview
https://www.framerspace.com/course/-Mx9gV_of5-self-directed-emotional-learning-for-empathy-and-kindness-short-course?cid=64815e6241de0ce10ee9c717

ISE-2:

1. Emotional Intelligence: Identifying emotions and applying it to personal and professional situations 20 marks
2. Spiritual Intelligence: Performing solutions based on given problems 30 Marks

Recommended Books:

1. Bar-On, R., & Parker, J.D.A.(Eds.) (2000). The handbook of emotional intelligence, San Francisco, California: Jossey Bros.
2. Goleman, D. (2005). Emotional Intelligence. New York: Bantam Book.

3. Sternberg, R. J. (Ed.). (2000). Handbook of intelligence. Cambridge University Press.
4. Thich Nhat Hanh, V. S. (2016). Spiritual Ecology: The Cry of the Earth. Golden Sufi Center.
5. Vivekananda, S. (2015). The Complete Book of Yoga. Solar Books.
6. Yogananda, P. (1946). Autobiography of a Yogi. Thomas Press Ltd.
7. Krishnaswami, O. (2006). Karma Yoga: Yoga of Action. Dev Publishers.
8. Buzan, T. (2001). Power of Spiritual Intelligence: 10 Ways to Tap into Your Spiritual Genius.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25OECS31	Embedded Systems	L	T	P	L	T	P	Total
		1	--	2	1	--	1	2
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	10	15	10	15	50	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes	Digital Electronics	
	At the End of the course students will be able to:	
Course Outcomes (CO)	CO1	Identify and describe various characteristic features and applications of Embedded systems
	CO2	Analyse and select hardware for Embedded system implementation
	CO3	Compare GPOS and RTOS and investigate the concepts of RTOS
	CO4	Evaluate and use various tools for testing and debugging embedded systems.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Embedded Systems**		02
	1.1	Definition, Characteristics, Classification, Applications	1,2	
	1.2	Design metrics of Embedded system and Challenges in optimization of metrics	1,2	
2		**Embedded system hardware**		04
	2.1	Hardware components of Embedded systems	1,2	
	2.2	Sensors an Actuators: Criteria for selection (with examples)	1,2	
	2.3	Communication Interfaces: I2C, CAN	1,2	
	2.4	Low-power Embedded system design	1,2	
3		**Embedded system software**		
	3.1	Real-time Operating system (RTOS): Need of RTOS in Embedded systems, Comparison with GPOS, Task, Task states, Multi-tasking, Task scheduling methods-Pre-emptive, Shortest Job First, Round-Robin, Priority, Rate Monotonic Scheduling, Earliest Deadline First.	2,3	05

	3.2	Inter-process communication: Usage of Semaphores Task synchronization: Issues, Deadlock condition and solutions Shared data problem, Priority inversion.	2,3	
4		**Testing /Debugging and System Integration**		**02**
	4.1	Hardware testing tools, White-Box and Black-Box testing.	2	
	4.2	Embedded Product Design Life-Cycle (EDLC)- Waterfall Model, Hardware-Software Co-design	2	
			Total	**13**

Sr.no	**Suggested List of experiments**	**Ref.**
1	Interfacing of LEDs /switches with any embedded core.	4
2	Interfacing of LCD/ Seven segment display with any embedded core.	4
3	Interfacing of Temperature sensor with any embedded core.	4
4	Implement the I2C communication to connect to DS1307 RTC	2
5	Implement a power saving mode with any embedded core	2
6	Porting of Free RTOS to Arduino/STM32.	5
7	Write a Program to Create Multiple Tasks and understand the Multitasking capabilities of RTOS (Free RTOS).	5
8	Write a Program to illustrate the use of Binary and Counting Semaphore for Task Synchronisation using Free RTOS.	5

Course Assessment:

Theory:

ISE1: Think-Pair- Share activity (any case study) -10 marks
ISE2: Assignment/Oral -10 marks

MSE: 15 Marks 60 minutes written examination based on 50% syllabus
ESE: 15 Marks 60 minutes written examination based on remaining syllabus after MSE

Lab:

ISE1 will be conducted for four experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.
ISE2 will be conducted for four experiments. Continuous pre-defined rubrics-based evaluation for 20 marks. Mini-project on design of an embedded system for any application for 10 marks

Recommended Books:

1. 1.Dr. K.V. K. K. Prasad, "Embedded Real Time System: Concepts, Design and Programming", Dreamtech, New Delhi, Edition 2014.

2. Rajkamal, "Embedded Systems: Architecture, Programming and Design", McGraw Hill Education (India) Private Limited, New Delhi, 2015, Edition 3rd.
3. Sriram Iyer, Pankaj Gupta, "Embedded Real Time Systems Programming", Tata McGraw Hill Publishing Company ltd., 2003.
4. M. A. Mazidi, J. C. Mazidi, Rolin D. McKinlay, "The 8051 Microcontroller and Embedded Systems
5. Using Assembly and C", Pearson Education, Second Edition, 2007.
6. www.freertos.org

Further Reading:

1. David Simon, "An Embedded Software Primer", Pearson, 2009.
2. Jonathan W. Valvano, "Embedded Microcomputer Systems – Real Time Interfacing", Publisher - Cengage Learning, 2012 Edition 3rd.
3. 3.FrankVahid, Tony Givargis, "Embedded System Design – A Unified Hardware/Software Introduction", John Wiley & Sons Inc., 2002.
4. Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, New Delhi, 2009

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25OECS32	Internet of Things (IOT)	L	T	P	L	T	P	Total
		1	--	2	1	--	1	2
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	10	15	10	15	50	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes	Introduction to emerging Technologies	
Course Outcomes	CO1	Explain the fundamentals of IoT and Industry 4.0, including their architectures, protocols, and applications. (Cognitive Level: Understand)
	CO2	Apply networking and communication protocols like MQTT, CoAP, and LoRa to design efficient IoT systems. (Cognitive Level: Apply)
	CO3	Analyze the requirements for IoT system design and development, integrating hardware platforms and software tools for real-world applications. (Cognitive Level: Analyze)
	CO4	Use appropriate tools to process and visualize real-time data. (Cognitive Level: Apply)
	CO5	Examine emerging trends such as AI in IoT, edge computing, and 5G to identify their potential impact on IoT and Industry 4.0 ecosystems. (Cognitive Level: Analyze)

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Module 1: Introduction to IoT and Industry 4.0**	1	3
	1.1	Concepts of IoT: Architecture, protocols, and standards..		
	1.2	Industry 4.0 Fundamentals: Smart factories, cyber-physical systems (CPS), and digital twins.		
	1.3	IoT Applications: Smart cities, healthcare, agriculture, and autonomous systems.		
	1.4	Technological Pillars of Industry 4.0: IoT, AI, big data, and robotics integration		
2		**Module 2: IoT Protocols and Networking**	1	3
	2.1	Networking Basics for IoT: IP-based and non-IP-based protocols.		
	2.2	IoT Communication Protocols: MQTT, CoAP, HTTP, LoRa, Zigbee, BLE, and 6LoWPAN.		
	2.3	Edge and Fog Computing: Concepts and role in IoT data processing		

	2.4	Security in IoT Networks: Challenges and solutions.		
		Module 3: IoT System Design and Development		
3		**IoT System Design and Development**	2	3
	3.1	IoT Hardware Platforms: Arduino, ESP32, and Raspberry Pi		
	3.2	IoT Software Tools: IDEs, Node-RED, and cloud platforms (AWS IoT, Google Cloud IoT).		
	3.3	Sensor and Actuator Integration: Types, working, and interfacing techniques.		
	3.4	Design Methodologies: Energy efficiency, scalability, and fault tolerance.		
		Module 4: IoT Data Management and Analytics	3	3
4	**4.1**	Data Analytics: Role of big data and machine learning in IoT. Visualization Tools: Grafana, Tableau, and Power BI.		
	4.2	IoT Data Lifecycle: Acquisition, transmission, storage, and visualization		
	4.3	IoT Databases: Time-series databases and NoSQL		
5		**Industry 4.0 Use Cases and IoT Applications, Future Trends and Emerging Technologies**	4	3
	5.1	Smart Manufacturing: Automation, predictive maintenance, and robotics.		
	5.2	IoT in Logistics and Supply Chain: RFID, smart tracking, and inventory management.		
	5.3	IoT in Renewable Energy: Smart grids, monitoring, and optimization		
	5.4	AI in IoT: Role of machine learning and deep learning. 5G and IoT: Opportunities and challenges. Edge AI: Combining IoT devices with AI at the edge. Sustainability in IoT: Energy-efficient frameworks and green IoT.		
			Total	**15**

Module No.	Sr.no	Suggested List of experiments	Hrs.
1	1	Experiment: Setup and Configuration of an IoT Development Board Objective: Install and configure ESP32 or Raspberry Pi for IoT projects. Tools: Arduino IDE, Python.	2
2	2	Experiment: Implement MQTT for Sensor Data Communication Objective: Transmit real-time sensor data to a cloud platform using MQTT. Tools: MQTT.fx, HiveMQ.	2
	3	Experiment: Compare IoT Protocols (CoAP vs. MQTT)	

		Objective: Analyze energy consumption and latency differences between protocols. Tools: Python, Wireshark.	
	4	Experiment: LoRa Communication Setup Objective: Establish communication between two LoRa nodes and measure range. Tools: LoRa modules, Arduino IDE.	2
3	5	Experiment: Interfacing Sensors and Actuators Objective: Interface temperature, humidity, and motion sensors with ESP32 to trigger an actuator. Tools: Arduino IDE, Blynk App.	2
	6	Experiment: Build a Smart Home Automation System Objective: Control appliances using voice commands via Google Assistant. Tools: ESP32, Node-RED, Google API.	4
	7	Experiment: IoT-Based Energy Monitoring Objective: Monitor and analyze household energy consumption in real-time. Tools: ESP32, Current Sensor, ThingSpeak.	4
4	8	Experiment: IoT Data Visualization Using Grafana Objective: Collect sensor data and visualize it in Grafana dashboards. Tools: InfluxDB, Grafana.	2
	9	Experiment: Real-Time IoT Data Analytics Objective: Perform basic analytics on IoT data (e.g., finding temperature trends). Tools: Python, Pandas, Matplotlib.	2
5	10	INDUSTRIAL VISIT	6

Course Assessment:

Theory:

ISE1:

Activity: Quiz and assignments 10 Marks
Case Study Presentation

ISE2:

Activity: Article Discussion, Quiz and Assignments 10 Marks
Outcome: Reflective Journal

MSE: 15 Marks 60 minutes written examination based on 50% syllabus
ESE: 15 Marks 60 minutes written examination based on remaining syllabus after MSE

Lab:

ISE1 will be conducted for four or 50% of experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.

ISE2

a. Remaining Four experiments or 50% of experiments. Continuous pre-defined rubrics-based evaluation for 30 marks.

b. Simulation using modern tools to solve the given problem statement for 10 marks/Mini project

Recommended Books:

1. Arshdeep Bahga, Vijay Madisetti "Internet of Things: A Hands-On Approach" Publisher: Orient Blackswan Private Limited - New Delhi
2. Peter Waher, "Mastering Internet of Things: Design and Create Your Own IoT Applications", Packt Publishing (March 28, 2018); eBook (Free Edition)
3. Perry Lea," "IoT and Edge Computing for Architects: Implementing Edge and IoT Systems from Sensors to Clouds with Azure IoT and AWS IoT Core", Publisher(s): Packt Publishing ISBN: 9781839214806
4. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Publisher New York, NY : Apress
5. David Hanes, Gonzalo Salgueiro, Rob Barton," IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things" Released June 2017Publisher(s): Cisco Press ISBN: 978013430709

Online Resources:

https://onlinelibrary.wiley.com/doi/book/10.1002/9781119740780?msockid=0d711fd0b87062382ca90a8bb9c26374(Print ISBN:9781119740759 |Online ISBN:9781119740780 |DOI:10.1002/9781119740780)

Further Reading:

1. Adrian McEwen, Hakim Cassimally, "Designing the Internet of Things"
2. Klaus Schwab, "The Fourth Industrial Revolution"

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
		1	--	2	1	--	1	2
25OECS33	E-Vehicle	Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	10	15	10	15		
		Practical	20	--	30	--	50	

Pre-requisite Course Codes		Digital Electronics
Course Outcomes	CO1	Describe significance of Electric vehicle for sustainability.
	CO2	Design and modelling of EV power train.
	CO3	Describe Electric motor speed control and regenerative braking.
	CO4	Describe battery monitoring and thermal protection.
	CO5	Describe vehicle control units and communication protocols.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction to Electric Vehicles	1,2	3
	1.1	Introduction to Electric vehicles, Advantages and significance of EVs, motors and power electronics		
	1.2	Different powertrain configuration of EVs and Hybrid vehicles.		
2		Components of EV Powertrain	1,2	6
	2.1	Vehicle modelling, Vehicle dynamics , drive cycle ,Basics of Power train simulation.		
	2.2	Sizing and specifications of different sub-systems, Role of Power Electronics and Motors in EVs.		
3		EV Motor Drive and Control:	1,4,5	6
	3.1	Introduction to different types of motors used in EVs and their comparison, Selection of Electric motor .		
	3.2	Overview of speed control of BLDC and PMSM, Regenerative braking concept, energy saving		
4		Battery Packs and Battery management System	1,4,5	6
	4.1	Different battery technologies, Advantages of Lithium ion battery , Battery pack , Battery specifications and selection criteria.		
	4.2	Battery monitoring and Protection , Thermal management, circuits and techniques for Battery management system (BMS)		
5		Vehicle Control and Communication	1,4,5	3

	5.1	Features and functionality of Vehicle Control Unit, Architecture and Protocols of VCUs, Communications requirements		
6		EV Safety & Standards:	1,4	**2**
	6.1	Safety aspects and protection arrangements, International and national standards		
			Total	**26**

Sr. no	**Suggested List of experiments**	**Hrs.**
1	Study of different powertrain configuration.	2
2	Vehicle modelling and Simulation .	3
3	Drive cycle simulation and plot under various driving conditions.	2
4	Design of simple battery charger circuit.	2
5	Design of Thermal protection circuit for EV.	2
6	Study of Electric motor speed control.	2
7	Survey report generation on EV Safety & Standards:	2
8	Mini project, case study :-Design and simulation study of any EV model available in the market.	5

Course Assessment:

Theory:

ISE1: Activity: Quiz and assignments, Practical assignment 20 Marks
ISE2: Activity: Crossword, MCQs, Quiz and Assignments
MSE: 15 Marks 60 minutes written examination based on 50% syllabus
ESE: 15 Marks 60 minutes written examination based on remaining syllabus after MSE

Lab:

ISE1:

ISE1 will be conducted for four or 50% of experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.

ISE2

a. Remaining Four experiments or 50% of experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.
b. Simulation using modern tools to solve the given problem statement for 10 marks/Mini project

Recommended Books:

1. Ali Emadi, "Advanced Electric Drive Vehicles", CRC Press, 2015

2. Mehrdad Ehsani, Yimin Gao and Ali Emadi, "Modern electric, hybrid electric and fuel cell vehicles : fundamentals, theory and design", CRC Press ; 2010 (available in IITB library)
3. James Larminie, John Lowry "Electric Vehicle Technology Explained", John Wiley & Sons Ltd, 2003 (available in IITB library)
4. Rodrigo Garcia-Valle, Joao A. Pecas Lopes, "Electric Vehicle Integration into Modern Power Networks", Springer, 2013
5. Ali Emadi, "Handbook of Automotive Power Electronics and Motor Drives", Taylor & Francis, 200

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25OECS34	Supply Chain Management	L	T	P	L	T	P	Total
		1	--	2	1	--	2	2
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	10	15	10	15	50	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes		--
Course Outcomes	CO1	Importance of Supply Chain Management (SCM) and its phases in any business.
	CO2	Identify the drivers of supply chain performance and uncertainty in supply chain management.
	CO3	Understand the core model and distribution technique in Supply chain
	CO4	Understand IT framework, strategies and techniques to minimize overall logistics cost
	CO5	Understand the role of digitization in supply chain management leading to sustainability

Module No.	Topics	Ref	Hrs.
1	Objectives of a Supply Chain Management, Value Chain Process and Cycle view of Supply Chain Process, Push Pull in SC, Design Phases stage, logistics & SCM	1,3	02
2	Supply Chain Drivers /decisions and obstacles, Supply chain strategies & strategic fit.	2	03
3	SCOR Model, Factors influencing distribution network design, Design options for distribution network	1,2	02
4	IT Framework and sustainable Supply Chain management, data analysis in SC, IoT role in SC	3	03
5	Blockchain in: Warehouse Management System (WMS), Transport Management System (TMS), ERP (SAP) and integration of technology, Logistics Vs Reverse Logistics	5	03
	Total		13

Course Assessment:

Theory:

ISE1: Quiz (10 Marks)

ISE2: Quiz (10 Marks)

MSE: 15 Marks 60 minutes written examination based on 50% syllabus

ESE: 15 Marks 60 minutes written examination based on remaining syllabus after MSE

Lab :

ISE1

Assignment write up / presentation on

- Supply Chain Drivers: Strategic fit and Uncertainty
- Supply Chain Management and its Components in modern Business

OR

- Supply Chain Network Design: Facility location analysis, distribution center network optimization
- Procurement Strategies: Sourcing, supplier selection, negotiation tactics

OR

- One assignment each on module 1, 2 and 3. Continuous pre-defined rubrics-based evaluation for 20 marks**.**

ISE-2

- Enterprise Resource Planning (ERP) Systems: Functionality, data integration, modules relevant to SCM
- Blockchain Technology in SCM: Traceability, transparency, smart contracts

OR

- Sustainable Supply Chain Practices: Environmental considerations in sourcing and logistics
- Transportation Management Systems (TMS): Route planning, carrier selection, shipment tracking

OR

- One assignment each on module 4, 5 and 6 followed by Presentation by groups based on recent updates on SC.

AND

- Data Analytics in SCM: Data mining, visualization, predictive modeling for supply chain decision-making

Recommended Books:

1. Sunil Chopra, P. Meindl, "Supply Chain Management", 6th Edition 2016, Pearson Education Asia.
2. D. Simchi-Levi, P. Kaminsky, E. Simchi-Levi, and Ravi Shankar, "Designing and Managing the Supply Chain concepts, Strategies and Case studies", 3rd Edition, Tata McGraw Hill, New Delhi, 2008
3. Rahul V Altekar, "Supply Chain Management: Concepts and cases", Edition 2009, PHI, ISBN: 9788120328594. Quality Control, 3rd edition, D. H. Besterfield, Pearson Education (2012).
4. R.P. Mohanty, S.G. Deshmukh, "Essentials of Supply Chain management", 1st Edition 2004, Jaico Publishing House.
5. Priyanka Chawla, Adarsh Kumar, Anand Nayyar, Mohd Naved "Blockchain, IoT, and AI Technologies for Supply Chain Management", Edition 1, CRC Press.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25OECS35	Design of Experiments	L	T	P	L	T	P	Total
		1	--	2	1	--	2	2
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	10	15	10	15	50	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes		--
Course Outcomes	CO1	Learner will be able to plan data collection, to turn data into information and to make decisions that lead to appropriate action
	CO2	Learner will be able to plan and analyse full factorial Experiments
	CO3	Learner will be able to plan and analyse fractional factorial Experiments
	CO4	Learner will be able to apply principles of Robust Design

Module No.	Topics	Ref	Hrs.
1	Introduction 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments	1,2	02
2	**Two-Level Factorial Designs and Analysis** 2.1 The 2^2 Design 2.2 The 2^3 Design 2.3 The General2^k Design 2.4 A Single Replicate of the 2^k Design	1,2	03
3	**Two-Level Fractional Factorial Designs and Analysis** 3.1 The One-Half Fraction of the 2^k Design 3.2 The One-Quarter Fraction of the 2^k Design 3.3 The General 2^{k-p} Fractional Factorial Design	1,2	02
4	**Taguchi Approach** 4.1 Crossed Array Designs and Signal-to-Noise Ratios 4.2 Analysis Methods 4.3 Robust design examples	3	03
5	5.1 Latin Square Designs 5.2 Conducting ANOVA 5.3 Regression Analysis 5.4 Response Surface Methodology	3	03
		Total	**13**

Lab:

Sr No	Assignment write up / presentation on/Case Study/Mini Project/Computer Based Analysis using suitable Software	No of Hours	ISE Evaluation
1	Deciding Strategy of Experimentation	4	**ISE 1**_Continuous pre-defined rubrics-based evaluation for 20 marks.
2	Full Factorial Experiment	4	
3	Fractional Factorial Experiment	4	
4	Taguchi's Robust Design Methodology	4	**ISE 2**_Continuous pre-defined rubrics-based evaluation for 30 marks.
5	Latin Square Design	4	
6	ANOVA	4	
	Total	24 Hours	

Course Assessment:

Theory:

ISE1: Quiz (10 Marks)
ISE2: Quiz (10 Marks)

MSE: 15 Marks 60 minutes written examination based on 50% syllabus
ESE: 15 Marks 60 minutes written examination based on remaining syllabus after MSE

Recommended Books:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Practical Experiment Designs for Engineers and Scientists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T. Voss
6. Quality Engineering Using Robust Design, Madhav S. Phadke

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
25OECS36	3D Printing	1	-	2	1	--	1	2
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	10	15	10	15	50	
		Tutorial	20	--	30	--	50	

Pre-requisite Course Codes		--
Course Outcomes	CO1	Illustrate understanding of various cost-effective alternatives for manufacturing products and select the feasible 3D Printing for specific technical application
	CO2	Understand and apply the principles of liquid-based rapid prototyping and tooling processes to build and generate data for additive manufacturing of various objects.
	CO3	Understand and apply the principles of solid-based rapid prototyping systems for efficient 3D Printing and product development.
	CO4	Understand and apply the principles of powder-based 3D Printing systems for efficient prototyping and production of complex geometries.
	CO5	Understand and apply reverse engineering techniques in additive manufacturing to reconstruct, modify, and optimize existing designs for manufacturing and prototyping.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	Introduction to 3D Printing, its historical development, advantages. Classification of 3D Printing process, Advantages & Disadvantages, Applications to various fields, Rapid Tooling, Design Consideration.	1-8	3
2	2.1	**Liquid-Based Systems:** Stereolithography (SLA): Photopolymerization process, Working Principle, Material used, Advantages and limitation, Application	1-8	3
3	3.1	**Solid based system:** FDM (Fused Deposition Modelling) System: Working Principle, Material used, Advantages and limitation, Application.	1-8	2

4	**4.1**	**Powder Based Systems:** SLS (Selective Laser Sintering): Working Principle, Material used , Advantages and limitation, Application.	1-8	3
5	**5.1**	**Reverse Engineering:** Data Extraction, Data Processing.		2
			Total	**13**

Tutorial:

Sr. No.	Suggested list of Experiments
1	Modelling of a component using 3D modelling software
2	Segmentation in Slicer's Segment Editor module for the purpose of 3D printing.
3	Application of various design considerations in 3D component printing.
4	Development of physical 3D component using any one of the Additive manufacturing processes

Course Assessment:

Theory:

ISE1:
Activity: Quizzes/Assignment on first two modules (10 Marks)

ISE2:
Activity: Quizzes/Assignment on last three modules (10 Marks)

MSE: 15 Marks 60 minutes written examination based on 50% syllabus

ESE: 15 Marks 60 minutes written examination based on remaining syllabus after MSE

Lab:

ISE1
First 2 Practical's (20 marks)
Continuous pre-defined rubrics-based evaluation for 20 marks.

ISE2
Next 2 Practical's (30 marks)
Continuous pre-defined rubrics-based evaluation for 30 marks

Recommended Books:

1. Chua C.K., Leong K.F., and Lim C.S., "Rapid Prototyping Principles and Applications",
2. World Publishing Co. Pte. Ltd.
3. Gibson, D.W. Rosen, and B. Stucker, "Additive Manufacturing Technologies Rapid
4. Prototyping to Direct Digital Manufacturing", 2010, Springer Inc.
5. Ali Kamrani, Emad Abouel Nasr, "Rapid Prototyping Theory and Practice", 2006, Springer

6. Rafiq Noorani, Rapid Prototyping: Principles and Applications, John Wiley & Sons, Inc.,
2006, ISBN 0-471-73001-7
7. James O. Hamblen, and Michael D. Furman, "Rapid Prototyping of Digital Systems", Kluwer Academic Publishers.
8. Kenneth G. Cooper, "Rapid Prototyping Technology Selection and Application", 2001,
Marcel Dekker Inc, New York.

Links for online NPTEL/SWAYAM courses:

1. https://onlinecourses.nptel.ac.in/noc24_me138/preview
2. https://onlinecourses.nptel.ac.in/noc22_me74/preview
3. https://onlinecourses.nptel.ac.in/noc22_me130/preview
4. https://onlinecourses.nptel.ac.in/noc25_mm02/preview

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
25OECS37	High Performance Computing	1	-	2	1	--	1	2
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	10	15	10	15	50	
		Tutorial	20	--	30	--	50	

Pre-requisite Course Codes		Programming fundamentals, Computer network
Course Outcomes	CO1	Appraise the modern high-performance architectures.
	CO2	Create fast, powerful, energy -efficient programs that scale to tackle big data.
	CO3	Engineering and computing to utilize high performing heterogeneous resources
	CO4	Design high performance applications in Multi-core processors.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Parallel Programming & Computing - Introduction**	1,3	4
	1.1	Era of Computing, Parallel Computing, Multiprocessors and Multicomputer Architectures,		
	1.2	Scalar VS Vector Processing, Multivector and Superscalar Machines, Pipelined Processors,		
	1.3	SIMD Computers, Conditions of parallelism, Program flow mechanisms,		
	1.4	Types of Parallelism – ILP, PLP, LLP, Program Partitioning and scheduling.		
2		**Introduction to High Performance Computing**	1,3	4
	2.1	Era of Computing, Scalable Parallel Computer Architectures, towards low-cost computing,		
	2.2	Network of Workstations project by Berkeley, Cluster Computing Architecture,		
	2.3	Components, Cluster Middleware and SSI		
	2.4	Need of Resource Management and Scheduling, Programming Environments		
3		**Cluster Computing**	2	4
	3.1	Clustering Models, Clustering Architectures, Clustering Architectures key factors,		
	3.2	types of clusters, Mission critical Vs Business Critical Applications		

	3.3	Fault Detection and Masking Algorithms, Check pointing, Heartbeats, Watchdog Timers, Fault recovery through Failover and Failback Concepts		
4		**High Speed Networks & Message Passing**	1,3	4
	4.1	Introduction to High-Speed Networks, Lightweight Messaging Systems,		
	4.2	Xpress Transport Protocol, Software RAID and Parallel File systems,		
	4.3	Load Balancing Over Networks – Algorithms and Applications,		
	4.4	Job Scheduling approaches and Resource Management in Cluster		

Sr.no	Suggested List of experiments
1	Write an algorithm and program to perform matrix multiplication of two n * n matrices on the 2-D mesh SIMD model, Hypercube SIMD Model or multiprocessor system.
2	Implement Pipelines using OpenMp.
3	Study of the Jacobi algorithm.
4	Study of Dense matrix transpose.
5	Study of the Sparse matrix-vector multiply
6	Case study-NCR Life keeper and Oracle Failsafe
7	Case study-Linux Network Load Balancing
8	Case study-Legion – Object based Meta System
9	Case study-Web Flow - framework for the wide-area distributed computing and meta computing
10	Study of the all pair shortest path All-pairs Dijkstra's algorithm
11	Study of the all pair shortest path All-pairs Floyd's algorithm
	Mini project/Presentation/Group activity/ Simulation using modern tools

Course Assessment:

Theory:

ISE-1: Activity: Quiz / Crosswords 10 marks
ISE-2: Activity: Memory design with interrupt controller (Poster) 10 marks

MSE: 15 Marks 60 minutes written examination based on 50% syllabus
ESE: 15 Marks 60 minutes written examination based on remaining syllabus after MSE

Lab:

ISE1: will be conducted for four experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.
ISE2: Will be conducted for next Four experiments. Continuous pre-defined rubrics-based evaluation for 20 marks. Activity: Mini-Project. 10 marks.

Recommended Books:

1. Rajkumar, High Performance Cluster Computing: Architectures and Systems, Vol. 1 Pearson Education
2. Georg Hager and Gerhard Wellein, Introduction to High Performance Computing for Scientists and Engineers, CRC Press
3. Kai Hwang, Advanced Computer Architecture: Parallelism, Scalability, Programmability, McGraw Hill International Editions

Online Recourses:

1. Course Name: High Performance Computing
   Link: https://nptel.ac.in/courses/106/108/106108055/
2. Course Name: High Performance Computing Architecture
   Link: https://nptel.ac.in/courses/106/105/106105033/

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PCC13CS16	Cryptography and Computer Security	L	T	P	L	T	P	Total
		2	--	2	2	--	1	3
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	30	100	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes		Computer Network
Course Outcomes	CO1	Apply concepts of modular arithmetic and number theory to classical encryption techniques to achieve system security goals.
	CO2	Apply modern cryptographic techniques to a given problem
	CO3	Analyze various hash functions and digital signature algorithms to authenticate and verify integrity
	CO4	Analyze various attacks on network security, and different security protocols.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction - Number Theory and Basic Cryptography**	1,2	8
	1.1	Security Goals, Security Attacks, Security Services and Security Mechanisms		
	1.2	Modular Arithmetic: Prime No, Euclidean Algorithm, Extended Euclidean Algorithm		
	1.3	Classical Encryption techniques, mono-alphabetic and polyalphabetic ciphers.		
	1.4	Substitution techniques: Vigenère cipher, Playfair cipher, Hill cipher, transposition techniques: keyed and keyless transposition ciphers		
2		**Symmetric and Asymmetric key Cryptography and key Management**	1,2	6
	2.1	Block cipher principles, DES, Double DES, Triple DES		
	2.2	Stream Ciphers: RC4 algorithm		
	2.3	Public key cryptography: Principles of public key cryptosystems- The RSA Cryptosystem		
	2.4	Symmetric key agreement: Diffie Hellman Key Exchange		
	2.5	Public key Distribution: Digital Certificate: X.509, PKI		
3		**Cryptographic Hash Functions**	1,2	3
	3.1	Cryptographic hash functions, Properties of secure hash function, MD5, SHA-1		
	3.2	MAC, HMAC		

4		**Authentication Protocols and Digital Signature Schemes**	1,2	4
	4.1	Symmetric Key Distribution: Needham-Schroeder protocol(symmetric), Kerberos Authentication protocol		
	4.2	RSA as a Digital Signature		
5		**Network and System Security**	1,2	5
	5.1	Network security basics: TCP/IP vulnerabilities (Layer wise), Network Attacks: Packet Sniffing, ARP spoofing, port scanning, IP spoofing, Denial of Service: DOS attacks, ICMP flood, SYN flood, UDP flood, Distributed Denial of Service		
	5.2	Firewall Characteristics Types of Firewalls, Intrusion Detection Systems: Host based and Network Based IDS, SSL and IPSEC :AH , ESP		
	5.3	**System Security:** Buffer Overflow, malicious Programs: Worms and Viruses, SQL injection, Trojan Horse		
			Total	**26**

Module No.	**Sr.no**	**Suggested List of experiments (Any 10)**
1	**1**	Design and Implementation of a product cipher using Substitution and Transposition ciphers
2	**2**	Implementation and analysis of public key cryptography.
	3	Implementation of Diffie-Hellman Key exchange algorithm.
3	**4**	For varying message sizes, test integrity of message using MD-5, SHA-1, and analyse the performance of the two protocols.
4	**5**	Implementation and analysis of Digital signature scheme
	6	Implementation of Salt and Pepper password protection technique
	7	Implement Needham Schroeder authentication protocol.
5	**8**	Explore the GPG tool of Linux to implement email security
	9	Study and Implement SQL Injection
	10	Study and Implement DOS Attacks
	11	Using NMAP for ports monitoring.
	12	Using open SSL for web server - browser communication.
	13	Explorer Kali Linux operating system and explain any one tool of kali Linux
	14	EXPLORING N-STALKER : To download the N-Stalker Vulnerability Assessment Tool and exploring the features.

Course Assessment:

Theory:

ISE1: Activity: Regular Quizzes 20 Marks

ISE2: Two hours 20 Marks

Activity: Article Discussion, Assignments

Outcome: Reflective Journal

MSE: 30 Marks 90 minutes written examination based on 50% syllabus
ESE: 30 Marks 90 Minutes written examination based on remaining syllabus after MSE

Lab:

ISE1: Continuous pre-defined rubrics-based evaluation for experiments (20 marks)
ISE2: Continuous pre-defined rubrics-based evaluation for experiments (20 marks)
Simulation using modern tools and mini project for (10 marks)

Recommended Books:

1. Atul Kahate, "Cryptography and Network Security", Tata McGraw-Hill Education, 2003.
2. William Stallings, "Cryptography and Network Security, Principles and Practice", 6th Edition, Pearson Education, March 2013
3. Behrouz A. Ferouzan, "Cryptography & Network Security", Tata McGraw Hill
4. Behrouz A. Forouzan & Debdeep Mukhopadhyay, "Cryptography and Network Security" 3rd Edition, McGraw Hill

Online Resources:

1. http://nptel.ac.in/courses/106105031/ lecture by Dr. Debdeep MukhopadhyayIIT Kharagpur
2. https://archive.nptel.ac.in/courses/106/105/106105162/
3. https://www.geeksforgeeks.org/cryptography-and-network-security-principles/

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PCC13CS17	Data Warehousing and Mining	L	T	P	L	T	P	Total
		2	--	2	2	--	1	3
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	30	100	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes	DBMS, Data analytics and visualization, Machine Learning	
	On successful completion of the course learner will be able to	
Course Outcomes	CO1	Build Data Warehouse schema for real life application
	CO2	Analyse data using OLAP operations so as to take strategic decisions.
	CO3	Implement Data Mining techniques to extract knowledge
	CO4	Explain the concepts of Web Mining

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Data Warehousing Fundamentals**		3	7
	1.1	Introduction to Data Warehouse, Data warehouse architecture, Data warehouse versus Data Marts, E-R Modeling versus Dimensional Modeling, Information Package Diagram		
	1.2	Data Warehouse Schemas; Star Schema, Snowflake Schema, Factless Fact Table, Fact Constellation Schema. Update to the dimension tables. Major steps in ETL process, OLTP versus OLAP, OLAP operations: Slice, Dice, Rollup, Drilldown and Pivot.		
2	**Data Mining Fundamentals**		1,2	4
	2.1	Data Mining Task Primitives, Architecture, KDD process, Issues in Data Mining, Applications of Data Mining, Data Exploration: Types of Attributes, Statistical Description of Data, Data Visualization, Data Preprocessing		
	2.2	Descriptive data summarization, Cleaning, Integration & transformation, Data reduction, Data Discretization and Concept hierarchy generation		
3	**Classification and Clustering**		1,2	6
	3.1	Basic Concepts, Decision Tree Induction, Naïve Bayesian Classification, Accuracy and Error measures, Evaluating the Accuracy of a Classifier: Holdout &		

		Random Subsampling, Cross Validation, Bootstrap.		
	3.2	Types of data in Cluster analysis, Partitioning Methods (k-Means, kMedoids), Hierarchical Methods (Agglomerative, Divisive).		
4	**Mining frequent patterns and associations**		1,2	6
	4.1	Market Basket Analysis, Frequent Item sets, Closed Item sets, and Association Rule, Frequent Pattern Mining, Apriori Algorithm		
	4.2	Association Rule Generation, Improving the Efficiency of Apriori, Mining Frequent Itemsets without candidate generation, Introduction to Mining Multilevel Association Rules and Mining Multidimensional Association Rules.		
5	**Web mining**		1,2,3	3
	5.1	Introduction, Web Content Mining: Crawlers, Harvest System, Virtual Web View, Personalization, Web Structure Mining: Page Rank, Clever, Web Usage Mining.		
			Total	**26**

Experiment No.	Suggested list of Experiments
1	Data Warehouse Construction a) Real life Problem to be defined for Warehouse Design b) Construction of star schema and snow flake schema c) ETL Operations.
2	Construction of Cubes , OLAP Operations, OLAP Queries
3	Using open source tools Implement Classifiers
4	Using open source tools Implement Association Mining Algorithms
5	Using open source tools Implement Clustering Algorithms
6	Implementation of any one classifier using languages like JAVA/ python
7	Implementation of any one clustering algorithm using languages like JAVA/ python
8	Implementation of any one association mining algorithm using languages like JAVA/ python
9	Implementation of page rank algorithm.
10	Implementation of HITS algorithm.

Course Assessment:

Theory:

ISE1: Two activities (each of 10 marks) Quiz/assignments/tutorial/ crossword/ seminar on initial 50% syllabus

ISE2: Two activities (each of 10 marks) Quiz/assignments/tutorial/ crossword/ seminar on remaining syllabus

MSE: 30 Marks 90 minutes written examination based on 50% syllabus
ESE: 30 Marks 90 Minutes written examination based on remaining syllabus after MSE

Lab:

ISE1: will be conducted for (40-50%) experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.
ISE2: will be conducted for remaining experiments. Continuous pre-defined rubrics-based evaluation for 20 marks, Mini project – 10 Marks

Recommended Books:

1. J Han and H. Kamber, "Data Mining: Concepts and Techniques", 3rd edition, Morgan Kaufmann.
2. P. N. Tan, M. Steinbach, Vipin Kumar, "Introduction to Data Mining", 2nd edition, Pearson Education.
3. Paulraj Ponniah, "Data Warehousing: Fundamentals for IT Professionals", 2nd edition, Wiley India

Online References:

1. www.leetcode.com
2. www.hackerrank.com
3. www.cs.usfca.edu/~galles/visualization/Algorithms.html
4. www.codechef.com

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PCC13CS18	Cloud Computing	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes	Operating System, Computer Network	
	On successful completion of the course learner will be able to	
Course Outcomes	CO1	Analyze cloud computing service models and develop real-world web applications for deployment on commercial cloud platforms.
	CO2	Apply various virtualization techniques in practical scenarios.
	CO3	Create and deploy real-world web applications on commercial cloud platforms.
	CO4	Implement serverless solutions with messaging services like AWS Lambda, SQS, and SNS for event-driven architectures.
	CO5	Explore key security mechanisms in the cloud and propose solutions to mitigate associated challenges.
	CO6	Apply the principles of containerization to practical implementations.

Exp. No.	Suggested list of experiments	Ref	Hrs
	Cloud basics		
1	**Title: Introduction and overview of cloud computing.** Objective: To understand the origin of cloud computing, cloud cube model, NIST model, characteristics of cloud, different deployment models, service models, advantages and disadvantages	3	2
	Virtualization		
2	**Title: To study and implement Hosted Virtualization using VirtualBox& KVM.** Objective: To know the concept of Virtualization along with their types, structures and mechanisms. This experiment should have demonstration of creating and running Virtual machines inside hosted hypervisors like VirtualBox and KVM with their comparison based on various virtualization parameters.	3	2
3	**Title: To study and Implement Bare-metal Virtualization using Xen, HyperV or VMware Esxi.**	3	

	Objective: To understand the functionality of Bare-metal hypervisors and their relevance in cloud computing platforms. This experiment should have demonstration of install, configure and manage Bare Metal hypervisor along with instructions to create and run virtual machines inside it. It should also emphasize on accessing VMs in different environments along with additional services provided by them like Load balancing, Auto-Scaling, Security etc.		
	Services		
4	**Title: To study and Implement Infrastructure as a Service using AWS/Microsoft Azure.** Objective: To demonstrate the steps to create and run virtual machines inside Public cloud platform. This experiment should emphasize on creating and running Linux/Windows Virtual machine inside Amazon EC2 or Microsoft Azure Compute and accessing them using RDP or VNC tools.	1,2,4	2
5	**Title: To study and Implement Platform as a Service using AWS Elastic Beanstalk/ Microsoft Azure App Service.** Objective: To demonstrate the steps to deploy Web applications or Web services written in different languages on AWS Elastic Beanstalk/ Microsoft Azure App Service.	1,2,4	2
6	**Title: To study and Implement Storage as a Service using Own Cloud/ AWS S3, Glaciers/ Azure Storage.** Objective: To understand the concept of Cloud storage and to demonstrate the different types of storages like object storage, block level storages etc. supported by Cloud Platforms like Own Cloud/ AWS S3, Glaciers/ Azure Storage.	1,2,4	2
7	**Title: To study and Implement Database as a Service on SQL/NOSQL databases like AWS RDS, AZURE SQL/ MongoDB Lab/ Firebase.** Objective: To know the concept of Database as a Service running on cloud and to demonstrate the CRUD operations on different SQL and NOSQL databases running on cloud like AWS RDS, AZURE SQL/ Mongo Lab/ Firebase.	1,2,4	2
	SECURITY		
8	**Title: To study and Implement Security as a Service on AWS/Azure** Objective: To understand the Security practices available in public cloud platforms and to demonstrate various Threat detection, Data protection and Infrastructure protection services in AWS and Azure.	1,4	2
9	**Title: To study and implement Identity and Access Management (IAM) practices on AWS/Azure cloud.**	1,2,4	2

	Objective: To understand the working of Identity and Access Management IAM in cloud computing and to demonstrate the case study based on Identity and Access Management (IAM) on AWS/Azure cloud platform.		
	Serverless and messaging		
10	**Lab Title: Exploring AWS Lambda: Building Serverless Event-Driven Applications** Objective: To understand and implement serverless event handling using AWS Lambda, focusing on creating, deploying, and testing event-driven functions integrated with AWS services.	1,4	2
11	**Lab Title: Implementing Scalable Messaging Systems with AWS SQS and SNS.** Lab Objective: To explore and implement cloud messaging services using Amazon SQS and SNS, focusing on building scalable, reliable, and event-driven communication systems.	1,4	
	Containerization		
12	**Title: To study and Implement Containerization using Docker** Objective: To know the basic differences between Virtual machine and Container. It involves demonstration of creating, finding, building, installing, and running Linux/Windows application containers inside local machine or cloud platform.	6,7	2
13	**Title: To study and implement container orchestration using Kubernetes** Objective: To understand the steps to deploy Kubernetes Cluster on local systems, deploy applications on Kubernetes, creating a Service in Kubernetes, develop Kubernetes configuration files in YAML and creating a deployment in Kubernetes using YAML	6,7	2
	Mini Project		
14	**Design a Web Application hosted on public cloud platform (Suggested list of Mini Project Topics)** 1. Deployment of a scalable web application on AWS using EC2, S3, and RDS. 2. Implementing a CI/CD pipeline for a machine learning project using Jenkins and Docker. 3. Building a serverless application using AWS Lambda for real-time data processing. 4. Developing a microservices architecture application deployed on Kubernetes. 5. Setting up and managing a multi-tier application on a private cloud using OpenStack.	Online resources	

Course Assessment:

ISE1: will be conducted for (40-50%) experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.
ISE2: will be conducted for remaining experiments. Continuous pre-defined rubrics-based evaluation for 20 marks, Mini project – 10 Marks

Recommended Books:

1. Bernard Golden, "Amazon Web Services for Dummies", John Wiley & Sons, Inc.
2. Michael Collier, Robin Shahan, "Fundamentals of Azure, Microsoft Azure Essentials", Microsoft Press.
3. RajkumarBuyya, Christian Vecchiola, S ThamaraiSelvi, "Mastering Cloud Computing", Tata McGraw-Hill Education.
4. Barrie Sosinsky, "Cloud Computing Bible", Wiley publishing ,John Paul Mueller, "AWS for Admins for Developers", John Wiley & Sons, Inc.
5. Ken Cochrane, Jeeva S. Chelladhurai, NeependraKhare , "Docker Cookbook - Second . Edition", Packt publication
6. Jonathan Baier, "Getting Started with Kubernetes-Second Edition", Packt Publication

Online Resources:

1. Website link :
   Docker Containers and Kubernetes Fundamentals – Full Hands-On Course
   https://www.youtube.com/watch?v=kTp5xUtcalw
   Docker and Kubernetes Tutorials Playlist
   https://www.youtube.com/playlist?list=PLuZ-P8G2omalspeot9_F_qnJjeLNVADbw
   Docker and Kubernetes Tutorial for Beginners
   https://www.youtube.com/playlist?list=PLy7NrYWoggjwPggqtFsI_zMAwvG0SqYCb
   Complete Kubernetes Tutorial for Beginners
   https://www.youtube.com/playlist?list=PLy7NrYWoggjziYQIDorlXjTvvwweTYoNC
2. NPtel link :
   https://onlinecourses-archive.nptel.ac.in/noc18_cs16/preview
   https://onlinecourses.nptel.ac.in/noc23_cs90/preview
   https://www.youtube.com/playlist?list=PLfiOAkfpIBRxwkGNQ25v_EY2HbU27luaN
3. Certification link :
   - AWS Cloud Solutions Architect Professional Certificate
   - Cloud Engineering with Google Cloud Professional Certificate
   - Preparing for Google Cloud Certification: Cloud Architect Professional Certificate

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PCC13CS19	Deep Learning	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	30	100	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes		Machine Learning, Data analytics and visualization
Course Outcomes	CO1	Design and Train deep learning models for supervised learning task.
	CO2	Design and Train deep learning models for unsupervised learning task
	CO3	Design, train, and optimize deep learning models by tuning hyperparameters to improve model performance.
	CO4	Select and implement appropriate deep learning model to solve real world problem.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Fundamentals of neural network**		3	3
	1.1	History of Deep Learning, Deep Learning Success Stories, Multilayer Perceptrons (MLPs), Representation Power of MLPs, Sigmoid Neurons, Gradient Descent, Feedforward Neural Networks, Representation Power of Feedforward Neural Networks		
	1.2	Deep Networks: Three Classes of Deep Learning Basic Terminologies of Deep Learning		
2	**Training, Optimization and Regularization of Deep Neural Network**		3	8
	2.1	Training Multi Layered Feed Forward Neural Network, Learning Factors, Activation functions: Tanh, Logistic, Linear, Softmax, ReLU, Leaky ReLU, Loss functions: Squared Error loss, Cross Entropy, Choosing output function and loss function		
	2.2	Optimization: Learning with backpropagation, Learning Parameters: Gradient Descent (GD), Stochastic and Mini Batch GD, Momentum Based GD, Nesterov Accelerated GD, AdaGrad, Adam, RMSProp		
		Regularization: Overview of Overfitting, Types of biases, Bias Variance Tradeoff Regularization Methods: L1, L2 regularization, Parameter sharing, Dropout, Weight Decay, Batch normalization, Early stopping, Data Augmentation, Adding noise to input and output		
3	**Autoencoders: Unsupervised Learning**		1,2	4

	3.1	Introduction, Linear Auto encoder, Under complete Auto encoder, Over complete Auto encoders, Regularization in Auto encoders.		
	3.2	Denoising Auto encoders, Sparse Auto encoders, Contractive Auto encoders		
4	**Convolutional Neural Networks (CNN): Supervised Learning**		1,2	6
	4.1	Convolution operation, Padding, Stride, Relation between input, output and filter size, CNN architecture: Convolution layer, Pooling Layer, Weight Sharing in CNN, Fully Connected NN vs CNN, Variants of basic Convolution function, Multichannel convolution operation,2D convolution.		
	4.2	Modern Deep Learning Architectures: LeNET: Architecture, AlexNET: Architecture, ResNet : Architecture		
5	**Recurrent Neural Networks (RNN)**		1,2,3	5
	5.1	Sequence Learning Problem, Unfolding Computational graphs, Recurrent Neural Network, Bidirectional RNN, Backpropagation Through Time (BTT), Limitation of "vanilla RNN" Vanishing and Exploding Gradients, Truncated BTT		
	5.2	Long Short Term Memory(LSTM): Selective Read, Selective write, Selective Forget, Gated Recurrent Unit (GRU)		
			Total	**26**

Exp. No.	Suggested list of experiments
1	**Introduction to Python Libraries for Deep Learning:** **Objectives:** To introduce various python libraries used for DL models. **Task:** Explore python libraries for deep learning e.g. Theano, TensorFlow, pytorch etc.
2	**Optimization algorithms:** a. Stochastic Gradient Descent b. Mini Batch Gradient Descent c. Momentum GD d. Nestorev GD e. Adagrad GD f. Adam Learning GD

3	**Fully Connected Neural Network:** Design and implement a fully connected deep neural network for classification, object recognition. Use appropriate Learning Algorithm, output function and loss function.
4	**Convolutional Neural Networks (CNNs) for Image Classification:** Design and implement CNNs for image classification tasks. . Build a CNN model with Convolutional layers (with filters, e.g., 32 filters of size 3x3), Pooling layers (max pooling), Fully connected layers at the end, Softmax output layer
5	**Transfer Learning with Pre-Trained Models:** Use a smaller dataset (e.g., Flowers dataset with 5 classes or any other suitable dataset). Classify flower species using a pre-trained models such as **VGG16, ResNet50**, or **InceptionV3** from Keras. Remove the final fully connected layers. Add a custom fully connected layer suited for your task.
6	**Time-Series Forecasting with Recurrent Neural Networks (RNNs):** Use Stock price data, temperature data, or any time-series dataset. Build and train an RNN/LSTM/GRU to predict future values based on historical data.
7	**Auto encoders for Dimensionality Reduction and Anomaly Detection:** Detect anomalous data points (e.g., outlier detection). Build an autoencoder with: • Encoder: A few convolutional or dense layers to reduce dimensionality. • Decoder: Reconstructs the input data.
8	**Generative Adversarial Networks (GANs) for Image Generation:** Use the **CelebA** dataset (celebrity faces). Generate realistic-looking faces from random noise. Implement a GAN with: • A **generator** network to generate fake images from random noise. • A **discriminator** network to distinguish real vs. fake images.
9	**Hyperparameter Tuning and Model Optimization:** To perform hyperparameter tuning for better model performance. Use **CIFAR-10** dataset. Build a neural network (MLP or CNN). 1. **Hyperparameters to tune**: Learning rate, batch size, number of epochs. Number of layers, units per layer, activation functions. 2. **Method**: Use **Grid Search** or **Random Search** for hyperparameter optimization.
10	**Mini Project:** **Task:** Defining the problem statement and objectives. Select, implement and train a suitable deep learning model to solve the real world problem. Evaluate the model based on suitable evaluation metrics. Interpret the results to understand how well the model addresses the problem. Implement the idea of Mini Project based on the content of the syllabus (Group of 2-3 students)

Note: Please note that the datasets and models referenced in the experiments may be subject to change. These are only suggested datasets and models. Students are encouraged to explore alternative datasets and models, in consultation with the subject teacher.

Course Assessment:

Theory:

ISE1: Two activities (each of 10 marks) Quiz/assignments/tutorial/ crossword/ seminar on initial 50% syllabus

ISE2: Two activities (each of 10 marks) Quiz/assignments/tutorial/ crossword/ seminar on remaining syllabus

MSE: 30 Marks 90 minutes written examination based on 50% syllabus

ESE: 30 Marks 90 Minutes written examination based on remaining syllabus after MSE

Lab

ISE1: will be evaluated based on (40-50%) experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.

ISE2: will be evaluated for remaining experiments. Continuous pre-defined rubrics-based evaluation for 20 marks, Mini project for 10 marks

Recommended Books:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville. ―Deep Learning, MIT Press Ltd, 2016
2. Li Deng and Dong Yu, ―Deep Learning Methods and Applications, Publishers Inc.
3. Satish Kumar "Neural Networks A Classroom Approach", Tata McGraw-Hill.
4. Deep Learning from Scratch: Building with Python from First Principles- Seth Weidman by O`Reilley
5. François Chollet. ―Deep learning with Python ―(Vol. 361). 2018 New York: Manning.
6. Douwe Osinga. ―Deep Learning Cookbook, O'REILLY, SPD Publishers, Delhi.
7. JM Zurada ―Introduction to Artificial Neural Systems, Jaico Publishing House
8. M. J. Kochenderfer, Tim A. Wheeler. ―Algorithms for Optimization, MIT Press.

Online References:

1. DeepLearning.AI Coursera: https://www.coursera.org/specializations/deep-learning
2. NPTEL course on Deep Learning: https://onlinecourses.nptel.ac.in/noc20_cs62/preview
3. https://stanford.edu/~shervine/teaching/cs-230/cheatsheet-recurrent-neuralnetworks
4. https://keras.io/examples/vision/autoencoder/
5. https://stanford.edu/~shervine/teaching/cs-230/cheatsheet-convolutional-neuralnetworks

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PEC2CS11	Social Media Analytics	L	T	P	L	T	P	Total
		2	1	--	2	1	--	3
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	30	100	
		Tutorial	20	--	30	--	50	

Pre-requisite Course Codes		Data Analytics and Visualization
Course Outcomes	CO1	Explain Concept of Social Media Analysis
	CO2	Compute network measures of a social media networks
	CO3	Analyze and review different social media data
	CO4	To use different social media analytics tools effectively and efficiently.
	CO5	Apply information filtering for recommendation system.
	CO6	Explain social media applications, privacy policies, and associated risks.

Module No.	Topics	Ref	Hrs
1	**Social Media Analytics: An Overview**	1,2	02
	Core Characteristics of Social Media, Types of Social Media, Social media landscape, Need for Social Media Analytics (SMA), SMA in small & large organizations. Purpose of Social Media Analytics, Social Media vs. Traditional Business Analytics, Seven Layers of Social Media Analytics, Types of Social Media Analytics, Social Media Analytics Cycle, Challenges to Social Media Analytics, Social Media Analytics Tools		
2	**Social Network Structure, Measures & Visualization**	1,2	04
	Basics of Social Network Structure - Nodes, Edges & Tie Describing the Networks Measures - Degree Distribution, Density, Connectivity, Centralization, Tie Strength & Trust Network Visualization - Graph Layout, Visualizing Network features, Scale Issues. Social Media Network Analytics - Common Network Terms, Common Social Media Network Types, Types of Networks, Common Network Terminologies, Network Analytics Tools.		
3	**Social Media Text, Action & Hyperlink Analytics**	1,2	04

	Social Media Text Analytics - Types of Social Media Text, Purpose of Text Analytics, Steps in Text Analytics, Social Media Text 8 Analysis Tools Social Media Action Analytics - What Is Actions Analytics? Common Social Media Actions, Actions Analytics Tools Social Media Hyperlink Analytics - Types of Hyperlinks, Types of Hyperlink Analytics, Hyperlink Analytics Tools		
4	**Social Media Location & Search Engine Analytics**	1,2	04
	Location Analytics - Sources of Location Data, Categories of Location Analytics, Location Analytics and Privacy Concerns, Location Analytics Tools Search Engine Analytics - Types of Search Engines, Search Engine Analytics, Search Engine Analytics Tools		
5	**Social Information Filtering**	2	06
	Social Information Filtering - Social Sharing and filtering , Automated Recommendation systems, Traditional Vs social Recommendation Systems Understanding Social Media and Business Alignment, Social Media KPI, Formulating a Social Media Strategy, Managing Social Media Risks		
6	**Social Media Analytics Applications and Privacy**	1,2	06
	Social media in public sector - Analyzing public sector social media, analyzing individual users, case study. Business use of Social Media - Measuring success, Interaction and monitoring, case study. Privacy - Privacy policies, data ownership and maintaining privacy online.		
		Total	26

Sr.no	Suggested List of Tutorials
1	Study various – i) Social Media platforms (Facebook, twitter, YouTube etc) ii) Social Media analytics tools (Facebook insights, google analytics netlytics etc) iii) Social Media Analytics techniques and engagement metrics (page level, post level, member level) iv) Applications of Social media analytics for business. e.g. Google Analytics https://marketingplatform.google.com/about/analytics/ https://netlytic.org/
2	Data Collection-Select the social media platforms of your choice (Twitter, Facebook, LinkedIn, YouTube, Web blogs etc) ,connect to and capture social media data for business (scraping, crawling, parsing).
3	Data Cleaning and Storage- Preprocess, filter and store social media data for business (Using Python, MongoDB, R, etc).
4	Exploratory Data Analysis and visualization of Social Media Data for business.

5	Develop Content (text, emoticons, image, audio, video) based social media analytics model for business. (e.g. Content Based Analysis :Topic , Issue ,Trend, sentiment/opinion analysis, audio, video, image analytics)
6	Develop Structure based social media analytics model for any business. (e.g. Structure Based Models -community detection, influence analysis)
7	Design the creative content for promotion of your business on social media platform
8	Implement content based and collaborative based filtering.
9	Develop social media text analytics models for improving existing product/ service by analyzing customer's reviews/comments.
10	Analyze how Individual / Organization use Social Media and Social media privacy policies.

Course Assessment:

Theory:

ISE1: 20 Marks - Activity: Quiz / assignments/Activity
ISE2: 20 Marks- Activity: Quiz/Assignments/ Article discussion/Activity
MSE: 30 Marks 90 minutes written examination based on 50% syllabus
ESE: 30 Marks 90 Minutes written examination based on remaining syllabus after MSE

Tutorial:

ISE1 will be based on first five tutorials (20 marks)
ISE2 will be based on remaining tutorials (30 marks)

Textbooks:

1. Seven Layers of Social Media Analytics_ Mining Business Insights from Social Media Text, Actions, Networks, Hyperlinks, Apps, Search Engine, and Location Data, Gohar F. Khan,(ISBN-10: 1507823207).
2. Analyzing the Social Web 1st Edition by Jennifer Golbeck
3. Mining the Social Web_ Analyzing Data from Facebook, Twitter, LinkedIn, and Other Social Media Sites, Matthew A Russell, O'Reilly
4. Charu Aggarwal (ed.), Social Network Data Analytics, Springer, 2011

Reference Books:

1. Social Media Analytics [2015], Techniques and Insights for Extracting Business Value Out of Social Media, Matthew Ganis, AvinashKohirkar, IBM Press
2. Social Media Analytics Strategy_ Using Data to Optimize Business Performance, Alex Gonçalves, APress Business Team

3. Social Media Data Mining and Analytics, Szabo, G., G. Polatkan, O. Boykin & A. Chalkiopoulus (2019), Wiley, ISBN 978-1-118-82485-6

Online Reference:

1. https://cse.iitkgp.ac.in/~pawang/courses/SC16.html
2. https://onlinecourses.nptel.ac.in/noc20_cs78/preview
3. https://nptel.ac.in/courses/106106146
4. https://7layersanalytics.com/

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PEC3CS12	Graph Data Science	L	T	P	L	T	P	Total
		2	1	--	2	1	--	3
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	30	100	
		Tutorial	20	--	30	--	50	

Pre-requisite Course Codes	Data Structure, Analysis of algorithms	
Course Outcomes	CO1	Understand and Apply Graph Theory Concepts
	CO2	Analyze and Implement Graph Algorithms
	CO3	Utilize Graph Databases for Data Storage and Querying
	CO4	Apply Graph-based Machine Learning Techniques
	CO5	Process and Analyze Large-Scale Graphs
	CO6	Explore Advanced Topics and Industry Applications

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Graphs and Graph Theory**	1	3
	1.1	• Basics of Graph Theory • Graph Representations: Adjacency Matrix, Adjacency List • Types of Graphs: Directed, Undirected, Weighted, Bipartite, Planar, Trees, Cyclic, Acyclic		
	1.2	• Graph Traversal Algorithms: Breadth-First Search (BFS), Depth-First Search (DFS) • Applications: Networks, Social Graphs, Biological Graphs, Web Graphs		
2		**Fundamental Graph Algorithms**	2	4
	2.1	• Shortest Path Algorithms: Dijkstra, Bellman-Ford, Floyd-Warshall • Minimum Spanning Trees: Kruskal's and Prim's Algorithm • Eulerian and Hamiltonian Graphs		
	2.2	• Topological Sorting (Kahn's Algorithm, DFS-based approach) • Strongly Connected Components (Kosaraju's and Tarjan's Algorithm)		
3		**Graph Databases and Query Languages**	3,6	5
		• Introduction to Graph Databases • Graph Data Models: Property Graphs, RDF Graphs • Query Languages: Cypher (Neo4j), Gremlin, SPARQL		

		• Comparative Study of Graph Databases (Neo4j, ArangoDB, JanusGraph) • Case Study: Social Network Analysis, Recommendation Systems		
4		**Graph Machine Learning & Network Science**	4	5
	4.1	• Graph Neural Networks (GNNs) and Their Applications • Node Classification, Link Prediction, Community Detection		
	4.2	• Graph Embeddings: Node2Vec, DeepWalk, GraphSAGE • Random Walks and PageRank Algorithm • Applications: Fraud Detection, Drug Discovery, Knowledge Graphs		
5		**Large-scale Graph Processing & Distributed Computing**	7	6
	5.1	• Large-scale Graph Processing Frameworks: Google Pregel, Apache Giraph • Distributed Graph Computing: Apache Spark GraphX, Deep Graph Library (DGL), PyTorch Geometric (PyG)		
	5.2	• Parallel Graph Processing Techniques • Graph Theory in Artificial Intelligence and Natural Language Processing (NLP) • Industry Case Study: Graphs in Cybersecurity, Healthcare Analytics		
6		**Advanced Topics and Research Trends in Graph Data Science**	7	3
		• Hypergraphs and Multilayer Networks • Temporal Graph Analysis • Knowledge Graphs and Ontologies • Graph Augmented Neural Networks (GATs, Graph Transformers) • Ethical Considerations in Graph-based AI		
			Total	**26**

Suggested List of Tutorials

1. Practice problems on BFS, DFS, and graph representations.
2. Problem-solving on shortest paths and MST algorithms.
3. Solve problems on Dijkstra and Bellman-Ford.
4. Writing queries in Cypher (Neo4j).
5. Understanding and implementing PageRank.
6. Apply Louvain method for detecting graph communities.

7. Hands-on example with GraphX or PyG.
8. Use Node2Vec on a real-world dataset.
9. Explore graphs in fraud detection or bioinformatics.
10. Research paper discussion on the latest GNN models and Graph Data Science Advancements

Course Assessment:

Theory:

ISE1: 20 Marks Activity: Assignment/quiz/Activity
ISE2: 20 Marks Activity: Assignments/quiz/case study
MSE: 30 Marks 90 minutes written examination based on 50% syllabus
ESE: 30 Marks 90 Minutes written examination based on remaining syllabus after MSE

Tutorial:

ISE1: 20 Marks Evaluation based on 50% tutorials
ISE2: 30 Marks Evaluation based on next 50% tutorials

Recommended Books:

1. Introduction to Graph Theory ,Douglas B. West , Pearson Education
2. Algorithms ,Sanjoy Dasgupta, Christos H. Papadimitriou, Umesh Vazirani, McGraw-Hill Education
3. Graph Algorithms: Practical Examples in Apache Spark & Neo4j – Mark Needham, Amy E. Hodler , O'Reilly Media
4. Graph-Powered Machine Learning, Alessandro Negro, Manning Publications
5. Network Science, Albert-László Barabási , Cambridge University Press
6. Graph Data Science: An Introductory Guide, Neo4j Team, Neo4j
7. Deep Learning on Graphs, Yao Ma, Jiliang Tang, Cambridge University Press

Useful links:

1. https://www.coursera.org/learn/graph-analytics
2. https://neo4j.com/graphacademy/
3. http://web.stanford.edu/class/cs224w/

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PEC2CS21	AI in Cyber Security	L	T	P	L	T	P	Total
		2	1	--	2	1	--	3
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	30	100	
		Tutorial	20	--	30	--	50	

Pre-requisite Course Codes		Artificial Intelligence
Course Outcomes	CO1	Understand key security risks in AI models and applications
	CO2	Evaluate security defenses for AI models
	CO3	Analyze the impact of adversarial AI in cybersecurity
	CO4	Assess AI security governance, regulatory frameworks, and secure AI development methodologies
	CO5	Explore real-world case studies of AI security failures and defenses

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Foundations of AI Security**			
	1.1	Introduction to AI Security: • Overview of AI, Machine Learning, and Deep Learning Security. • Security challenges in AI-driven applications. • Threat Models in Adversarial Machine Learning.	1,2	3
	1.2	Understanding AI Vulnerabilities and Attack Surfaces: • Model tampering and AI security risks • Threat landscapes for AI in cybersecurity.	1,2	2
2	**AI Security Defenses and Robustness Strategies**			
	2.1	Adversarial AI Attacks and Threat Models: • Categories of adversarial attacks • Model tampering with Trojan horses and adversarial manipulations • Real-world AI attack case studies	1,2	3
	2.2	Defensive Strategies for AI Systems: • Supply chain vulnerabilities in AI models • Secure AI model deployment techniques • Protection against data poisoning and model theft	1,2	3
3	**AI in Cybersecurity – Adversarial AI and Cyber Threats**			
	3.1	Using AI for Cyber Threat Intelligence • AI-powered cyber attacks and adversarial prompt injections	1,2	3

		• Generative AI threats: Deepfakes and adversarial content generation • AI-powered cybersecurity: AI in malware detection		
	3.2	Mitigation Strategies for AI-Driven Cyber Threats: • AI in phishing detection and fraud prevention • Security against adversarial prompts and AI prompt injection attacks	1,2	2
4	**AI Governance, Ethics, and Security Compliance**			
	4.1	AI Privacy Risks and Governance Challenges: • Model extraction attacks and adversarial privacy threats • Privacy risks in AI-powered applications • Model inversion and membership inference attacks	1,2	3
	4.2	Privacy-Preserving AI and Secure AI Development: • Differential privacy, homomorphic encryption • Secure AI frameworks and compliance	1,2	2
5	**Future of AI Security and Real-World Case Studies**			
	5.1	Security by Design in AI • Building trustworthy AI models • Secure model development and AI robustness testing • AI security compliance and best practices	1,2	3
	5.2	AI Security Operations and Continuous Monitoring: • AI security governance frameworks • AI risk management in industry applications • AI in cybersecurity operations (MLSecOps) • Case studies in AI security breaches	1,2	2
			Total Hours	**26**

Sr. No.	Suggested Tutorials
1	**Case Study Analysis: AI Security Breaches** **Activity Type:** Case Study Review **Objective:** Analyze real-world AI security breaches to understand vulnerabilities and mitigation strategies. **Instructions:** • Choose a **real-world AI security incident** (e.g., Google AI bias, Tesla autopilot failures, ChatGPT jailbreaks, etc.). • Discuss **attack vectors, AI vulnerabilities, and failure points**. • Suggest improvements and mitigation techniques. • **Submission:** 3-4 page report.
2	**Group Discussion: The Future of AI Security Threats** **Activity Type:** Group Discussion **Objective:** Encourage students to explore emerging threats in AI security. **Instructions:**

	• Divide students into groups. Each group presents a **potential future AI security threat** (e.g., AI-powered malware, adversarial deepfakes, autonomous system hacking). • Discuss **ethical, technical, and regulatory challenges**. • Propose risk mitigation strategies.
3	**Poster Making: AI Attack & Defense Strategies** **Activity Type:** Creative Poster Making **Objective:** Visually represent AI adversarial attacks and corresponding defenses. **Instructions:** • Create a **poster explaining adversarial attacks and defense mechanisms** (e.g., FGSM attack vs. Adversarial Training, Model Stealing vs. Encryption). • Include real-world examples. • Present and explain to the class.
4	**Research Assignment: AI Governance & Legal Frameworks** **Activity Type:** Research-Based Assignment **Objective:** Explore global and Indian regulatory frameworks for AI security. **Instructions:** • Compare AI security laws like **GDPR, NIST AI RMF, EU AI Act, Indian AI regulations**. • Discuss compliance requirements for **AI models, data privacy, and ethical AI development**. • Propose regulatory improvements for securing AI systems.
5	**Simple Implementation: Adversarial Thinking Exercise** **Activity Type:** Threat Modeling Exercise (No Coding) **Objective:** Develop **adversarial thinking** for AI security. **Instructions:** • Provide an AI-based system scenario (e.g., **autonomous vehicle AI, AI in healthcare, chatbot AI**). • Students must identify potential **threats and vulnerabilities**. • Suggest security defenses.
6	**Demo/Presentation: Deepfake & Generative AI Security** **Activity Type:** Student Presentations (Conceptual) **Objective:** Explore security concerns in **deepfake and generative AI** models. **Instructions:** • Each student picks a subtopic (e.g., **how deepfakes are made, detecting deepfakes, deepfake regulations, GAN security**). • Present findings using **real-world case studies**. • Discuss **threats and countermeasures**.
7	**Case Study: AI in Cybersecurity - Strengths & Risks** **Activity Type:** Case Study Analysis **Objective:** Understand the role of AI in cybersecurity and its risks. **Instructions:** • Choose an **AI-powered security system** (e.g., AI in **malware detection, phishing detection, threat intelligence**).

	• Explain how **AI enhances cybersecurity** and discuss **limitations and risks** (e.g., bias, adversarial attacks).
8	**Discussion Panel: Ethical Dilemmas in AI Security** **Activity Type:** Panel Discussion **Objective:** Debate **ethical issues** in AI security. **Instructions:** • Assign students roles (e.g., **AI ethics expert, security analyst, government regulator, hacker, business leader**). • Discuss topics like **privacy vs. security, AI bias, accountability in AI security breaches**.
9	**Mock AI Security Policy Design** **Activity Type:** Policy Drafting Exercise **Objective:** Draft an AI security policy for a **hypothetical AI company**. **Instructions:** • Define AI security guidelines for **model development, adversarial attack protection, data privacy**. • Align with global AI security regulations.
10	**Research Report: AI & Supply Chain Security Risks** **Activity Type:** Research Paper **Objective:** Study AI **supply chain threats** and propose security measures. **Instructions:** • Identify risks in the **AI supply chain** (e.g., **model theft, poisoned datasets, software dependencies**). • Research **real-world cases of AI supply chain attacks (or industry specific case)**.
11	**Debate: "Can AI Fully Secure Itself?"** **Activity Type:** Debate **Objective:** Evaluate if **AI can be fully self-secured**. **Instructions:** • Split students into **"YES" and "NO" teams**. • Debate **autonomous AI security, AI-driven SOC (Security Operations Center), self-healing AI models**.
12	**Write an Article: "The Future of AI Security"** **Activity Type:** Writing Assignment **Objective:** Encourage students to **speculate on the future of AI security**. **Instructions:** • Write a **3-page article** on where AI security is headed. • Topics: **Autonomous AI security, AI vs. AI cyber warfare, future regulatory landscapes**.
13	**Explainer Video: "How Hackers Attack AI Models"** **Activity Type:** Short Explainer Video (Reel Format) **Objective:** Help students articulate adversarial AI attacks in a simple and engaging way. ***Instructions:***

	• **Students create a 2-3 minute video explaining how AI models can be attacked** using adversarial techniques (e.g., **data poisoning, model inversion, adversarial examples**). • The video should **use animations, real-world examples, or sketches** to explain the attack process. • Include a **simple defense mechanism** for the attack. • **Use storytelling**, for example: "Imagine an AI system in a self-driving car being fooled into thinking a STOP sign is a speed limit sign—this is how adversarial attacks work!"
14	**AI Security Myth-Busting Reel: "AI is 100% Secure - True or False?"** **Activity Type:** Interactive Myth-Busting Video **Objective:** Debunk common AI security misconceptions in a fun and engaging way. ***Instructions:*** • **Students create 3-minute video debunking 3-5 common myths** about AI security, such as: o "AI models are immune to hacking." o "Encrypted AI models cannot be stolen." o "Deepfake detection is 100% reliable." • Each myth should be **briefly explained and debunked with real-world examples**. • Students can **use memes, short interviews, infographics, or dramatized scenarios** to make the video engaging.
15	**Tutorial Video: "AI in Cybersecurity – Good vs. Evil"** **Activity Type:** Educational Tutorial Video **Objective:** Explore the dual use of AI in cybersecurity: **attack vs. defense**. ***Instructions:*** • **Students create a 3-5 minute video explaining how AI is used for cybersecurity both offensively and defensively.** • They must include **two sections in the video**: o **"Evil AI"** – How AI is used by cybercriminals (e.g., phishing, AI-generated malware, automated hacking). o **"Good AI"** – How AI defends against cyber threats (e.g., AI in SOC, automated intrusion detection, fraud prevention). • Encourage students to **use screen recordings, whiteboard-style animations, or even role-playing** to illustrate their points.

Course Assessment:

Theory:

ISE1: Activity: Quiz and assignments 20 Marks
ISE2: Activity: Case studies/ Article Discussion/ Quiz/ Assignments 20 marks

MSE: 30 Marks 90 minutes written examination based on 50% syllabus
ESE: 30 Marks 90 Minutes written examination based on remaining syllabus after MSE

Tutorial:

ISE1: Activity/ Quizzes/ Assignments/ Code based implementations (20 Marks)
ISE2: Activity: Case studies/ Article Discussion, Quiz/ Assignments/ Code based implementations (30 Marks), Group presentations/ demonstrations(10Marks)

Recommended Books:

1. Hu, Fei, and Xiali Hei, eds. AI, Machine Learning and Deep Learning: A Security Perspective. CRC Press, 2023.
2. John Sotiropoulos, Adversarial AI: Attacks, Mitigations, and Defense Strategies(2024), Packt Publishing
3. Parisi, Alessandro. Hands-On Artificial Intelligence for Cybersecurity: Implement smart AI systems for preventing cyber attacks and detecting threats and network anomalies. Packt Publishing, 2019.

Online Resources:

1. EU AI Act: first regulation on artificial intelligence: https://www.europarl.europa.eu/topics/en/article/20230601STO93804/eu-ai-act-first-regulation-on-artificial-intelligence, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32024R1689
2. National Strategy for Artificial Intelligence, NITI Aayog: https://www.niti.gov.in/sites/default/files/2023-03/National-Strategy-for-Artificial-Intelligence.pdf
3. REGULATION (EU) 2024/1689 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 13 June 2024: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32024R1689
4. AI Standards, NIST: https://www.nist.gov/artificial-intelligence/ai-standards

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PEC3CS22	FinTech	L	T	P	L	T	P	Total
		2	1	0	2	1	0	3
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	30	100	
		Tutorial	20	--	30	--	50	

Pre-requisite Course Codes	Statistics	
Course Outcomes	CO1	Analyze the evolution and growth of FinTech globally and recognize its impact on financial systems.
	CO2	Analyze the FinTech Ecosystem and Stakeholders
	CO3	Evaluate Digital Payment Systems and Mobile Wallets
	CO4	Apply blockchain, AI in Fintech application

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to FinTech and Digital Finance**	1	5
	1.1	**FinTech Overview** – Definition and evolution of FinTech Key segments in FinTech: Digital payments, lending, wealth management, blockchain, InsurTech FinTech ecosystems: Startups, incumbents, and regulators Global FinTech landscape and trends Key drivers of FinTech growth		
	1.2	**Financial Services vs. FinTech: Traditional vs. Disruptive Models** Traditional financial services: Banks, insurance, stock exchanges How FinTech disrupts traditional finance Benefits and challenges of FinTech innovation Key players in the FinTech ecosystem (e.g., PayPal, Square, Revolut, Stripe)		
2		**FinTech Ecosystem in India**	2	5
	2.1	**Understanding the FinTech Ecosystem** Overview of the FinTech ecosystem: Key players and stakeholders **Startups**: FinTech firms, accelerators, incubators **Incumbents**: Banks, traditional financial institutions, and their role in the ecosystem **Regulators**: Role of financial regulatory bodies (e.g., SEC, FCA, CFTC) in shaping the ecosystem **Investors**: Venture capital, private equity, crowdfunding, and angel investors in FinTech		

		Technology Providers: Cloud services, APIs, data platforms, blockchain developers Collaboration between startups and incumbents Challenges of operating within a fragmented ecosystem Key market trends and the rise of partnerships and ecosystems within FinTech		
	2.2	**Key Players in the FinTech Ecosystem** • **Banks and Financial Institutions**: Their adaptation to FinTech through partnerships and internal innovation (e.g., open banking, API integrations) • **Startups**: The role of challenger banks and disruptive FinTech firms • **Tech Giants**: The involvement of tech companies like Google, Apple, and Amazon in digital payments and financial services • **Regulatory Bodies**: How regulators (e.g., PSD2, GDPR) influence FinTech development • **Investors and VCs**: The impact of funding and venture capital on FinTech innovation (e.g., Sequoia Capital, Andreessen Horowitz)		
3		**Digital Payments and Mobile Wallets**	3	**6**
	3.1	**Types of digital payments**: Online payments, contactless payments, mobile payments, Payment gateways, processing networks, and acquiring banks, Key players in the payment ecosystem: Visa, MasterCard, PayPal, Stripe, and fintech startups, Advantages of digital payments: Speed, accessibility, and security		
	3.2	**Mobile Wallets and Peer-to-Peer Payments** : introduction to mobile wallets (Apple Pay, Google Pay, Samsung Pay, Venmo) Key technologies: NFC, QR codes, tokenization, and biometrics Peer-to-peer (P2P) payment systems: Venmo, PayPal, Zelle Security and fraud prevention in digital payment systems		
4		**Role of Blockchain, AI in Finance**	4	10
	4.1	**Introduction to blockchain**: Structure, decentralization, consensus algorithms, Types of blockchains: Public, private, and consortium, Blockchain use cases beyond cryptocurrencies: Smart contracts, decentralized applications (DApps), Blockchain in financial services: Payments, remittances, and clearing		
	4.2	**Cryptocurrency and Decentralized Finance (DeFi)** Overview of cryptocurrencies: Bitcoin, Ethereum, and		

		altcoins Blockchain's role in cryptocurrency and DeFi (Decentralized Finance), Decentralized exchanges (DEXs), liquidity pools, and smart contracts, Risks and challenges in cryptocurrency markets, Regulation and compliance in crypto markets		
	4.3	**AI applications in finance**: Algorithmic trading, robo-advisors, fraud detection Predictive analytics in risk management and credit scoring		
			Total	**26**

Exp. No.	Suggested list of tutorials
1	Interactive discussion on the shift from traditional banking to digital banking.
2	Group analysis of real-world FinTech companies and their innovation
3	Hands-on activity to understand how blockchain transactions work.
4	Simulation of a simple smart contract
5	Demonstration of a mobile wallet application.
6	Group discussion on the pros and cons of digital payments.
7	Case study analysis of AI applications in major FinTech firms.
8	Scenario-based exercise on handling a data breach in a FinTech company.
9	**FinTech Company Analysis: Business Models and Innovations** : Choose a FinTech company (e.g., Stripe, Revolut, Robinhood, Square, or any other notable FinTech firm). Provide a detailed overview of the company's business model (e.g., how it makes money, what services it offers).Analyze the innovation introduced by the company in the financial space. Discuss the company's market positioning, competition, and customer base. Evaluate the impact of the company on traditional finance and its contribution to financial inclusion or disruption. Conclude by assessing the company's prospects in the FinTech sector. A report (1500-2000 words) summarizing the findings. And PowerPoint presentation (5-10 slides) to highlight key insights.
10	**Designing a Digital Payment System** Identify a specific financial problem or pain point related to payments (e.g., international remittance, peer-to-peer payments, or mobile payments in underserved areas). Design a digital payment system that addresses this problem. Outline the key features of your system (e.g., payment channels, security features, user experience). Explain the technology behind the system (e.g., QR codes, NFC, blockchain). Discuss the potential regulatory challenges and compliance requirements for the system. Consider the scalability, security, and accessibility of your solution. Deliverables: A detailed project report (1000-1500 words) explaining your payment solution. A prototype/mockup of the digital payment system (could be through wireframes or an app design tool).

Course Assessment:

Theory:

ISE1: MCQ: 20 Marks

ISE2: MCQ: 20 Marks

MSE: 30 Marks 90 minutes written examination based on 50% syllabus
ESE: 30 Marks 90 Minutes written examination based on remaining syllabus after MSE

Tutorial:

ISE1 will be conducted for four tutorials. Continuous pre-defined rubrics-based evaluation for 20 marks.

ISE2 will be conducted for next four tutorials. Continuous pre-defined rubrics-based evaluation for 20 marks. Report and presentation (10 marks)

Recommended Books:

1. "FinTech: The New DNA of Financial Services", by Pranay Gupta, T. M. Vinod Kumar, 1st Edition, Publisher: De Gruyter
2. "The FinTech Book", by Susanne Chishti & Janos Barberis, first edition, John Wiley & Sons Publication
3. "Digital Payments in India: Background, Trends and Opportunities" Jaspal Singh, published by New Century Publications.
4. "Mastering Bitcoin: Unlocking Digital Cryptocurrencies", by Andreas M. Antonopoulos, O'Reilly Media publication

Useful Links:

1. https://www.udemy.com/course/fintech-fundamentals/learn/lecture/33707706#overview

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
25PEC2CS31	UI/UX Design	2	1	--	2	1	--	3

	Examination Scheme				
	ISE1	MSE	ISE2	ESE	Total
Theory	20	30	20	30	100
Tutorial	20	--	30	--	50

Pre-requisite Course Codes		Data visualization
Course Outcomes	CO1	Understand the Foundations of UI/UX Design.
	CO2	apply Design Thinking and Process Models.
	CO3	Conduct Effective UX Research and Create User-Centric Artifacts.
	CO4	Design Interactive Prototypes and Evaluate Usability.
	CO5	Leverage Generative AI for Enhancing UI/UX Workflows.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	**Introduction to UI/UX:** UI vs UX, A Day in the life of a UX Designer, Different design roles in the industry, Agile and Waterfall Process, Design System Fundamentals	1,2,4	3
2	2.1	**Design Process and Thinking Method:** Solving Problems with UI/UX, UX problems with Examples, Introduction to Design Thinking Process, Double Diamond Model, Case study Examples, Measuring Design Impact, Introduction to Research in UX, Choosing the Right Research Method	1,2	6
3	3.1	**Research to Discover:** User interview, UX Surveys, Field Study, Stakeholder Interview, Well Conducted Primary Research Examples, Writing a UX Research Report	1,2,3	5
	3.2	**Research to Explore:** Competitive analysis, Persona creation, Empathy Map, User flows, Customer Journey Map, User stories with poor and better examples, Card sorting with examples		
4	4.1	**Introduction to UI:** Atomic Design Principle, UI Elements, UI Design Principles, 5 Levels of UI Design Skills, Low Fidelity Wireframes, Mid Fidelity Wireframes, High Fidelity Wireframes	5	4
	4.2	**Introduction to UX Design:** UX design patterns, Laws of UX with practical examples, Principles of making Good UX Design, Interaction Design Process		
5	5.1	**Usability Evaluation**: Intro to usability evaluation, Types of usability evaluation, Quantitative and qualitative evaluation, User loads (Cognitive, motor and visual), Conducting a usability study	5	8

	5.2	**Application of Generative AI in the UI/UX:** Introduction to Generative AI in UI/UX, Generative AI applications in assisting UX/UI design, AI for Visual Design, AI for Rapid Prototyping, Generative AI for User Research, Predictive Analytics for UI/UX Optimization, Ethical Considerations of AI in Design, Future Trends in AI for UI/UX, How designers and AI can work together, Creating Effective Text Prompt for UX Design		
			Total	**26**

Module No.	Exp. No.	Suggested List of Tutorial
1	1	**Installation of Figma. Demonstration of the working** • Figma Interface • Frames • Images: Raster and Vector • Vector Networks & Booleans • Masks • Gradients • Plugins
2	2	**Demonstration of the working Graphic Design** • Balance • Contrast • Emphasis • Unity • Alignment • Hierarchy • Proportion • White Space • Typography • Color in UI Design
3	3	**UI/UX Design Capstone Project** A full-fledged capstone project with 2 to 3 projects as options, 1. **Personalized Health Coach App** Users often struggle to achieve and maintain their fitness goals due to generic workout and diet plans that don't account for individual needs. The problem statement here is to create an app that helps users create a personalised fitness plan with the help of top-rated personal fitness trainers or health coaches. 2. **Smart Travel Assistant App** Travellers frequently face difficulties in planning trips due to the abundance of information and lack of personalised recommendations that cater to their preferences. The problem

		statement here is to create a smart travel assistant app that helps personalize travel plans in minutes. **3. AI-Enhanced Customer Support Platform** Businesses often encounter challenges in managing a high volume of customer queries with limited human resources, leading to slow response times and customer dissatisfaction. The problem statement here is to create a web application that helps reduce the turnaround time and increases customer satisfaction. **4. Intelligent Content Recommendation System** Users on media and e-commerce websites often struggle to find relevant content due to overwhelming options and generic recommendations. The problem statement here is to build an intelligent system that recommends the best content as per user preference.
4	4	**Graphic Designing with Figma** Creating thumbnails of your projects
4	5	**Graphic Designing with Figma** Create a cover page for your projects
5	6	**Graphic Designing with Figma** Create complex compositions with illustrations and typography
5	7	**Graphic Designing with Figma** Use real mockup to create dynamic posters for your project
5	8	**Case Study Title** **"Revamping the E-Learning Experience: Enhancing Usability and Engagement for Online Students"** **Case Study Outline** **1. Overview** • Brief introduction to the problem you aim to solve. • Why this project matters: the importance of e-learning usability. • Final outcome: a refined prototype or improved design solution. **2. Project Scope** • **Challenge**: Identify common user pain points in e-learning platforms (e.g., navigation, engagement, or accessibility). • **Goal**: Improve ease of use, increase student retention, and enhance accessibility. • **Deliverables**: o Research insights o Wireframes o Interactive prototypes o Usability test results **3. Research Phase**

		• **User Research**:
		  o Conduct surveys or interviews with students, educators, and accessibility experts.
		  o Define target personas: "Student Sarah," "Busy Professional John."
		• **Competitive Analysis**:
		  o Compare features and usability in top e-learning platforms (e.g., Coursera, Udemy).
		• **Problem Statement**:
		  o Example: "Online learners struggle with overwhelming interfaces, resulting in lower engagement rates."
		4. Ideation and Design
		• **Brainstorming Solutions**:
		  o Use techniques like Crazy 8s or Mind Mapping.
		  o Identify innovative solutions like personalized dashboards or gamification.
		• **Low-Fidelity Prototypes**:
		  o Sketch out wireframes for initial ideas.
		  o Example: Focus on improving navigation for better course discovery.
		5. Usability Testing and Iteration
		• **Methodology**:
		  o Perform usability tests with 5-7 participants.
		  o Observe behavior and gather feedback.
		• **Iterations**:
		  o Refine designs based on feedback.
		  o Example: Users found the "progress tracker" unclear; simplify the layout.
		6. Final Design
		• **High-Fidelity Prototype**:
		  o Use tools like Figma or Adobe XD to create the final product.
		  o Highlight improved user flow, color schemes, typography, and micro-interactions.
		• **Key Features**:
		  o Accessible design (WCAG-compliant).
		  o Engaging features like badges for completed courses.
		  o Intuitive navigation structure.
		7. Results and Impact
		• **Quantitative Metrics**:
		  o Increase in task completion rates (e.g., finding a course in under 2 minutes).
		  o Reduction in bounce rates on specific pages.
		• **Qualitative Metrics**:

		○ Positive feedback from usability tests (e.g., "It feels simpler and more intuitive."). **8. Reflections** • **What Worked**: ○ Example: The streamlined dashboard improved user satisfaction. • **Challenges**: ○ Example: Balancing simplicity with functionality for power users. • **Future Improvements**: ○ Example: Implement AI-driven course recommendations in the next iteration. **9. Conclusion** • Recap the problem, your solution, and the value it adds to the users. • End with a personal reflection on the design process and what you learned.
		Tools You Can Use • **Research**: Google Forms, Maze, Optimal Workshop • **Design**: Figma, Adobe XD, Sketch • **Prototyping**: InVision, Marvel App • **Testing**: UsabilityHub, Lookback

Course Assessment:

Theory:

ISE1: 20 Marks
Activity: Conduct any four activities (each of 5 marks) like Assignments/ quiz/ crossword/ case study

ISE2: 20 Marks
Activity: Conduct any two activities (each of 10 marks) like Assignments/ quiz/ crossword/ case study

MSE: 30 Marks 90 minutes written examination based on 50% syllabus

ESE: 30 Marks 90 Minutes written examination based on remaining syllabus after MSE

Tutorial:

ISE1: Continuous rubric-based evaluation of first four tutorial (20 Marks)

ISE2: Assessment of Mini Project based on Rubrics (10 Marks), Continuous rubric-based evaluation of next four tutorial (20 Marks)

Recommended Books:

1. Krug, Steve. Don't Make Me Think, Revisited: A Common-Sense Approach to Web Usability. New Riders.
2. Norman, Don. The Design of Everyday Things. Basic Books, A Member of the Perseus Books Group, New York.
3. Allen, Jesmond, and James Chudley. Designing User Experiences. New Riders
4. Unger, Russ, and Carolyn Chandler. A Project Guide to UX Design: For User Experience Designers in the Field or in the Making. New Riders
5. Eyal, Nir. Hooked: How to Build Habit-Forming Products. Portfolio

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PEC3CS32	Computer Vision	L	T	P	L	T	P	Total
		2	0	0	2	--	--	2
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	20	30	20	30	100	
		Tutorial	20	--	30	--	50	

Pre-requisite Course Codes		Linear Algebra, Image Processing
Course Outcomes	CO1	Apply geometric transformations and camera calibration techniques.
	CO2	Analyze image features and perform feature matching.
	CO3	Develop stereo vision and depth estimation solutions.
	CO4	Implement Structure from Motion (SfM) for 3D reconstruction.
	CO5	Apply motion tracking and object recognition in real-world applications.

Module No	Unit No.	Topics	Ref	Hrs
1		**Introduction to Computer Vision**	1,2	3
	1.1	• Definition, applications, and significance of computer vision • Historical evolution and key developments • Fundamental concepts: cameras, image formation, and perspective projection		
2		**Image Representation and Feature detection**	1,2,4	9
	2.1	• Image formation, pinhole camera model, and coordinate systems • Homogeneous coordinates and 2D projective transformations • Affine, perspective, and homography transformations • Camera calibration techniques (intrinsic and extrinsic parameters)		
	2.2	• Edge and corner detection (Harris, Shi-Tomasi) • Scale-Invariant Feature Transform (SIFT) and Speeded-Up Robust Features (SURF) • Oriented FAST and Rotated BRIEF (ORB) features • Feature matching using RANSAC for robust homography estimation		
3		**Multi view Geometry**	1,3,5	8
		• Epipolar geometry and fundamental matrix • Essential matrix and relative pose estimation		

		• Stereo vision and disparity maps • Triangulation and depth estimation		
	3.2	• Multi-view geometry and bundle adjustment • Structure from Motion (SfM) pipeline • 3D point cloud generation and reconstruction • Applications in robotics and augmented reality		
4		**Object Detection and Recognition**	2	3
	4.1	• Contour detection and shape analysis • Template matching and Hough Transform for shape detection • Feature-based object recognition • Applications in industrial automation and surveillance		
5		**Motion Analysis and Tracking**	1,6	3
	5.1	• Optical flow: Lucas-Kanade and Horn-Schunck methods • Kalman filtering for motion prediction • Object tracking using Mean-Shift and CAMShift algorithms • Real-world applications in robotics and video surveillance		
			Total	**26**

Sr. No.	**Suggested list of Tutorial**
1	Understand image formation, homogeneous coordinates, and transformations. • Load and display an image using OpenCV. • Convert images between color spaces (RGB ↔ Grayscale). • Apply affine transformations (scaling, rotation, translation) using OpenCV.
2	Calibrate a camera and compute intrinsic and extrinsic parameters. • Capture images of a chessboard for calibration. • Use OpenCV's cv2.calibrateCamera() function to estimate parameters. • Compute the perspective projection matrix and transform 3D points to 2D.
3	Implement keypoint detection and matching techniques. • Apply Harris corner detection and Shi-Tomasi corner detection. • Detect features using SIFT, SURF, and ORB. • Match keypoints between two images using FLANN or Brute-Force Matcher.
4	Estimate the homography matrix and warp images to create a panorama. • Detect and match keypoints between two overlapping images. • Compute the homography matrix using RANSAC. • Warp and blend images to create a panoramic image.
5	Understand epipolar constraints in stereo vision.

	• Compute Fundamental Matrix (F) from corresponding points. • Plot epipolar lines on stereo image pairs. • Validate epipolar constraints by verifying that x'Fx = 0.
6	Implement stereo disparity estimation to compute depth. • Capture stereo image pairs or use an online dataset (e.g., KITTI). • Compute disparity maps using OpenCV's StereoBM() or StereoSGBM(). • Convert disparity maps to depth maps using camera parameters.
7	Recover a 3D scene structure from multiple 2D images. • Detect keypoints and track features across multiple images. • Compute the Essential Matrix (E) and recover camera motion. • Generate a 3D point cloud using triangulation.
8	Detect objects using contours and shape analysis. • Convert an image to binary and detect contours. • Fit bounding boxes, circles, and ellipses to objects. • Classify objects based on Hu Moments or HOG descriptors.
9	Track motion in videos using optical flow. • Compute Lucas-Kanade Optical Flow on a moving object. • Apply Dense Optical Flow (Farneback Method) to track object motion. • Use Kalman Filtering to predict the object's next position.
10	Implement real-time object tracking. • Track a moving object in a video using Mean-Shift Algorithm. • Improve tracking using CAMShift (adaptive Mean-Shift). • Compare results with Optical Flow-based tracking.

Course Assessment:

Theory:

ISE1: Any two activities like Quiz/assignments/Oral/crossword etc. 20 Marks
ISE2: Any two activities like Quiz/assignments/Oral/crossword etc. 20 Marks
MSE: 30 Marks 90 minutes written examination based on 50% syllabus
ESE: 30 Marks 90 Minutes written examination based on remaining syllabus after MSE

Tutorial

ISE1: Continuous pre-defined rubrics-based evaluation for first four tutorials for 20 marks
ISE2: Continuous pre-defined rubrics-based evaluation for next six tutorials for 30 marks

Recommended Books:

1. "Computer Vision: Algorithms and Applications" – Richard Szeliski, 2nd Edition, Springer Publication

2. "Computer Vision: A Modern Approach" – David Forsyth, Jean Ponce, 2nd Edition, Pearson Publication
3. Multiple View Geometry in Computer Vision" – Richard Hartley, Andrew Zisserman, 2nd Edition, Cambridge University Press
4. Feature Extraction and Image Processing for Computer Vision" – Mark S. Nixon, Alberto S. Aguado, 4th Edition, Academic Press (Elsevier)
5. An Invitation to 3D Vision" – Yi Ma, Stefano Soatto, Jana Košecká, and S. Shankar Sastry, 1st Edition, Springer
6. "Robotics, Vision and Control" – Peter Corke, 2nd Edition, Springer Publication

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PECL2CS11	knowledge Representation and Ontology Lab	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes		DBMS, Web programming
Course Outcomes	CO1	To Design and Implement ontologies for specific domains, including class definition, properties, instances, and relationships using tools like Protégé and OWL.
	CO2	To Query ontologies using SPARQL and Perform automated reasoning using tools like HermiT and Pellet to infer new knowledge.
	CO3	To Demonstrate the ability to model, query, and optimize semantic datasets by integrating relational and linked data using advanced SPARQL techniques and tools, enabling efficient data retrieval and interoperability across heterogeneous data sources.
	CO4	To Integrate knowledge representation methods with technologies such as Natural Language Processing (NLP) and/or Machine Learning (ML) to enhance automated reasoning, knowledge extraction, and decision-making in complex systems.
	CO5	To Apply ontologies in real-world scenarios, such as multi-agent systems, expert systems, and the Semantic Web.

Exp. No.	Topics
1	**Study Semantic Web open source tools-** Apache TinkerPro, RDFLib, Apache Jena, protégé, Sesame.
2	**Construct a Simple Ontology-** Design and Create an ontology (RDF/OWL) to represent a domain. Define classes, object properties, data properties, and instances. (Tools: Protégé)
3	**Semantic Querying Using SPARQL** Use SPARQL to query RDF dataset for data retrieval. (Tool: Protégé)
4	**Ontology Mapping and Alignment:** Map concepts between two ontologies (e.g., one for healthcare and one for biology). Evaluate and validate mappings. Identify overlaps and resolve conflicts. Tools: Agreement Maker Light (AML) or OWL API
5	**Reasoning with Description Logics:** Load the ontology into Protégé. Use a reasoner to check for consistency, infer new facts, and classify concepts. Demonstrate how inferred knowledge can be extracted based on logical rules. Tools: HermiT or Pellet Reasoner (via Protégé)

6	**Building an expert system using Knowledge Representation techniques:** Design a simple expert system (e.g., a medical diagnosis system or a course recommendation system). Tools: Jess (Java Expert System Shell), CLIPS
7	**Semantic Web and Linked Data:** Create linked datasets and use SPARQL to perform federated queries across multiple datasets. (Tools: Protégé, SPARQL endpoint)
8	**Query relational data using ontologies:** Use an OBDA framework to connect relational data to an ontology. Perform SPARQL queries over the relational database. (Tools: Ontop, Morph)
9	**Advanced SPARQL Queries and Optimization:** Explore advanced SPARQL techniques such as filtering, aggregation, and optimization. Query large datasets efficiently. (Tools: SPARQL endpoints, Apache Jena)
10	**Integrating Ontologies with Machine Learning:** Use SPARQL queries to fetch relevant data from an ontology. Integrate the data into a machine learning model for classification or prediction. Tools: Python, scikit-learn, RDFLib, SPARQL **Or** **NLP for Ontology Population :** Extract entities and relationships from unstructured text. Populate an existing ontology using the extracted data using NLP. Tools: Stanford NLP, spaCy, Protégé
11	**Mini Project:** (Group of 2-3 students) The Mini project will demonstrate the integration of concepts learned throughout the course. It will be evaluated based on the complexity of the problem, the design of the ontology or knowledge representation system, and the quality of the implementation showcased with presentation. Solve real world problem. (e.g. Ontology-based decision support system, Semantic data integration, etc.).

Course Assessment:

ISE-1: will be conducted for (40-50%) experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.

ISE-2: will be conducted for remaining experiments. Continuous pre-defined rubrics-based evaluation for 20 marks, Mini project for 10 marks

Recommended Books:

1. "Learning SPARQL: Querying and Updating with SPARQL 1.1" by Bob DuCharme
2. "Knowledge Representation and Reasoning" by Ronald J. Brachman and Hector J. Levesque
3. John Davies, Rudi Studer and Paul Warren, "Semantic Web Technologies Trends and Research in Ontology-based Systems", Wiley, 2006 Edition
4. "Linked Data: Evolving the Web into a Global Data Space" by Tom Heath and Christian Bizer

Reference Books:

1. "Foundations of Artificial Intelligence: A Knowledge Representation Approach" by David W. Aha.
2. "Semantic Web for the Working Ontologist: Effective Modeling in RDFS and OWL" by Dean Allemang and James Hendler.
3. "The Description Logic Handbook: Theory, Implementation, and Applications" by Franz Baader et al.
4. "Foundations of Semantic Web Technologies" by Pascal Hitzler, Markus Krötzsch, and Sebastian Rudolph

Online Repository:

1. Protégé: https://protege.stanford.edu/
2. SPARQL: https://www.w3.org/TR/rdf-sparql-query/
3. OWL: https://www.w3.org/TR/owl-guide/
4. LINKED Data: https://www.coursera.org/learn/web-data#modules
5. Jena :https://jena.apache.org/documentation/inference/
6. Pellet Reasoner : https://github.com/stardog-union/pellet
7. Jess Expert System Shell: https://www.jessrules.com/
8. Stanford NLP: https://stanfordnlp.github.io/CoreNLP/

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PECL2CS21	Generative AI Lab	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes		Artificial Intelligence
Course Outcomes	CO1	Apply deep neural network fundamentals for solving a given problem.
	CO2	Implement a variational autoencoder for a given generation task.
	CO3	Implement a Generative Adversarial Network for given generation task.
	CO4	Develop a transformer model for a given problem.
	CO5	Implement diffusion and stable diffusion model for the given problem.
	CO6	Develop a generative AI application for the given requirement.

Sr. No.	Suggested List of Experiment	Ref. No.
1	**Fundamentals of deep neural networks:** Convolutional Neural Networks, Recurrent Neural Networks, Setting up of TensorFlow lab Tasks: a. Develop an application for image classification using CNNs b. Develop an application of sentence completion using RNNs.	OR1, OR2
2	**Variational Autoencoders:** Autoencoder basics, Variational autoencoder building blocks Task: Develop an application to generate new images using variational autoencoder.	1,2
3	**Generative Adversarial Networks:** Basics of Generative Adversarial Network, Vanilla GAN architecture Tasks: a. Develop an application for generating an image using Vanilla GANs b. Style transfer using CycleGANs or PixtoPix GANs	1,2
4	**Transformer models:** Basics of transformer models, Fundamentals of language models- text tokenization, predicting probabilities, generating text, zero-shot and few-shot generalization Task: Implement a transformer model for text generation task.	3, OR3

5	**Diffusion models:** Basics of diffusion models, training a diffusion model, noise schedules, UNets fundamentals Task: Implement a diffusion model for image generation task.	3, OR3
6	**Stable diffusion models:** Conditional diffusion models, latent diffusion, stable diffusion fundamental building blocks Task: Implement a stable diffusion model for image generation task.	3, OR3

Course Assessment:

ISE-1:

Continuous pre-defined rubrics-based evaluation of experiments in modules 1-3 for 20 marks.

ISE-2:

a. Continuous pre-defined rubrics-based evaluation of experiments in modules 4-6 for 15 marks.
b. Mini Project- Rubrics based evaluation for 15 marks. It is recommended to make a group of 2-3 students. Every group must develop a generative AI application for the given problem statement and present their results.

Recommended Books:

1. David Foster, "Generative Deep Learning- teaching machines to paint, write, compose and play", O'Reilly Media, 1st Edition
2. Joseph Babcock and Raghav Bali, "Generative AI with Python and TensorFlow2", Packt Publishing, 1st Edition
3. Omar Sanseviero, Pedro Cuenca, Apolinario Passos and Jonathan Whitaker, "Hands-on Generative AI with Transformers and Diffusion Models", 1st Edition

Online Resources:

1. https://www.coursera.org/learn/introduction-generative-ai
2. https://archive.nptel.ac.in/noc/courses/noc19/SEM1/noc19-cs18/
3. https://youtu.be/XfpMkf4rD6E?si=efzEk2GaaCqMfWqF – Stanford CS25: V2 | Introduction to transformers w/ Andrej karpathy
4. https://youtube.com/playlist?list=PLoROMvodv4rPOWAomMM6STXaWW4FvJT8&si=hh44mZSLMBD7-2L8 - Stanford CS236: Deep Generative Models

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PECL2CS31	Soft Computing Lab	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes		Machine Learning, Python
		Upon completion of this course, students will be able to
Course Outcomes	CO1	Implement fuzzy logic control system for various real-world applications.
	CO2	Implement and train neural network models for a variety of tasks using different neural network architectures
	CO3	Apply genetic algorithms to solve optimization problems in various domains, such as function optimization, scheduling and engineering design problems.
	CO4	Solve real-world engineering and computational problems using hybrid soft computing techniques

Exp. No.	Suggested List of Experiments
1	Introduction to Soft Computing • Objective: Understanding soft computing concepts and basic algorithms. • Theory: Introduction of soft computing, difference between soft computing and hard computing, Overview of Fuzzy Logic, Genetic Algorithms, Neural Networks. • Practical: Setup and basic tools for Soft Computing, Introduction to MATLAB/Python.
2 3 4	Fuzzy Logic • Objective: Implement a fuzzy inference system. • Theory: Concepts of fuzzy sets, fuzzy rules, and fuzzy inference systems. • Practical list: ➢ Implement Fuzzy set operations (Union, Intersection, Difference and Complement) ➢ To Perform Union, Intersection, max-min and max-product composition of two fuzzy relations ➢ To implement controller using MAMDANI fuzzy model
	Artificial Neural Networks (ANN) • Objective: Implement and train a neural network. • Theory: Understanding perceptrons, multi-layer perceptrons, and backpropagation.

5 6 7 8	• Practical list: ➢ Implement an ANN for pattern recognition or regression using MATLAB or Python (with TensorFlow/Keras). ➢ Implement Error back propagation training algorithm (EBPTA) and solve XOR problem ➢ Write a program to implement Hopfield auto-associative memory ➢ Simulate Boltzmann Machine
9 10 11	Genetic Algorithm • Objective: Implement a basic genetic algorithm for optimization. • Theory: Basic concepts of Genetic Algorithm (Selection, Crossover, Mutation). • Practical list: ➢ Code a genetic algorithm to solve optimization problems such as the Traveling Salesman Problem. ➢ Genetic algorithm for job scheduling ➢ Genetic algorithm for knapsack problem
12 13	Hybrid Soft Computing Techniques • Objective: Combine fuzzy logic with neural networks or genetic algorithms. • Theory: Overview of hybrid systems. Practical list: ➢ Design a hybrid system for real-time applications. ➢ Case study of adaptive neuro fuzzy inference system (ANFIS)

Course Assessment:

ISE1: will be conducted for (40-50%) experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.

ISE-2: will be conducted for remaining experiments. Continuous pre-defined rubrics-based evaluation for 20 marks, Quiz for 10 marks

Recommended Books:

1. "Soft Computing: Techniques and Applications" by S. N. Sivanandam and S. N. Deepa
2. "Fuzzy Logic with Engineering Applications" by Timothy J. Ross
3. "Neural Networks: A Comprehensive Foundation" by Simon Haykin
4. "Introduction to Genetic Algorithms" by S. N. Sivanandam and S. Sumathi

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PCC13CS20	Software Testing Lab	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	20	--	30	--	50	

Pre-requisite Course Codes		Programming Fundamentals
Course Outcomes	CO1	Recognize failures in the system
	CO2	Design test cases for the given application
	CO3	Design test plan for given application
	CO4	Execute test cases using automated tools
	CO5	Use tools to manage the testing process

Sr. No.	Suggested List of Experiment	Ref. No.
1	Write a program for any one function of the selected system. Introspect the causes for its failure and write down the possible reasons for its failure	1,2
2	Design test cases for the system using boundary value analysis as a black box testing technique	1,2
3	Design test cases for the system using Equivalence Class Partitioning as a black box testing technique	1,2
4	Find cyclomatic complexity for given codes and then perform white box testing on those codes.	1,2
4	Design a test plan document for the given application	1,2
5	Design unit test cases using Junit framework in Java	3
6	Perform automated testing using Selenium on a web application	4
7	Use Qase as a test management tool for given application	OR1
8	Use JIRA for defect management for a given application	OR2

Course Assessment:

ISE1:

Continuous pre-defined rubrics-based evaluation of experiments in modules 1-4 for 20 marks.

ISE2:

Continuous pre-defined rubrics-based evaluation of experiments in modules 5-8 for 20 marks. Article discussion on advanced concepts in software testing in a group of 3 students for 10 marks.

Recommended Books:

1. Naresh Chauhan, "Software Testing Principles and Practices", Oxford Higher Education, 2nd Edition
2. Kshirasagar Naik and Priyadarshi Tripathy, "Software Testing and quality assurance theory and practice", Wiley Publication, 1st Edition
3. Catalin Tudose, "Junit in Action", Manning Publishing, 3rd Edition
4. Mark Collin, "Mastering Selenium WebDriver", Packt Publishing, 1st Edition

Online Resources:

1. https://docs.qase.io/ - Test case management with Qase, official documentation
2. https://confluence.atlassian.com/jira - Official JIRA documentation

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25MDM04	Public Relations and Corporate Communication	L	T	P	L	T	P	Total
		2	--	--	2	--	--	2
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	50	--	50	--	100	

Pre-requisite Course Codes	--	
Course Outcomes	CO1	Develop professional communication skills through training and practice
	CO2	Draft professional documents with precision
	CO3	Develop effective communication strategies for diverse, cultural, and global business environment

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Professional Communication Skills	1,3	8
	1.1	Resume Writing & Cover Letter for Employment		
	1.2	Group Discussion		
	1.3	Formal dressing		
	1.4	Communication – language and articulation		
	1.5	Interview Techniques		
	1.6	Formal email writing		
2		Synergy Communication	4	6
	2.1	Presentation Skills – creating and delivering presentations		
	2.2	Report Writing- Importance, Objective, type – versioning and storage		
	2.3	Meetings and Documentation: Notice, Agenda, Minutes		
	2.4	Phone and video communication		
3		Cross-Cultural Communication	2,4	6
	3.1	Cultural awareness		
	3.2	Language barriers		
	3.3	Global communication strategies		
	3.4	Corporate etiquettes		
4		Corporate Identity and Branding	5	6
	4.1	Corporate image and reputation		
	4.2	Branding strategies		
	4.3	Visual identity		
	4.4	Messaging and tone		
	4/5	Cultural context of branding		
			Total	26

Course Assessment:

Sr. No.	List of Written and Oral Assignments	ISE	Marks
1	Resume/ Cover Letter	ISE1	10
2	GD Practices		10
3	Mock Interview HR Question		10
4	Team Building Activity		10
5	Notice & Agenda and Minutes of the Meeting		10
6	Formal presentation	ISE2	10
7	GD Practices		20
8	Mock Interview HR Question		20
	Total		100

Recommended Textbooks:

1. Dr. K.Alex, Soft Skills- Know Yourself & know the World, S.Chand
2. John Hayes, Interpersonal Skills at Work, McGraw Hill Education
3. Ankur Malhotra,Campus Placement: A Comprehensive Guide, McGraw Hill Education
4. Meenakshi Raman,Sangeeta Sharma, Communication Skills, Oxford, India
5. Courtland L. Bovee, Business Communication Today, Pearson