PAAVAI ENGINEERING COLLEGE, NAMAKKAL – 637018
(AUTONOMOUS)
REGULATIONS 2023
CHOICE BASED CREDIT SYSTEM
B.E. CSE – INTERNET OF THINGS
CURRICULUM
(Applicable to the candidates admitted during the academic year 2023-2024 onwards)

SEMESTER V

S. No	Category	Course Code	Course Title	L	T	P	C
Theory							
1	PC	BA23151	Entrepreneurship Development	3	0	0	3
2	PC	CI23501	Theory of Computation	3	1	0	4
3	PC	CI23502	Embedded Systems with IOT	3	0	0	3
4	PC	CI23503	Computer Networks	3	0	0	3
5	PC	CI23504	Design and Analysis of Algorithms	3	0	0	3
6	PE	CI23***	Professional Elective – I	3	0	0	3
Practical							
7	PC	CI23505	Embedded Systems with IOT Laboratory	0	0	2	1
8	PC	CI23506	Computer Networks Laboratory	0	0	4	2
9	EE	CI23507	Industrial Training	0	0	2	1
10	EE	GE23501	Professional Development III	0	0	2	1
			Total	**18**	**1**	**10**	**24**

VERTICAL SYLLABUS LIST

S. No	Subject Code	Name of the Subject	L	T	P	C
VERTICAL - I						
1	CI23151	Foundations of Data Science	3	0	0	3
2	CI23152	Image and Video Analytics	3	0	0	3
3	CI23153	Neural Networks	3	0	0	3
4	CI23154	Blockchain Technology	3	0	0	3
5	CI23155	Knowledge Engineering	3	0	0	3
6	CI23156	Data Visualization	3	0	0	3
7	CI23157	Big Data Analytics	2	0	2	3
VERTICAL - II						
1	CI23251	Mobile Application Development for IoT	2	0	2	3
2	CI23252	Principles of Programming Languages	3	0	0	3
3	CI23253	Programming Languages for IoT	3	0	0	3
4	CI23254	Web Technologies	3	0	0	3
5	CI23255	R Programming	3	0	0	3
6	CI23256	Software Testing and Automation	2	0	2	3
7	CI23257	DevOps	3	0	0	3
VERTICAL - III						
1	CI23351	Data Warehousing and Data Mining	3	0	0	3
2	CI23352	Edge Computing	3	0	0	3
3	CI23353	Cloud Services Management	3	0	0	3
4	CI23354	Storage Technologies	3	0	0	3
5	CI23355	IoT Platforms and System Design	3	0	0	3
6	CI23356	Software Defined Networks	3	0	0	3
7	CI23357	Virtualization	3	0	0	3

S. No	Subject Code	Name of the Subject	L	T	P	C
VERTICAL - IV						
1	CI23451	Cryptography and Network Security	3	0	0	3
2	CI23452	Mobile Ad Hoc Networks	3	0	0	3
3	CI23453	Network Security	3	0	0	3
4	CI23454	Cyber Security	3	0	0	3
5	CI23455	Privacy and Security in IOT	3	0	0	3
6	CI23456	Ethical Hacking	3	0	0	3
7	CI23457	Digital and Mobile Forensics	3	0	0	3
VERTICAL - V						
1	CI23551	IoT Device Programming	3	0	0	3
2	CI23552	Service Oriented Architecture	3	0	0	3
3	CI23553	UI and UX Design	3	0	0	3
4	CI23554	3D Design Principles and Patterns	3	0	0	3
5	CI23555	Cloud Computing	3	0	0	3
6	CI23556	Architecting Smart IoT Devices	3	0	0	3
7	CI23557	Dynamic Paradigm in IoT	3	0	0	3
VERTICAL - VI						
1	CI23651	IoT Automation	3	0	0	3
2	CI23652	Virtual Reality and Augmented Reality	3	0	0	3
3	CI23653	Fog and Edge Computing	3	0	0	3
4	CI23654	Deep Learning	3	0	0	3
5	CI23655	Machine Learning Techniques	3	0	0	3
6	CI23656	Natural Language Processing	3	0	0	3
7	CI23657	Social Network Security	3	0	0	3

BA23151	ENTREPRENEURSHIP DEVELOPMENT	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1	empower to adopt the management principles
2	build entrepreneurial competencies and analyze support from government and agencies in entrepreneurship development.
3	appraise factors for launching a small business
4	adopt business opportunities and prepare feasibility reports.
5	develop entrepreneurial mindset, creativity, and understand startup ecosystems

UNIT I	BASICS OF MANAGEMENT AND ENTREPRENEURSHIP	9

Management: Meaning, Definition, Nature and Importance, Roles - Levels of Management - Functional areas of Management: Marketing, Finance, Production, HRM, IT, Research and Development. Introduction to Entrepreneurship and Intrapreneurship – similarities, differences, types of entrepreneurs - Functions of an entrepreneur

UNIT II	ENTREPRENEURIAL COMPETENCE AND ENVIRONMENT	9

Entrepreneurial Competence: Definitions, Roles, Styles, Characteristics, Competencies

Entrepreneurial Environment: Socio-cultural, Economic, Political factors; Institutional Support for small entrepreneurs. Central and State Government Industrial Policies and Regulations - Entrepreneurial Skillset: motivation, stress, ethical challenges

UNIT III	ENTREPRENEURIAL DEVELOPMENT AND STRUCTURES	9

Ownership Structures: Proprietorship, Partnership, Company, Cooperative, Franchise. Business Opportunity Identification, Feasibility Report, Financial & Technical Evaluation. Entrepreneurial Development Programs, Role of SSI, Failure Causes and Turnaround Strategies. Creativity techniques: Six Thinking Hats, Idea validation, Lean Canvas model.

UNIT IV	BUSINESS PLAN AND FUNDING STRATEGIES	9

Business Plan: Business opportunities-SWOT, Business plan process, Feasibility Study - AI in business plan preparation.

Financing ventures: sources of raising capital, seed funding, venture capital funding, funding opportunities for start-ups in India, - AI driven startup evaluation and scoring - Pitching, funding mix (debt vs equity), incubators, accelerators, crowd funding, angel investors.

UNIT V	WOMEN ENTREPRENEURSHIP AND SECTORAL OPPORTUNITIES	9

Women Entrepreneurship: Growth, Challenges, development. Strategic planning and growth for startups – Women Entrepreneurship Platform in India – Entrepreneurial schemes for women – SSI and MSME

Entrepreneurship in Formal Sector: AI in Rural, Agriculture, Tourism, Manufacturing, Healthcare, Transport and allied services. Digital economy tools: social media marketing, affiliated marketing, influential marketing, mobile marketing.

	TOTAL PERIODS	45

COURSE OUTCOMES		
At the end of this course, students will be able to		**BT Mapped (Highest Level)**
CO1	implement the necessary managerial skills to become an entrepreneur	Applying (K3)
CO2	develop self-employment having been exposed to entrepreneurial environment.	Synthesis (K5)
CO3	select a best business idea by using appropriate methods to assess its viability	Knowledge(K1)
CO4	formulate a business plan and deploy the resources for sustainable growth	Synthesis (K5)
CO5	analyze government support systems and startup ecosystem resources like incubators and funding options..	Analyzing (K4)

TEXT BOOKS

1. Entrepreneurship: Theory, Process, and Practice By Donald F. Kuratko 11th Edition, 2021, Cengage Learning
2. Entrepreneurship Development: New Venture Creation By S.S. Khanka 6th Edition, 2021, S. Chand Publishing

REFERENCE BOOKS

1. Entrepreneurship Development, by Sharma Sangeeta – Second Edition, 2020, PHI Learning
2. Entrepreneurship by Rajeev Roy – Second Edition, 2011, Oxford University Press
3. The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company, By Steve Blank and Bob Dorf, 2020 Edition
4. Entrepreneurship: Starting and Operating A Small Business, By Steve Mariotti and Caroline Glackin, 7th Edition, 2021, Pearson

CO-PO MAPPING :

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes(POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	1	-	1	-	-
CO2	-	-	-	-	1	2
CO3	-	-	-	1	-	1
CO4	-	-	2	-	2	-
CO5	1	-	1	-	2	-

CI23501	THEORY OF COMPUTATION	3	1	0	4

COURSE OBJECTIVES

To enable the students to

1.	learn the concepts of finite automata with its types and construction.
2.	understand regular languages, finite automata, and their theoretical foundations.
3.	apply context-free grammars, derivation techniques, and normal forms in formal language theory.
4.	understand the design and operation of pushdown automata and their equivalence to context-free grammars.
5.	learn about Turing machines, decidable and undecidable problems.

UNIT I	INTRODUCTION TO AUTOMATA	12

Need for automata theory - Introduction to formal proof – Finite Automata (FA) – Deterministic Finite Automata (DFA) – Non-deterministic Finite Automata (NFA) – Equivalence between NFA and DFA – Conversion from NFA to DFA.

UNIT II	REGULAR EXPRESSIONS AND LANGUAGES	12

Regular expression – Regular Languages- Equivalence of Finite Automata and regular expressions – Proving languages to be not regular (Pumping Lemma) – Closure properties of regular languages

UNIT III	CONTEXT FREE GRAMMAR	12

Context-Free Grammar (CFG) – Defintions – Derivations and Parse trees – Ambiguity in grammars and languages – Chomsky Normal Form (CNF) – Pumping lemma for CFL – Closure properties of Context Free Languages.

UNIT IV	PUSH DOWN AUTOMATA	12

Push Down Automata (PDA): Definition – Moves - Instantaneous descriptions -Languages of pushdown automata – Equivalence of pushdown automata and CFG-Conversion of CFG to PDAPDA to CFG – Deterministic Pushdown Automata.

UNIT V	TURING MACHINES AND UNDECIDABILITY	12

Turing Machine: Basic model – Language acceptance by TM – Universal Turing Machine – Unsolvable Problems – Post Correspondence Problem(PCP) – Tractable and Intractable problems - P and NP completeness – 3-CNF SAT problems.

	TOTAL PERIODS	60

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	construct finite automata for a given language with its types.	Applying (K3)
CO2	prove the equivalence of languages described by finite automata and regular expressions.	Applying (K3)
CO3	construct CFG for a given language, simplify and transform to a normal form.	Applying (K3)
CO4	design push down automata, convert into CFG and vice-versa.	Applying (K3)

CO5	construct Turing machine and prove the undecidability or complexity of a variety of problems.	Applying (K3)

TEXT BOOKS

1. Hopcroft J.E., Motwani R. & Ullman J.D., "Introduction to Automata Theory, Languages and Computations", 3rd Edition, Pearson Education, 2008.
2. John C Martin, "Introduction to Languages and the Theory of Computation", 4th Edition, Tata McGraw Hill, 2011.

REFERENCES

1. Harry R Lewis and Christos H Papadimitriou, "Elements of the Theory of Computation", 2nd Edition, Prentice Hall of India, 2015.
2. Peter Linz, "An Introduction to Formal Language and Automata", 6th Edition, Jones & Bartlett, 2016. K.L.P.Mishra and N.Chandrasekaran, "Theory of Computer Science: Automata Languages and Computation", 3rd Edition, Prentice Hall of India, 2006.
3. H.R.Lewis and C.H.Papadimitriou, Elements of the theory of Computation, Second Edition, PHI, 2003.
4. Deepak D' Souza, Priti Shankar, "Modern Applications of Automata Theory", IISc Press, 2012.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
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	Programme Outcomes PO's												PSO's	
CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	3	2	-	-	-	-	-	1	1	3	3
CO2	2	2	2	2	2	-	-	-	-	-	1	1	3	2
CO3	3	2	3	3	3	-	-	-	-	-	1	1	2	3
CO4	2	3	2	2	2	-	-	-	-	-	1	1	3	3
CO5	3	3	3	3	3	-	-	-	-	-	1	1	2	2

CI23502	EMBEDDED SYSTEMS WITH IOT	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	know the basic concept and components of embedded systems.
2.	understand the design of embedded systems.
3.	recognize the functions of real-time operating systems.
4.	learn the architecture and design flow of IoT.
5.	build an IoT based system.

UNIT I	INTRODUCTION TO EMBEDDED SYSTEMS	9

Introduction - Classification of an embedded system -Major application areas of embedded systems -Purpose of Embedded Systems - General purpose computers vs embedded system - Typical embedded system - Core of the Embedded System - Memory – Communication interface - Embedded firmware – Other system components - PCB and passive components.

UNIT II	DESIGN OF EMBEDDED SYSTEMS	9

Sensors and actuators - models of sensors and actuators, common sensors; Embedded Processors -Types of processors, parallelism; Memory architecture - Memory technologies, memory hierarchy, memory models; Input and output hardware - Sequential software in a concurrent world.

UNIT III	OPERATING SYSTEM FOR EMBEDDED SYSTEMS	9

Fundamentals of Real Time Operating System (RTOS) – The Kernel, Types of operating systems: Tasks, Process and Threads: Multiprocessing and Multitasking - Task scheduling - Task communication -Task synchronization - Device drivers - How to choose an RTOS.

UNIT IV	IOT NETWORK ARCHITECTURE AND DESIGN	9

Drivers behind new network Architecture, Constrained devices and networks, Comparing IoT Architecture – the oneM2M IoT standardized Architecture, IoT World Forum (IoTWF) standardized Architecture, simplified Architecture of IoT, IoT data management and Compute stack.

UNIT V	EMBEDDED SYSTEMS WITH IOT APPLICATIONS	9

Case Studies: Home Automation, Smart Cities – an IoT strategy, Architecture, connected street light, smart traffic control with applications, IoT use cases for transportation, Environment and Agriculture.

	TOTAL PERIODS	45

COURSE OUTCOMES		
At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	recognize the components and classification of embedded systems.	Understanding (K2)
CO2	describe about the design of embedded systems.	Understanding (K2)
CO3	identify embedded systems using the concepts of RTOS.	Applying (K3)
CO4	learn the architecture and protocols of IoT.	Understanding (K2)

CO5	design an IoT based system for any application.	Applying (K3)

TEXT BOOKS

1. Shibu K.V, "Introduction to Embedded Systems" , Second Edition, Mc Graw Hill, 2017.
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press, 2017.

REFERENCES

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things", Cisco Press, 2017.
2. Steve Ferbur, "ARM System on Chip", 2nd Edition, Pearson, 2017.
3. Raj Kamal, "Embedded Systems", Tata McGraw Hill, 4th Edition, 2020.
4. Dr. Ovidin Vermesan, Dr. Peter Fress, "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publisher, 2013.

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(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	-	-	-	2	1	-	-	2	1	3	2
CO2	3	2	1	-	-	-	2	-	-	-	2	1	3	2
CO3	3	2	2	-	2	-	2	-	-	-	2	2	3	2
CO4	3	3	2	2	2	-	-	-	-	-	-	3	3	2
CO5	3	3	3	3	3	-	-	-	-	-	-	3	3	2

CI23503	COMPUTER NETWORKS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	introduce the foundational concepts of the computer network, structure, switching methods, and performance metrics.
2.	explore the design and operation of application-layer protocols and network applications including IoT-specific models.
3.	study the principles, protocols, and services of the transport layer, focusing on reliability and congestion control.
4.	understand the functions and components of the network layer including IP addressing, routing algorithms, and SDN.
5.	describe the link layer functionalities, LAN technologies, wireless networks, network security, and IoT connectivity options.

UNIT I	INTRODUCTION TO COMPUTER NETWORKS	9

Computer Networks and the Internet - definition, services and protocols - uses of networks, types of networks, types of topology - Network edge - Access networks, Physical media – Network core - Packet switching, Circuit switching, Network of networks - Delay, loss and throughput in packet-switched networks – Protocol Layered Architecture – The Reference Models: OSI and TCP/IP reference Model.

UNIT II	APPLICATION LAYER	9

Principles of network applications – Client-server and peer-to-peer models – Web and HTTP – File Transfer Protocol (FTP) – Electronic Mail – Domain Name System (DNS) – Video streaming and content distribution - Socket programming: Creating Network applications - Case Study: IoT-focused application protocols: MQTT, CoAP.

UNIT III	TRANSPORT LAYER	9

Transport layer services – Multiplexing and demultiplexing – Connectionless Transport: UDP – Principle of Reliable Data Transfer- Connection-Oriented Transport: TCP - TCP congestion control – Case Study: Transport issues in IoT.

UNIT IV	NETWORK LAYER	9

Overview – Inside a router – Internet Protocol (IP): IPv4, Addressing, IPv6 – Generalized forwarding and SDN –Routing algorithms: Link-State and Distance-Vector – Intra-AS routing in the Internet: OSPF – ICMP – SNMP – Case Study: addressing modes in IoT.

UNIT V	LINK LAYER, LAN AND NETWORKS ADVANCEMENT	9

Link Layer Overview – Error detection and correction – Physical Layer and Transmission Media - Multiple access protocols: ALOHA, CSMA/CD, CSMA/CA – Switched Local Area Networks – Wireless LANs: IEEE 802.11 Architecture, MAC Protocol – Personal Area Networks: Bluetooth, Zigbee – Mobile IP – Network Security - SSL – IPsec and VPN – Operational Case Study: LPWAN for IoT.

	TOTAL PERIODS	45

COURSE OUTCOMES		
At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	explain the fundamentals of computer networks.	Understanding (K2)
CO2	use HTTP, DNS, and IoT-focused protocols MQTT and CoAP in application layer and design a top-down approach application.	Applying (K3)
CO3	analyze the mechanisms of transport protocols TCP and UDP and evaluate congestion control techniques to ensure reliable transport communication.	Analyzing (K4)
CO4	apply IP addressing, routing algorithms, and the concept of Software-Defined Networking (SDN) in the network layer.	Understanding (K2)
CO5	discuss link layer protocols, wireless technologies, and network security techniques and incorporate into IoT environments.	Understanding (K2)

TEXT BOOKS

1. James F. Kurose and Keith W. Ross, "Computer Networking: A Top-Down Approach", 8th Edition, Pearson Education, 2022.
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press, 2017.

REFERENCES

1. Behrouz A. Forouzan," Data Communications and Networking", 5th Edition, McGraw Hill, 2017.
2. William Stallings, "Data and Computer Communications", 10th Edition, Pearson Education, 2013.
3. Andrew S. Tanenbaum, David J. Wetherall," Computer Networks", 5th Edition, Prentice Hall.
4. James F. Kurose, Keith W. Ross, "Computer Networking: A Top-Down Approach", 7th Edition, Pearson Education, 2017.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

	Programme Outcomes PO's												PSO's	
CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	-	2	-	-	-	-	-	1	1	3	3
CO2	3	2	2	2	2	1	1	-	1	2	2	1	3	2
CO3	3	3	2	2	1	1	-	-	1	-	-	1	2	3
CO4	3	3	3	2	1	1	-	2	2	-	-	1	3	3
CO5	3	3	2	2	-	-	-	-	-	-	-	1	2	2

CI23504	DESIGN AND ANALYSIS OF ALGORITHMS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the different techniques for problem solving and algorithm design.
2.	analyze the importance of brute force and divide-and-conquer techniques.
3.	apply dynamic programming and greedy techniques to solve complex optimization problems effectively.
4.	learn the iterative design techniques applying in real life problems.
5.	acquire knowledge of backtracking and branch and bound techniques.

UNIT I INTRODUCTION 9

Algorithm - Fundamentals of Algorithmic Problem Solving - Important Problem Types - Fundamentals of the Analysis of Algorithm Efficiency – The Analysis Framework - Asymptotic Notations and its properties - Mathematical Analysis of Recursive and Non-Recursive Algorithms – Computing nth Fibonacci Number.

UNIT II BRUTE FORCE AND DIVIDE-AND-CONQUER TECHNIQUES 9

Brute Force: Selection and Bubble Sort - Sequential Search and String Matching – Exhaustive Search: Travelling Salesman Problem - Knapsack Problem - Assignment Problem – Depth-First and Breadth-First Search - Divide and Conquer: Merge sort - Quick sort - Binary tree traversals - Multiplication of Large Integers and Strassen's Matrix Multiplication.

UNIT III DYNAMIC PROGRAMMING AND GREEDY TECHNIQUES 9

Dynamic Programming: Knapsack Problem and Memory functions, Optimal Binary Search Tree - Warshall's and Floyd's algorithms - Greedy Technique: Prim's algorithm - Kruskal's algorithm - Dijkstra's algorithm - Huffman trees and Codes.

UNIT IV ITERATIVE IMPROVEMENT AND LIMITATIONS OF ALGORITHM POWER 9

Iterative Improvement: The Simplex Method - The Maximum-Flow Problem - Maximum Matching in Bipartite Graphs - The Stable marriage Problem; Limitation of Algorithm Power - Lower Bound Arguments, Decision Trees, P, NP, NP Complete Problems.

UNIT V BACKTRACKING AND BRANCH AND BOUND TECHNIQUES 9

Backtracking: n-Queens problem - Hamiltonian Circuit Problem - Subset Sum Problem - Branch and Bound: Assignment problem - Knapsack problem - Travelling Salesman Problem - Approximation Algorithms for NP-hard Problems: Traveling Salesman problem - Knapsack problem.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	explain the various frameworks for algorithmic design.	Understanding (K2)
CO2	analyze the efficiency of various problems of brute and force and divide and conquer technique.	Analyzing(K4)

CO3	make use of dynamic programming and greedy techniques to solve overlap or sub problems.	Applying (K3)
CO4	illustrate the real-life problems solving by iterative design techniques.	Understanding (K2)
CO5	solve difficult combinatorial problems with backtracking and branch & bound techniques.	Applying (K3)

TEXT BOOKS

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

REFERENCES

1. Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, "Data Structures and Algorithms", Pearson Education, Reprint 2013.
2. Sandeep Sen and Amit Kumar, "Design and Analysis of Algorithms: A Contemporary Perspective", IIT Delhi, 2018.
3. Steven S. Skiena, "The Algorithm Design Manual", Third Edition, Springer, 2021.
4. Donald E. Knuth, "The Art of Computer Programming", Volumes 1 & 3, Pearson Education, 2016.

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	Programme Outcomes PO's												PSO's	
CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	2	-	-	-	-	-	-	2	3	3
CO2	2	3	2	2	2	-	-	-	-	-	-	1	3	3
CO3	3	2	3	1	3	-	-	-	-	-	-	-	2	3
CO4	2	3	2	2	2	-	-	-	-	-	-	-	3	3
CO5	3	3	3	3	3	-	-	-	-	-	-	2	3	3

CI23505	EMBEDDED SYSTEMS WITH IOT LABORATORY	0	0	2	1

COURSE OBJECTIVES

To enable the students to

1.	understand the fundamentals of LED and seven segment display.
2.	understand about the components such as Buzzer and LCD.
3.	understand working principles of sensors such as temperature and LDR.
4.	understand about key input and servo motor and DC Motor.

LIST OF EXPERIMENTS

1. Implement a program to Blink LED using ESP32.
2. Implement a program for LCD Display using ARM.
3. Implement a program for Buzzer Indication using ESP32.
4. Implement a program for LDR using ESP32.
5. Implement a program for LM35 Sensor for temperature measurement using ESP32.
6. Implement a program for Servo Motor Control using ESP32.
7. Implement a program for DC Motor Control using ESP32.
8. Determine digital output for a given Analog input using internal ADC of ARM Controller
9. Interface a 4*4 keyboard and display the key code on an LCD Using Arm Cortex.
10. Display the Hex digits 0 to F on a 7 Segment LED interface, with an appropriate delay in between Using Arm Cortex.

TOTAL PERIODS	**30**

COURSE OUTCOMES

At the end of this course, students will be able to		**BT Mapped (Highest Level)**
CO1	acquire knowledge about Arduino, LED and control intensity of light.	Applying (K3)
CO2	implement buzzer and LCD in applications.	Applying (K3)
CO3	implement LM35sensor, LDR in applications	Applying (K3)
CO4	implement the way to blink LED through key input and working with servo motor.	Applying (K3)

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	-	-	-	1	-	-	-	2	1
CO2	3	2	2	1	3	-	-	-	1	-	-	1	2	1
CO3	3	2	3	1	3	-	-	-	1	-	1	2	2	1
CO4	3	2	3	1	3	-	-	-	1	-	2	3	2	1

CI23506	COMPUTER NETWORKS LABORATORY	0	0	4	2

COURSE OBJECTIVES

To enable the students to

1.	understand and analyze the functioning of various network protocols using packet analysis tools like Wireshark.
2.	develop basic client-server applications using socket programming techniques.
3.	explore and simulate network topologies and devices using tools such as Cisco Packet Tracer.
4.	interpret protocol behavior and troubleshoot network performance using real-time data capture and analysis.

LIST OF EXPERIMENTS

1. Installation and exploration of the packet / protocol analyzer tool Wireshark.
2. Capture HTTP packets by retrieving different HTML files and experiment HTTP GET/POST connections and HTTP authentication using Wireshark.
3. Capture the DNS packets that are generated by ordinary web-surfing activity and produce the details of DNS query and response messages using Wireshark.
4. Create UDP and TCP based network applications using socket programming.
5. Capture UDP packet traces through DNS messages and prepare UDP datagrams with the packet summary fields using Wireshark.
6. Transfer a file to a remote server, analyze the traces of the TCP segments sent and received and investigate the behaviors of TCP using Wireshark.
7. Capture packets from an execution of traceroute/tracert program and analyze the IPv4 datagram, IP fiagmentation, IPv6 datagrams using Wireshark.
8. Capture and analyze the packet traces of DHCP and ICMP using Wireshark.
9. Capture packet traces by retrieving an HTML file and investigate the operations of Ethernet protocol and the ARP protocol using Wireshark.
10. Simulate the network topologies (Bus, Ring, Star and Mesh) using Cisco Packet Tracer.
11. Simulate and identify the difference in working operation of Hub and Switch using Cisco Packet Tracer.

TOTAL PERIODS	**60**

COURSE OUTCOMES

At the end of this course, students will be able to		**BT Mapped (Highest Level)**
CO1	analyze protocol operations such as HTTP, DNS, DHCP, ARP, and ICMP using Wireshark.	Applying (K3)
CO2	implement and test TCP and UDP client-server applications using socket programming.	Applying (K3)
CO3	simulate different network topologies and devices to understand real-world networking scenarios using Cisco Packet Tracer.	Applying (K3)
CO4	investigate and interpret the behavior of network layers and protocols based on packet-level traces and simulations.	Applying (K3)

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	2	-	-	-	-	-	-	3	2	2
CO2	3	2	3	-	2	-	-	-	-	-	-	2	2	2
CO3	3	2	3	2	2	-	-	-	-	-	-	3	2	3
CO4	3	3	2	2	2	-	-	-	-	-	-	3	2	3

CI23507	INDUSTRIAL TRAINING	0	0	2	1

COURSE OBJECTIVES

To enable the students to

1.	understand the organizational hierarchy and operational workflows in software companies.
2.	gain exposure to real-time problem solving skills in IoT based projects.
3.	familiarize with industry tools, platforms, and coding standards followed in software industries.
4.	develop hands-on experience in project execution, deployment, and teamwork in a professional setup.

DESCRIPTION

- The objective of the Industrial Training is to provide hands-on exposure to real-time software applications in reputed companies or institutions, focusing on areas such as IoT, AI, data science, web development, machine learning, cloud computing. , etc.,
- The training involves hands-on experience in real-world systems like Sensors, Devices, software development, exposure to machine learning workflows, case studies in system design, data handling, and emerging techniques in IoT, artificial intelligence, analytics, cloud computing, etc., used in the industry.
- The students are required to undergo industrial training for a duration of 10–15 days / 90 hours in a reputed company, preferably a Private Limited company in Bangalore, Chennai, or other IT hubs.
- Students will work in teams of up to four members, collaborating on project-based or task-oriented assignments as allocated by the host industry. The students shall submit and present the progress report at the Institute at least thrice in this duration for internal assessment. The presentation will be attended by a committee. Alternately, a faculty mentor may visit the Industry to get the feedback of the students.
- The final assessment will be conducted through seminar, viva-voce, submission of training report, and a certificate issued by the company.
- Each student must submit a report detailing the company profile, tools and technologies used, the nature of the tasks assigned, and learning outcomes. This report should be attested by the company supervisor and submitted within 2 to 4 weeks of completing the training via email or hard copy.
- Students will be evaluated twice: once midway through the training and again at the end, to track progress and provide constructive feedback.
- The assessment shall be carried out by a committee comprising of a representative of the Industry where the candidate is undergoing training and a faculty member from the respective program from the college.

- For Institution level evaluation of industrial training, a committee consisting following faculty members. (1) Head of Dept. concerned. (2) Faculty member who assessed the student in the industry (3) any other staff member of department concerned may be formed.

TOTAL PERIODS	**30**

COURSE OUTCOMES At the end of this course, the students will be able to		**BT MAPPED** (Highest Level)
CO1	appreciate the organizational hierarchy and team structure in IT/software companies.	Analyzing (K2)
CO2	practice software development, IoT integration and AI workflows followed in industry.	Applying (K3)
CO3	develop programming, data handling, and analytical skills.	Applying (K3)
CO4	understand the software project lifecycle and deployment processes.	Understanding (K2)

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	-	-	-	-	-	-	-	2	1	-	2	2	3
CO2	2	2	3	2	3	-	-	-	2	2	-	2	3	3
CO3	3	2	3	2	2	-	-	-	1	2	-	3	3	3
CO4	2	2	2	2	2	-	-	-	2	2	-	2	3	2

GE23501	PROFESSIONAL DEVELOPMENT III	0	0	2	1

COURSE OBJECTIVES

To enable students to

1.	enhance their Resume writing skills and improving corporate vocabularies to survive in the corporate world.
2.	evaluate their interview skills and improve their interview presentation.
3.	solve the quantitative aptitude problems and improve their mental ability.
4.	improve critical thinking and reasoning skills.

UNIT I	RESUME WRITING SKILLS	6

Updated Resume Building III – Self Introduction III – Dressing Etiquette – JAM V – Corporate Vocabulary.

UNIT II	INTERVIEW SKILLS	6

Interview skills – General guidelines - Work Ethics – Group Discussion III – JAM VI – Presentation Competence – Mock Interview.

UNIT III	QUANTITATIVE APTITUDE	9

Cube Root and Square Root - Time and Work - Ages - Permutation and Combination - Probability – Calendar.

UNIT IV	LOGICAL REASONING	9

Series Completion - Blood Relations - Coding and Decoding - Data Sufficiency - Statements and Assumptions.

TOTAL PERIODS:	30

COURSE OUTCOMES Upon completion of the course, the students will be able to		BT MAPPED (Highest Level)
CO1	excel in drafting Resumes and speaking.	Applying (K3)
CO2	demonstrate the participative skills in group discussions and Interviews.	Applying (K3)
CO3	solve problems based on quantitative aptitude.	Applying (K3)
CO4	enhance their logical and verbal reasoning.	Analyzing (K4)

TEXTBOOKS

1. Aggarwal, R. S. A Modern Approach to Verbal & Non-Verbal Reasoning. Revised ed., 2024–25, S. Chand & Company Ltd., 2024.
2. Aggarwal, R. S. Objective General English: Fully Revised Video Edition. S. Chand & Company Ltd., 2022.

REFERENCES

1. Abhijit Guha, "Quantitative Aptitude ", Tata-Mcgraw Hil1.2015.
2. Word Power Made Easy By Norman Lewis, Wr.Goyal Publications.2016.
3. Johnson, D.W. Reaching out — Interpersonal Effectiveness and self- actualisation. Boston: Allyn and Bacon.2019.
4. Infosys Campus Connect Program — students' guide for soft skills.2015.

CO/PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes (PO's)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
CO1	3	2	2	3	3	1	-	-	-	-	-	-	3	2
CO2	-	2	3	-	2	-	2	-	-	-	-	-	3	2
CO3	3	2	2	2	-	-	1	-	-	-	-	-	2	3
CO4	3	2	2	-	-	1	-	-	-	-	2	-	2	3

VERTICAL - I

DATA SCIENCE

CI23151	FOUNDATIONS OF DATA SCIENCE	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the data science fundamentals and its process
2.	describe the data for building the model along and statistical basis for AI
3.	analyses the relationship between data using predictive model evaluation
4.	utilize the Python libraries for Data Wrangling.
5.	present and interpret data using visualization libraries in Python

UNIT I	INTRODUCTION	9

Data Science: Benefits and uses – facets of data - Data Science Process: Overview – Defining research goals – Retrieving data – Data preparation - Exploratory Data analysis – build the model– presenting findings and building applications.

UNIT II	DESCRIBING DATA	9

Types of Data - Types of Variables - Basic Statistical descriptions of Data - Describing Data with Tables and Graphs –Describing Data with Averages - Describing Variability - Normal Distributions and Standard (z) Scores.

UNIT III	DESCRIBING RELATIONSHIPS	9

Correlation –Scatter plots –correlation coefficient for quantitative data –computational formula for correlation coefficient – Regression –regression line –least squares regression line – Standard error of estimate – interpretation of r2 –multiple regression equations –regression towards the mean.

UNIT IV	PYTHON LIBRARIES FOR DATA WRANGLING	9

Basics of Numpy arrays –aggregations –computations on arrays –comparisons, masks, boolean logic – fancy indexing – structured arrays – Data manipulation with Pandas – data indexing and selection – operating on data – missing data – Hierarchical indexing – combining datasets – aggregation and grouping – pivot tables.

UNIT V	DATA VISUALIZATION	9

Importing Matplotlib – Line plots – Scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation – customization – three dimensional plotting – Geographic Data with Basemap - Visualization with Seaborn.

	TOTAL PERIODS	45

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	define the data science process	Understanding (K2)
CO2	understand different types of data description for data science process	Analyzing (K4)

CO3	gain knowledge on relationships between data	Applying (K3)
CO4	use the Python Libraries for Data Wrangling	Applying (K3)
CO5	apply visualization Libraries in Python to interpret and explore data	Analyzing (K4)

TEXT BOOKS

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, "Introducing Data Science", Manning Publications 2016.(Unit - I)
2. Robert S. Witte and John S. Witte, "Statistics", Eleventh Edition, Wiley Publications, 2017.(Unit – II & III)
3. Jake VanderPlas, "Python Data Science Handbook", O'Reilly, 2016. (Unit – IV & V)

REFERENCES

1. Auerlien Geron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd or 3rd Edition, O'Reilly Media.
2. Allen B. Downey, "Think Stats: Exploratory Data Analysis in Python", Green Tea Press, 2014.
3. Avrim Blum, John Hopcroft, Ravindran Kannan, "Foundations of Data Science", Cambridge Press, 2020.
4. Brennan Davis, Hunter Glanz, "Data Science for all", 1st Edition,Pearson Publication, 2024

CO-PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes

(3/2/1 indicates strength of correlation) 3-Strong,2-Medium,1-Weak

COs	Programme Outcomes(POs)												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	2	-	-	-	1	1	1	2	2	2
CO2	2	1	-	1	1	-	-	-	2	1	1	2	2	3
CO3	2	2	1	2	2	1	1	-	1	2	1	3	2	2
CO4	3	2	2	1	1	-	-	-	1	1	2	2	3	3
CO5	2	2	1	2	2	1	1	-	1	1	1	2	2	2

CI23152	IMAGE AND VIDEO ANALYTICS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1. understand the basics of image processing techniques for computer vision.
2. learn the techniques used for image pre-processing.
3. discuss the various object detection techniques.
4. understand the various Object recognition mechanisms.
5. elaborate on the video analytics techniques.

UNIT I INTRODUCTION — 9

Computer Vision – Image representation and image analysis tasks - Image representations - digitization – Digital image properties – color images – Data structures for Image Analysis - Levels of image data representation - Traditional and Hierarchical image data structures.

UNIT II IMAGE PRE-PROCESSING — 9

Pixel brightness transformations – Geometric transfonnations - Local pre-processing - Image smoothing - Edge detectors - Zero-crossings of the second derivative - Scale in image processing - Canny edge detection - Parametric edge models - Edges in multi- speralct images - Local pre-processing in the frequency domain - Line detection by local pre-processing operators - Image restoration.

UNIT III OBJECT DETECTION USING MACHINE LEARNING — 9

Object detection– Object detection methods – Deep Learning framework for Object detection– bounding box approach-Intersection over Union (IoU) – Non-max suppression – Anchor boxes - Deep Learning Architectures - R-CNN - Faster R-CNN-You Only Look Once(YOLO)-Salient features-Loss Functions-YOLO architectures – Single shot Multibox Detector (SSD).

UNIT IV FACE RECOGNITION AND GESTURE RECOGNITION — 9

Face Recognition-Introduction-Applications of Face Recognition-Process of Face Recognition- DeepFace solution by Facebook- FaceNet for Face Recognition- Implementation using FaceNet - Gesture Recognition.

UNIT V VIDEO ANALYTICS — 9

Video Processing – use cases of video analytics-Vanishing Gradient and exploding gradient problem- RestNet architecture- RestNet and skip connections-Inception Network- GoogleNet architecture- Improvement in Inception v2-Video analytics- RestNet and Inception v3.

TOTAL PERIODS — 45

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	understand the basics of image processing techniques for computer vision and video analysis.	Understanding (K3)
CO2	explain the techniques used for image pre-processing.	Understanding(K3)
CO3	develop various object detection techniques.	Analyzing (K4)

CO4	understand the various face recognition mechanisms.	Understanding (K3)
CO5	elaborate on deep learning-based video analytics.	Analyzing (K4)

TEXT BOOKS

1. Milan Sonka, Vaclav Hlavac, Roger Boyle, "Image Processing, Analysis, and Machine Vision", 4th edition, Thomson Learning, 2013. (UNIT- I and II)
2. Vaibhav Verdhan,(2021, Computer Vision Using Deep Learning Neural Network Architectures with Python and Keras,Apress 2021(UNIT- III,IV and V).

REFERENCES

1. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer Verlag London Limited, 2011.
2. Caifeng Shan, FatihPorikli, Tao Xiang, Shaogang Gong, "Video Analytics for Business Intelligence", Springer, 2012.
3. D. A. Forsyth, J. Ponce, "Computer Vision: A Modern Approach", Pearson Education, 2003.
4. E. R. Davies, (2012), "Computer & Machine Vision", Fourth Edition, Academic Press.

CO-PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes

(3/2/1 indicates strength of correlation) 3-Strong,2-Medium,1-Weak

COs	Programme Outcomes(POs)												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	2	2	2	-	-	-	3	3	2	1	2	1
CO2	2	2	3	3	3	-	-	-	3	2	1	1	2	2
CO3	1	2	2	2	3	-	-	-	1	2	1	2	1	1
CO4	1	2	3	2	3	-	-	-	2	2	2	3	2	2
CO5	3	5	1	3	2	-	-	-	2	1	1	3	3	2

CI23153	NEURAL NETWORKS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	introduce the foundations of Artificial Neural Networks.
2.	learn various types of pattern association in Neural Networks.
3.	evaluate whether neural networks are appropriate to a particular application.
4.	apply neural networks to particular application.
5.	analyze the steps needed to improve performance of the selected neural network.

UNIT I INTRODUCTION 9

Artificial Neural Networks, Biological Neural Networks, Where and how Neural Nets are Being Used – Signal Processing, Control, Pattern Recognition, Medicine, Speech Processing, Speech Recognition, Business; How Are Neural Networks Used- Typical Architecture, Setting the Weights, Common Activation Functions, Summary of Notation; The McCulloch Pitts Neuron – Architecture, Algorithm, Applications; Simple neural nets for pattern classification - Neural Net Architecture, Biases and Thresholds, Linear Separability, Data Representation; Hebb net - Algorithm, Applications; Perceptron - Architecture, Algorithm, Applications, Perceptron Learning Rule Convergence Theorem; Adaline - Architecture, Algorithm, Applications, Derivations. Madaline,

UNIT II PATTERN ASSOCIATION 9

Training Algorithms for Pattern Association - Hebb Rule for Pattern Association, Delta Rule for Pattern Association; Hetero associative Memory Neural network - Architecture, Application, Autoassociative net - Architecture, Algorithm, Application and Storage capacity , Iterative auto associative net - Recurrent Linear Autoassociator, Brain-State-in-a-Box, Autoassociator With Threshold Function, Discrete Hopfield Net; Bidirectional Associative memory - Architecture, Algorithm, Application, Analysis.

UNIT III NEURAL NETWORK BASED ON COMPETITION 9

Fixed weight competitive nets - Maxnet, Mexican Hat, Hamming Net; Korhonen self-organizing maps - Architecture, Algorithm, Application; Learning vector quantization - Architecture, Algorithm, Application, variations; Counter propagation - Full Counterpropagation, Forward-Only Counterpropagation; Adaptive Resonance Theory - Introduction, Motivation, Basic Architecture , Basic Operation; ART1 – architecture, algorithm, applications, analysis; ART2 – architecture, algorithm, applications, analysis.

UNIT IV ATTRACTOR NEURAL NETWORKS 9

Back Propagation Neural Net- standard backpropagation architecture, algorithm, applications; Variations - Alternative Weight Update Procedures, Alternative Activation Functions, Strictly Local Backpropagation, Number of Hidden Layers; Theoretical Results - Derivation of learning rules, Multilayer Neural Nets as Universal Approximators; Fixed Weight Nets for Constrained Optimizatio - boltzmann Machine, continuous Hopfield, Gaussian Machine, Cauchy Machine; A Few More Nets that Learn - Modified Hebbian Learning , Boltzmann Machine with Learning, Simple Recurrent Net , Backpropagation in Time , Backpropagation Training for Fully Recurrent; Adaptive Architectures - Probabilistic Neural Net, Cascade Correlation ; Neocognitron - Architecture, Algorithm.

UNIT V	SELF-ORGANIZING FEATURE MAP AND FUZZY SETS	9

Self-organization, Maximal Eigenvector Filtering, Extracting Principal Components, Generalized Learning Laws, Competitive Learning, Vector Quantization, Mexican Hat Networks, SOM, Application of SOM, Fuzzy Sets- Need for Numeric and Linguistic Processing, Fuzzy Uncertainty and the Linguistic Variable, Membership Functions, Geometry of Fuzzy Sets, Simple Operations on Fuzzy Sets, Fuzzy Rules for Approximate Reasoning, Rule Composition and Deffuzification, Fuzzy Engineering.

TOTAL PERIODS	45

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	explain about Artificial Neural Networks.	Understanding (K2)
CO2	differentiate various types of Artificial Neural Networks	Analyzing (K4)
CO3	analyze the architectures of various competitive and self-organizing neural network models.	Analyzing (K4)
CO4	apply neural networks to particular application	Applying (K3)
CO5	analyze the steps needed to improve performance of the selected neural network.	Analyzing (K4)

TEXT BOOKS

1. Laurene Fausett, "Fundamentals of Neural Networks, Architectures, Algorithms and Applications", 2019, Prentice Hall publications.(Unit I-IV)
2. Satish Kumar, "Neural Networks A Classroom Approach", McGraw Hill Education (India) Pvt. Ltd, Second Edition. (UNIT V)

REFERENCES

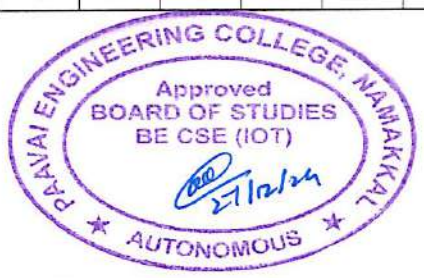
1. Simon Haykin, "Neural Networks and Learning Machines", 3rd Edition, Pearson Prentice Hall.
2. Michael Nielsen, "Neural Networks and Deep Learning", 2015, Determination Press.
3. J.M. Zurada "Introduction to Artificial Neural Systems", 2019, Jaico Publications.
4. Herbert Jones "Neural Networks: An Essential Beginners Guide to Artificial Neural Networks and their Role in Machine Learning and Artificial Intelligence", 2020, Bravex Publications.

CO-PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes

(3/2/1 indicates strength of correlation) 3-Strong,2-Medium,1-Weak

COs	Programme Outcomes(POs)												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	2	2	2	-	-	-	3	3	2	1	2	1
CO2	2	2	3	3	3	-	-	-	3	2	1	1	2	2
CO3	1	2	2	2	3	-	-	-	1	2	1	2	1	1
CO4	1	2	3	2	3	-	-	-	2	2	2	3	2	2
CO5	3	5	1	3	2	-	-	-	2	1	1	3	3	2



CI23154	BLOCKCHAIN TECHNOLOGY	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	define and explain the fundamentals of Blockchain.
2.	familiarize the mechanism of cryptography in cryptocurrency.
3.	understand the fundamentals of bitcoin and its applications.
4.	learn the standard rules and regulations of cryptocurrency.
5.	identify the real-time scenario of transforming blockchain in to cryptocurrency.

UNIT I	INTRODUCTION TO BLOCKCHAIN	9

The growth of blockchain Technology - Distributed Systems - The history of blockchain - Generic elements of a blockchain - Benefits and Limitations of blockchain - Tiers of blockchain technology - features of a blockchain- Types of blockchain – Consensus - CAP theorem and blockchain.

UNIT II	DECENTRALIZATION, CRYPTOGRAPHY AND TECHNICAL FOUNDATIONS	9

Decentralization - Decentralization using blockchain - methods of decentralization - Symmetric Cryptography – Cryptography – Confidentiality – Integrity – Authentication - Cryptographic primitives - Public key cryptography - Asymmetric cryptography - Public and private keys - Discrete logarithm problem in ECC - Hash functions - Elliptic Curve Digital signature algorithm.

UNIT III	BITCOIN AND ALTERNATIVE COINS	9

Introducing Bitcoin – Bitcoin – Transactions – Blockchain - Bitcoin Network and Payments – Bitcoin payments Alternative Coins – Theoretical foundations - Bitcoin limitations - Name coin – Litecoin – Primecoin – Zcash Smart Contracts.

UNIT IV	ETHEREUM	9

Ethereum 101 - Ethereum blockchain - The Ethereum network - Components of the Ethereum ecosystem - Further Ethereum – Programming Languages – Runtime byte code - Blocks and blockchain - fee Schedule - Ethereum Development Environment - Development Tools and Framework – Solidity Language.

UNIT V	HYPERLEDGER AND REAL-TIME APPLICATIONS	9

Hyperledger - Projects under Hyperledger - Hyperledger as a Protocol - Fabric - Hyperledger Fabric – Sawtooth Lake – Corda - Alternative Blockchains - Alt Coins - Outside of Currencies - Internet of Things - Future of Blockchain.

	TOTAL PERIODS	45

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	explain the concepts of blockchain.	Understanding(K2)
CO2	illustrate decentralization and practical aspects of Cryptography.	Analyzing (K4)

CO3	present bitcoin technology, alternative coins and smart contracts.	Understanding(K2)
CO4	develop a distributed application using Ethereum.	Analyzing (K4)
CO5	deploy an application using Hyperledger.	Analyzing (K4)

TEXT BOOKS

1. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, decentralization, and smart contracts explained", 2nd Edition, Packt Publishing Ltd, March 2018. (Unit 1-5]
2. Andreas Antonopoulos, "Mastering Bitcoin: Programming the open blockchain", 2nd Edition, O'Reilly Media, 2017. [unit5]

REFERENCES

1. Brenn Hill, Samanyu Chopra & Paul Valencourt, "Blockchain Quick Reference: A guide to exploring decentralized blockchain application development", Packt, 2018.
2. William Stallings, "Network Security Essentials (Applications and Standards)", Pearson Education, India, 2017.
3. Aravind Narayanan, Joesph Bonneau, Edward Felten, Andrew Miler and Steven Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction", Princeton University Press, 2016.
4. Bellaj Badr, Richard Horrocks, Xun (Brian) Wu, "Blockchain By Examples: A developer's guide to creating decentralized applications using Bitcoin, Ethereum and Hyperledger", Packt Publishing Limited, 2018.

CO-PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes

(3/2/1 indicates strength of correlation) 3-Strong,2-Medium,1-Weak

COs	Programme Outcomes(POs)												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	3	3	3	-	3	-	-	-	3	3	3
CO2	1	2	3	3	3	3	-	3	-	-	-	3	3	2
CO3	2	2	3	3	3	3	-	3	-	-	-	3	3	3
CO4	1	3	3	3	3	3	-	3	-	-	-	3	2	3
CO5	1	3	3	3	3	3	-	3	-	-	-	3	3	3

CI23155	KNOWLEDGE ENGINEERING	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	understand the basics of Knowledge Engineering.
2.	discuss methodologies and modeling for Agent Design and Development.
3.	design and develop ontologies with rules.
4.	understand learning and rule learning.
5.	define the role of agents, use planning and designing with principles for critique-based applications.

UNIT I	REASONING UNDER UNCERTAINTY	9

Introduction – Understanding the World through Evidence-based Reasoning - Abductive reasoning - Probabilistic reasoning - Evidence-based reasoning - Artificial Intelligence - Knowledge Engineering - Evidence-Based Reasoning - Sample Evidence-based Reasoning Task: Intelligence Analysis - Other Evidence-based Reasoning Tasks.

UNIT II	METHODOLOGY AND MODELING	9

Methodologies and Tools for Agent Design and Development - A Conventional Design and Development - Development tools and Reusable Ontologies - Agent Design and Development using Learning Technology - Modeling the Problem-Solving Process.

UNIT III	ONTOLOGIES, DESIGN AND DEVELOPMENT AND RULES	9

Ontologies - Ontology Design and Development – Design and Development Methodologies - Steps in Ontology Development - Domain Understanding and Concept Elicitation - Modelling-based Ontology Specification - Guidelines for Developing Generalization Hierarchies - Guidelines for Defining Features and Values - Reasoning with Ontologies and Rules.

UNIT IV	LEARNING AND RULE LEARNING	9

Learning for Knowledge-based Agents - Introduction to Machine Learning – Concepts - Generalization and Specialization Rules – Types - Formal definition of Generalization - Rule Learning - Rule Refinement – Incremental rule Refinement - Hypothesis Refinement - Guidelines.

UNIT V	AGENTS AND DESIGN PRINCIPLES	9

Abstraction of Reasoning - Disciple Agents - Disciple-WA: Military Engineering Planning – Disciple-COA: Course of Action Critiquing - Disciple-VPT: Multi-Agent Collaborative Planning - The Virtual Experts Library - Multidomain Collaborative Planning - Design Principles for Cognitive Assistants.

	TOTAL PERIODS	45

COURSE OUTCOMES		
At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	explain the basics of Knowledge Engineering.	Understanding (K2)

CO2	apply methodologies and modelling for design and develop for Agents and reusable ontologies.	Analyzing (K4)
CO3	illustrate ontologies with proper guidelines and rules in the method of design and development.	Analyzing (K4)
CO4	define learning, rule learning and refinement practice.	Understanding(K2)
CO5	use ontologies engineering to create and manage knowledge-based model.	Applying (K3)

TEXT BOOKS

1. Gheorghe Tecuci, Dorin Marcu, Mihai Boicu, David A. Schum, Knowledge Engineering Building Cognitive Assistants for Evidence-based Reasoning, Cambridge University Press, First Edition, 2016. (Unit I -V)
2. Ronald J. Brachman, Hector J. Levesque: Knowledge Representation and Reasoning, Morgan Kaufmann, 2004.

REFERENCES

1. Ela Kumar, Knowledge Engineering, I K International Publisher House, 2018.
2. John F. Sowa: Knowledge Representation: Logical, Philosophical, and Computational Foundations, Brooks/Cole, Thomson Learning, 2000.
3. King, Knowledge Management and Organizational Learning, Springer, 2009.
4. Jay Liebowitz, Knowledge Management Learning from Knowledge Engineering, 1st Edition, 2001.

CO-PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes

(3/2/1 indicates strength of correlation) 3-Strong,2-Medium,1-Weak

COs	Programme Outcomes (POs)												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1	1	1	-	-	1	2	1	2	1	1
CO2	3	2	3	2	2	-	-	-	2	1	2	1	3	3
CO3	2	2	3	2	2	-	-	-	3	2	2	2	3	2
CO4	2	2	3	1	1	-	-	-	2	2	2	2	1	1
CO5	2	2	2	1	1	-	-	-	2	1	1	1	2	1

CI23156	DATA VISUALIZATION	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the principles of visual perception and carryout preprocessing in real time data.
2.	identify the various visualization techniques.
3.	apply visualization techniques for the applications.
4.	create a different visualization technique for the given problems.
5.	understand the best practices in information dashboard.

UNIT I	INTRODUCTION	9

Visualization – visualization process – role of cognition – Pseudocode conventions – Scatter plot - Data foundation: Types of data - Structure within and between records - Data preprocessing –perception in visualization – Visualization foundations – The visualization process in detail – semiology of graphical symbols - The eight visual variables.

UNIT II	SPATIAL AND GEOSPATIAL, TIME ORIENTED DATA AND MULTIVARIATE DATA	9

One, Two, Three dimensional data – Dynamic data – Combining techniques - Visualization of spatial data - Visualization of point data - Visualization of line data - Visualization of area data - Issues in Geospatial data Visualization – Characterizing and visualizing Time oriented data- Point, Line ad region based techniques for multivariate data.

UNIT III	TREE, GRAPH, NETWORKS, TEXT AND DOCUMENT	9

Displaying hierarchical structure – Displaying Arbitrary Graphs/Networks – Other issues. Visualization techniques for Tree- Graph and Networks - Levels of text representation – Vector space model – Single Document Visualization – Document collection visualization- Extended text visualization.

UNIT IV	DESIGNING EFFECTIVE VISUALIZATION	9

Steps in Designing Visualization – problems in Designing Effective Visualization – Comparing and evaluating visualization techniques – Visualization Systems.

UNIT V	INFORMATION DASHBOARD DESIGN	9

Characteristics of dashboards – Key goals in visual design process – Dashboard display media – Designing dashboards for usability – Meaningful organization – Maintaining consistency – Aesthetics of dashboards – Testing for usability – Case Studies: Sales dashboard, Marketing analysis dashboard.

	TOTAL PERIODS	45

COURSE OUTCOMES

This course will enable the student to:		BT Mapped (Highest Level)
CO1	describe principles of visual perception and carryout preprocessing in real time data.	Understanding (K2)
CO2	apply visualization techniques for various data analysis tasks.	Applying (K3)
CO3	apply visualization techniques for the applications using unstructured data.	Applying (K3)
CO4	make use of different visualization techniques for the given problems.	Analyzing (K4)
CO5	design information dashboard for Sales and marketing analysis.	Analyzing (K4)

TEXT BOOKS	
1.	Matthew O. Ward., Georges Grinstein and Daniel Keim, "Interactive Data Visualization: Foundations, Techniques, and Applications", 2nd Edition, CRC Press, 2015. (UNIT I – IV)
2.	Stephen Few, "Information Dashboard Design: The Effective Visual Communication of Data", 2nd Edition, O'Reilly, 2013 (Unit V)

REFERENCES	
1.	Stephen Few, "Now you see it: Simple Visualization Techniques for Quantitative Analysis", Analytics Press, 2013.
2.	Ben Fry, "Visualizing data: Exploring and explaining data with the processing environment", O'Reilly, 2012.
3.	Gert H.N.Laursen and Jesper Thorlund, "Business Analytics for Managers: Taking business intelligence beyond reporting", Wiley 2012.
4.	Edward R.Tufte,"The Visual display of quantitative information", Second Edition, Graphics Press, 2010.

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CO3	3	3	3	1	3	3	-	-	3	3	1	3	3	2
CO4	3	3	3	1	3	2	-	2	3	2	2	3	3	3
CO5	3	2	1	1	1	3	-	1	2	3	2	3	3	2

CI23157	BIG DATA ANALYTICS	2	0	2	3

COURSE OBJECTIVES

To enable the students to

1.	understand fundamentals and applications of Big Data analytics.
2.	learn and use NoSQL big data management.
3.	learn MapReduce analytics using Hadoop and related tools.
4.	employ MapReduce programming model to process the big data.
5.	understand the usage of Hadoop related tools for Big Data Analytics.

UNIT I	UNDERSTANDING BIG DATA	6

Introduction to big data – convergence of key trends – unstructured data – industry examples of big data – web analytics – big data applications– big data technologies – introduction to Hadoop – open source technologies – cloud and big data – mobile business intelligence – Crowd sourcing analytics – inter and trans firewall analytics.

UNIT II	NOSQL DATA MANAGEMENT	6

Introduction to NoSQL – aggregate data models – key-value and document data models – relationships – graph databases – schemaless databases – materialized views – distribution models – master-slave replication – consistency - Cassandra – Cassandra data model – Cassandra examples – Cassandra clients.

UNIT III	MAP REDUCE APPLICATIONS	6

MapReduce workflows – unit tests with MRUnit – test data and local tests – anatomy of MapReduce job run – classic Map-reduce – YARN – failures in classic Map-reduce and YARN – job scheduling – shuffle and sort – task execution – MapReduce types – input formats – output formats.

UNIT IV	BASICS OF HADOOP	6

Data format – analyzing data with Hadoop – scaling out – Hadoop streaming – Hadoop pipes – design of Hadoop distributed file system (HDFS) – HDFS concepts – Java interface – data flow – Hadoop I/O – data integrity – compression – serialization – Avro – file-based data structures - Cassandra – Hadoop integration.

UNIT V	HADOOP RELATED TOOLS	6

Hbase – data model and implementations – Hbase clients – Hbase examples – praxis. Pig – Grunt – pig data model – Pig Latin – developing and testing Pig Latin scripts. Hive – data types and file formats – HiveQL data definition – HiveQL data manipulation – HiveQL queries.

	TOTAL PERIODS	30

PRACTICAL EXERCISES

List of Experiments:

1. Downloading and installing Hadoop; Understanding different Hadoop modes. Startup scripts, Configuration files.
2. Hadoop Implementation of file management tasks, such as Adding files and directories, retrieving files and Deleting files.

3. Implement of Matrix Multiplication with Hadoop Map Reduce.
4. Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm.
5. Installation of Hive along with practice examples.
6. Installation of HBase, Installing thrift along with Practice examples.
7. Practice importing and exporting data from various databases.

	TOTAL PERIODS	30

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	describe big data and use cases from selected business domains.	Understanding (K2)
CO2	explain NoSQL big data management.	Understanding (K2)
CO3	install, configure, and run Hadoop and HDFS.	Analyzing (K3)
CO4	perform map-reduce analytics using Hadoop.	Analyzing (K3)
CO5	use Hadoop-related tools such as HBase, Cassandra, Pig, and Hive for big data analytics.	Applying (K4)

TEXT BOOKS

1. Michael Minelli, Michelle Chambers, and Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013.
2. Eric Sammer, "Hadoop Operations", O'Reilley, 2012.
3. Sadalage, Pramod J. "NoSQL distilled", 2013.

REFERENCES

1. E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilley, 2012.
2. Lars George, "HBase: The Definitive Guide", O'Reilley, 2011.
3. Eben Hewitt, "Cassandra: The Definitive Guide", O'Reilley, 2010.
4. Alan Gates, "Programming Pig", O'Reilley, 2011.

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Mapping of Course Outcomes with Programme Outcomes

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COs	Programme Outcomes(POs)												PSO's	
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CO3	3	1	3	1	3	-	-	-	2	-	2	1	2	2
CO4	3	1	3	1	3	-	-	-	2	-	2	1	2	2
CO5	3	-	3	1	3	-	-	-	2	-	2	1	2	2

Vertical - II SOFTWARE DEVELOPMENT

CI23251	MOBILE APPLICATION DEVELOPMENT FOR IOT	2	0	2	3

COURSE OBJECTIVES

To enable the students to

1.	understand the architectural overview of IoT
2.	understand the basic UI design of mobile applications.
3.	design IoT based mobile app in real-world scenario.
4.	learn frameworks and architectures to design UI in Android development environment.
5.	develop IoT applications that integrate physical devices with digital systems

UNIT I	OVERVIEW	6

IoT-An Architectural Overview - Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service (XaaS), M2M and IoT Analytics.

UNIT II	BASIC DESIGN	6

Introduction - Basics of embedded systems design - Embedded OS - Design constraints for mobile applications, both hardware and software related - Architecting mobile applications - user interfaces for mobile applications - touch events and gestures - Achieving quality constraints - performance, usability, security, availability and modifiability.

UNIT III	IoT MOBILE APPS	6

IoT Mobile App Development Trends In 2020 - Role of Mobile Apps in revolutionizing the world of IoT - UX / UI design for IoT Mobile apps - challenges of UX/UI design for IoT applications - practice tips on design for IoT mobile apps - IoT App Design Solutions.

UNIT IV	ANDROID ARCHITECTURE	6

Introduction - Establishing the development environment - Android architecture - Activities and views - Interacting with UI - Persisting data using SQLite - Packaging and deployment - Interaction with server side applications - Using Google Maps, GPS and Wifi - Integration with social media applications- an overview of IoS.

UNIT V	ANDROID THINGS	6

Android things - Installation of Android things - Verification of Android things installation - API in Android IoT Setting up the Android things - Building your first IOT-Android application with Android Things.

	TOTAL PERIODS	30

PRACTICAL EXERCISES

List of Experiments:

1. Set up a basic mobile application in Android Studio
2. Establish communication between the mobile app and an IoT device
3. Fetch temperature data from an IoT sensor using Mobile Application
4. Create a mobile app to collect real-time data from IoT sensors.
5. Implement a button to turn an LED on/off
6. Integrate control buttons (e.g., ON/OFF, Increase/Decrease) in the mobile UI.

	TOTAL PERIODS	30

COURSE OUTCOMES

At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	explain the fundamental concepts of IoT and its technology evolution.	Understanding (K2)
CO2	discuss the basic designing consideration of mobile applications and UI.	Understanding (K2)
CO3	identify the various mobile applications applied in IoT environment.	Applying (K3)
CO4	design UI in Android development environment.	Applying (K3)
CO5	Analyze the scenario of integrating APIs in IoT based mobile app.	Analyzing (K4)

TEXT BOOKS

1. IoT Product Development with Programming: Stepwise programming approach with Particle Development board Kindle Edition by Mahesh Jadhav and Tejas Sarang Patil.
2. Kale, Vivek. Parallel Computing Architectures and APIs: IoT Big Data Stream Processing 1st edition, CRC Press, 2019.

REFERENCES

1. IoT Product Development with Programming: Stepwise programming approach with Particle Development board Kindle Edition by Mahesh Jadhav and Tejas Sarang Patil.
2. Jeff McWherter and Scott Gowell, "Professional Mobile Application Development", Wrox, 2012.
3. Charlie Collins, MichelGalpin and Matthias Kappler, "Android in Practice", DreamTech, 2012.

CO-PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes

(3/2/1 indicates strength of correlation) 3-Strong,2-Medium,1-Weak

CO	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1	-	-	-	-	-	-	1	2	1
CO2	1	2	-	3	-	1	-	-	-	-	-	2	-	2
CO3	3	-	1	2	2	-	-	-	-	-	2	1	-	2
CO4	2	2	-	3	-	-	-	2	-	-	-	-	-	2
CO5	3	2	1	2	-	-	-	1	-	-	-	2	-	2

CI23252	PRINCIPLES OF PROGRAMMING LANGUAGES	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	describe syntax and semantics of programming languages.
2.	understand data, data types, and basic statements.
3.	understand call-return architecture and ways of implementing them.
4.	apply object-orientation, concurrency, and event handling in programming languages.
5.	develop programs in non-procedural programming paradigms

UNIT I	INTRODUCTION TO PROGAMMING LANGUAGES	9

Evolution of programming languages – Describing syntax – Formal Methods of Describing Syntax– Attribute grammars – Describing semantics – Lexical Analysis – Parsing Problem – Recursive-Descent – Bottom up parsing.

UNIT II	BASIC PRIMITIVES	9

Names – Variables – Binding –Scope – Scope and Lifetime – Referencing Environments- Named Constants – Primitive Data Types – Character String Types – Array Types – Associative Arrays – Record types – Union types – Pointers and References Types – Arithmetic Expressions – Overloaded Operators – Type conversions – Relational and Boolean Expressions – Assignment Statements – Mixed Mode Assignment – Control structures – Selection – Iterations – Branching – Guarded Statements.

UNIT III	SUBPROGRAMS AND IMPLEMENTATION	9

Subprograms–Design Issues–Local Referencing–Parameter Passing Methods–Overloaded Subprograms– Generic Subprograms– Semantics of call and return – Implementing Simple Subprograms – Stack and Dynamic Local Variables–Nested Subprograms – Blocks – Dynamic Scoping.

UNIT IV	OBJECT-ORIENTED AND CONCURRENT PROGRAMMING	9

Object-Orientation – Design issues for OOP languages – Implementation of object-oriented constructs – Concurrency – Semaphores – Monitors – Message passing – Threads – Statement level concurrency – Exception handling – Event handling.

UNIT V	FUNCTIONAL AND LOGIC PROGRAMMING LANGUAGES	9

Introduction to Lambda Calculus – Fundamentals of Functional Programming Languages – Programming with LISP – Programming with ML – A Comparison of Functional And Imperative Languages - An Overview of Logic Programming – The Origins of Prolog – The basic Elements of Prolog – Deficiencies of Prolog – Applications of Logic Programing.

	TOTAL PERIODS	45

COURSE OUTCOMES		
At the end of this course, students will be able to		BT MAPPED (Highest Level)
CO1	explain the syntax and semantics of programming languages.	Understanding (K2)
CO2	define and identify data, data types, and basic statements in problem solving.	Understanding (K2)
CO3	demonstrate call-return, nested structure, the scope of variables in subprograms.	Applying (K3)
CO4	apply object-orientation, concurrency, and event handling in programming languages.	Applying (K3)
CO5	develop programs in non-procedural programming paradigms.	Applying (K3)

TEXT BOOKS

1. Robert W. Sebesta, "Concepts of Programming Languages", Twelfth Edition, Pearson, 2022.
2. Franklyn Turbak, David Gifford, and Mark A. Sheldon, "Design Concepts in Programming Languages"

REFERENCES

1. Michael L. Scott, "Programming Language Pragmatics", Fourth Edition, Elsevier, 2018.
2. R. Kent Dybvig, "The Scheme programming language", Fourth Edition, Prentice Hall, 2011.
3. Jeffrey D. Ullman, "Elements of ML programming", Second Edition, Pearson, 1997.
4. W. F. Clocksin and C. S. Mellish, "Programming in Prolog: Using the ISO Standard", Fifth Edition, Springer, 2003.

CO-PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes :
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COs	Programme Outcomes (POs)												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	3	2	1	-	-	-	-	-	-	3	2	3
CO2	3	3	3	2	2	-	-	-	-	-	-	3	2	2
CO3	3	3	3	2	2	-	-	-	-	-	-	3	2	3
CO4	3	3	3	3	2	-	-	-	-	-	-	-	3	2
CO5	3	3	3	3	3	-	-	-	-	-	-	-	3	3

CI23253	PROGRAMMING LANGUAGES FOR IOT	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	equipped with professional knowledge and strong practical skills in the Raspberry Pi
2.	focuses on higher-level operating systems with computing intensive IoT applications
3.	connect devices ans systerms to collect, exchange and analyze data
4.	learn how to develop IoT applications using various technologies and platforms
5.	learn how to assess the impact of data acquisition and integration strategies on IoT system

UNIT I	INTRODUCTION	9

Getting Started with Raspberry Pi: Basic functionality of Raspberry Pi B+ board, setting up the board, configuration and use, booting Raspberry Pi 3, Downloading an Operating System, format an SD card and booting the OS, Interfacing Hardware with the Raspberry Pi, Raspberry Pi Remote Access, operates the Raspberry Pi in "headless mode".

UNIT II	INTRODUCING MICRO PYTHON	9

MicroPython Features, MicroPython Limitations, Experimenting with Python on PC, Installing Python 3 on Windows 10, Running the Python Console, Running Python Programs with the Interpreter, The Run, Evaluate, Print Loop (REPL Console), Off and Running with MicroPython, Additional Hardware, Basic Electronics Kit, Breadboard and Jumper Wires and 3 Examples.

UNIT III	IOT PHYSICAL SERVERS AND CLOUD OFFERINGS	9

IoT Physical Servers and Cloud Offerings: Introduction to Cloud Storage models and communication APIs. Web Server – Web server for IoT, Cloud for IoT, Python web application framework. Designing a RESTful web API. Connecting to APIs.

UNIT IV	BAKING Pi	9

Powering Raspberry Pi, Formatting SD cards, Installing and connecting Raspberry pi,Raspberry pi working, Installing Raspbian with NOOBS, Networking Raspberry Pi, Connecting with Ethernet, Connecting Via Local Computer Network, Connecting Via Wireless Network, Updating and Upgrading, Setting up a Host Name,

UNIT V	CASE STUDIES WITH JAVA	9

Bill of Materials, Getting Started with NetBeans, Downloading and Configuring NetBeans, Revisiting HelloRaspberryPi, Brewing Java, Communicating with a USB Scale, Coffee Calculator, Asynchronous Communication, Coffee Brewing Recipe, Commercial Licensing.

	TOTAL PERIODS	45

COURSE OUTCOMES		
At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	appreciate the development technology for IoT	Applying (K3)
CO2	familiar with basic concepts of Linux.	Understanding (K2)
CO3	design real time IoT devices using python programming and libraries.	Applying (K3)
CO4	comprehend the basic concepts of mobile cloud computing.	Applying (K3)
CO5	understand the applications of IoT.	Understanding (K2)

TEXT BOOKS

1. Simon Monk, "Programming the Raspberry Pi: Getting Started with Python", January 2012, McGraw Hill Professional.
2. MicroPython for the Internet of Things, A Beginner's Guide to Programming with Python on Microcontrollers, Charles Bell, Apress.

REFERENCES

1. Eben Upton and Gareth Halfacree, "Raspberry Pi User Guide", August 2016, 4th edition, John Wiley & Sons.
2. Alex Bradbury and Ben Everard, "Learning Python with Raspberry Pi", Feb 2014, John Wiley & Sons.
3. Michael Margolis, "Arduino Cookbook", First Edition, March 2011, O'Reilly Media, Inc The official raspberry Pi Projects Book.
4. "Raspberry Pi with Java: Programming the Internet of Things (IoT)", Oracle Press, 1st edition.

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CO3	3	-	1	2	2	-	-	-	-	-	2	1	-	2
CO4	2	2	-	3	-	-	-	2	-	-	-	-	-	2
CO5	3	1	2	1	2	-	-	1	-	-	-	2	-	2

CI23254	WEB TECHNOLOGIES	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand about web pages, HTML and CSS
2.	design interactive and dynamic web pages using JavaScript.
3.	develop web applications using CANVAS, XML, AJAX.
4.	create a server side web application using PHP with database connectivity.
5.	develop web applications using frameworks.

UNIT I	INTRODUCTION TO HTML AND CSS	9

Introduction – Web Basics, Web 2.0; HTML 5 -- Introduction, Linking, List, Tables, Forms, Input types, Page structure Elements; CSS - Inline, embedded and external style sheets, Backgrounds, Color, Shadows, Animations.

UNIT II	JAVA SCRIPT	9

JAVA SCRIPT - Introduction to Scripting; Control Statements; Functions; Arrays; Objects; Document Object Model (DOM).

UNIT III	GRAPHICS DEVELOPMENT	9

CANVAS- Introduction, Drawing, Shadows, Images, Patterns, Transformation; XML- Basics, DTD, XLS, DOM; AJAX – Introduction, Rich Internet Applications with AJAX, Creating a Full Scale Ajax Enabled Applications.

UNIT IV	DATABASE-DRIVEN WEB DEVELOPMENT	9

Web Server - HTTP Transactions, Apache and IIS; Database - Relational Database Overview, SQL, MySQL, LINQ and Java DB; PHP – Data types, Operators, String and form processing, reading Database. Web Server - HTTP Transactions, Apache and IIS; Database - Relational Database Overview, SQL, MySQL, LINQ and Java DB; PHP – Data types, Operators, String and form processing, reading Database.

UNIT V	WEB APPLICATIONS FRAMEWORK	9

Web App Development- Multitier Application Architecture, ASP.NET Application, Controls, Session Tracking; C# - SOAP, REST, JSON, Case study.

	TOTAL PERIODS	45

COURSE OUTCOMES

At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	design and develop static web pages using HTML and CSS.	Applying (K3)
CO2	develop interactive and dynamic web pages using JavaScript.	Applying (K3)
CO3	develop the graphics design and Internet applications using technologies like XML, AJAX.	Applying (K3)
CO4	Apply back-end technologies like databases and server-side scripting PHP, etc.	Applying (K3)

CO5	develop a complete, full-stack web application using modern frameworks and tools like ASP.Net and C#.	Applying (K3)

TEXT BOOKS

1. Deitel and Deitel and Nieto, Internet and World Wide Web - How to Program, Prentice Hall, 5th Edition, 2012.
2. Jeffrey C and Jackson, Web Technologies A Computer Science Perspective, Pearson Education, 2011

REFERENCES

1. Uttam K.Roy, Web Technologies, Oxford University Press, 2010.
2. Rajkamal, Web Technology, Tata McGraw-Hill, 2009
3. Gopalan N.P. and Akilandeswari J., "Web Technology", Prentice Hall of India, 2011.
4. Chris Bates, Web Programming – Building Intranet Applications, 3rd Edition, Wiley Publications, 2009.
5. Uttam K.Roy, Web Technologies, Oxford University Press, 2010.

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CO3	3	3	3	2	3	-	-	-	-	-	2	2	3	3
CO4	3	3	2	3	2	-	-	-	-	-	1	-	3	2
CO5	3	3	3	3	3	-	-	-	-	-	2	2	3	3

CI23255	R PROGRAMMING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the basic fundamentals of R language.
2.	knowledge the basic types of statistical models.
3.	equip R programming from a statistical perspective.
4.	understand the operations of control statements.
5.	provide insights into interfaces.

UNIT I	INTRODUCTION TO R	9

Introduction - History and overview of R - elements and data structures - Sessions and Functions - Variables - Data Types - Vectors - Scalars - Conclusion - Data Frames - Lists - Matrices - Arrays – Classes- Data input/output - Data storage formats - Subsetting objects -Vectorization.

UNIT II	MATRICES, ARRAYS AND LISTS	9

Matrices, Arrays and Lists - Creating matrices Matrix operations Applying Functions to Matrix Rows and Columns Adding and deleting rows and columns Vector/Matrix Distinction Avoiding Dimension Reduction Higher Dimensional arrays lists Creating lists General list operations Accessing list components and values applying functions to lists recursive lists.

UNIT III	DATA MANIPULATION	9

Math and Simulation in R, Functions, Math Function, Probability Calculation Cumulative Sums and Products- Minima and Maxima- Data sorting - Linear Algebra Operation on Vectors and Matrices – Set Operation.

UNIT IV	CONTROL STATEMENTS, FUNCTIONS, R GRAPHS	9

Control statements -Arithmetic and Boolean operators and values-Default values for arguments - Returning Boolean values functions are objects Environment and Scope issues. Writing Upstairs - Recursion Replacement functions Tools for composing function code Math and Simulations in R Creating Graphs -Customizing Graphs -Saving graphs to files -Creating three-dimensional plots.

UNIT V	INTERFACING	9

Interfacing R to other languages -Parallel R-Basic Statistics- Linear Model Generalized Linear models- Non-linear models - Time Series and Auto-correlation Clustering.

	TOTAL PERIODS	45

COURSE OUTCOMES

At the end of the course, the students will be able to		BT MAPPED (Highest Level)
1.	state the capabilities of R and its data, variable types.	Understanding (K2)
2.	describe various operators, control statements and scoping rules in R.	Analyzing (K4)

3.	apply R programming for manipulation of datasets and analyze data using real time examples.	Applying (K3)
4.	produce various graphs and distribution plots using R.	Applying (K3)
5.	develop interfacing R to other languages.	Analyzing (K4)

TEXT BOOKS

1. Chris Brunsdon, Lex Comber, An Introduction to R for Spatial Analysis and Mapping , 2nd Revised Edition, Sage Publications Ltd (UK), 2019.
2. Norman Matoff,"The Art of R Programming: A tour of Statistical Software Design" NO Starch Press.2011.

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1. Mark Gardener, Beginning R -The Statistical Programming Language , John Wiley and Sons,Inc., 2012.
2. Jared P Lander,"R For Everyone : Advanced Analytics and Graphics Addsion-Wesley Data Analytics Series,2013

CO-PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes
(3/2/1 indicates strength of correlation) 3-Strong,2-Medium,1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1	-	-	-	-	-	-	1	2	1
CO2	1	2	-	3	-	1	-	-	-	-	-	2	-	2
CO3	3	-	1	2	2	-	-	-	-	-	2	1	-	2
CO4	2	2	-	3	-	-	-	2	-	-	-	-	-	2
CO5	3	1	2	1	2	-	-	1	-	-	-	2	-	2

CI23256	SOFTWARE TESTING AND AUTOMATION	2	0	2	3

COURSE OBJECTIVES

To enable the students to

1.	understand the basics of software testing
2.	learn how to do the testing and planning effectively
3.	build test cases and execute them
4.	focus on wide aspects of testing and understanding multiple facets of testing
5.	get an insight about test automation and the tools used for test automation

UNIT I	FOUNDATIONS OF SOFTWARE TESTING	6

IoT-An Architectural Overview - Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service(XaaS), M2M and IoT Analytics, Knowledge Management

UNIT II	TEST PLANNING	6

Introduction - Basics of embedded systems design - Embedded OS - Design constraints for mobile applications, both hardware and software related - Architecting mobile applications - user interfaces for mobile applications - touch events and gestures - Achieving quality constraints - performance, usability, security, availability and modifiability.

UNIT III	TEST DESIGN AND EXECUTION	6

IoT Mobile App Development Trends In 2020 - Role of Mobile Apps in revolutionizing the world of IoT – UX / UI design for IoT Mobile apps - challenges of UX/UI design for IoT applications - practice tips on design for IoT mobile apps - IoT App Design Solutions

UNIT IV	ADVANCED TESTING CONCEPTS	6

Introduction - Establishing the development environment - Android architecture - Activities and views - Interacting with UI - Persisting data using SQLite - Packaging and deployment - Interaction with server side applications - Using Google Maps, GPS and Wifi - Integration with social media applications.

UNIT V	TEST AUTOMATION AND TOOLS	6

Android things - Installation of Android things - Verification of Android things installation - API in Android IoT Setting up the Android things - Building your first IOT-Android application with Android Things

	TOTAL PERIODS	30

PRACTICAL EXERCISES

List of Experiments:

1. Develop the test plan for testing an e-commerce web/mobile application (www.amazon.in)
2. Design the test cases for testing the e-commerce application
3. Test the e-commerce application and report the defects in it.
4. Develop the test plan and design the test cases for an inventory control system.

5.	Execute the test cases against a client server or desktop application and identify the defects.
6.	Test the performance of the e-commerce application.
7.	Automate the testing of e-commerce applications using Selenium.
8.	Integrate TestNG with the above test automation.
9.	Mini Project: a) Build a data-driven framework using Selenium and TestNG b) Build Page object Model using Selenium and TestNG c) Build BDD framework with Selenium, TestNG and Cucumber

TOTAL PERIODS	**30**

COURSE OUTCOMES

At the end of this course, the students will be able to		**BT MAPPED** (Highest Level)
CO1	understand the basic concepts of software testing and the need for software testing	Applying (K3)
CO2	design Test planning and different activities involved in test planning	Understanding (K2)
CO3	design effective test cases that can uncover critical defects in the application	Applying (K3)
CO4	carry out advanced types of testing	Applying (K3)
CO5	automate the software testing using Selenium and TestNG	Understanding (K2)

TEXT BOOKS

1. Yogesh Singh, "Software Testing". Cambridge University Press, 2012
2. Unmesh Gundecha, Satya Avasarala, "Selenium WebDriver 3 Practical Guide" - Second Edition 2018

REFERENCES

1. Glenford J. Myers, Corey Sandler, Tom Badgett, The Art of Software Testing, 3rd Edition, 2012, John Wiley & Sons, Inc.
2. Ron Patton, Software testing, 2nd Edition, 2006, Sams Publishing
3. Paul C. Jorgensen, Software Testing: A Craftsman's Approach, Fourth Edition, 2014, Taylor & Francis Group.
4. Carl Cocchiaro, Selenium Framework Design in Data-Driven Testing, 2018, Packt Publishing.

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CO4	2	2	-	3	-	-	-	2	-	-	-	-	-	2
CO5	3	1	2	1	2	-	-	1	-	-	-	2	-	2

CI23257	DEVOPS	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1	understand the different Version control tools like Git, Mercurial
2	understand the concepts of Continuous Integration/ Continuous Testing/ Continuous Deployment)
3	understand Configuration management using Ansible
4	illustrate the benefits and drive the adoption of cloud-based DevOps tools to solve real- world problems
5	implement the devop pipelines

UNIT I	INTRODUCTION TO DEVOPS	9

Devops Essentials - Introduction to AWS, GCP, Azure - Version control systems: Git and GitHub.

UNIT II	COMPILE AND BUILD USING MAVEN & GRADLE	9

Introduction, Installation of Maven, POM files, Maven Build lifecycle, Build phases (compile build, test, package) Maven Profiles-Maven repositories (local, central, global)- Maven plugins- Maven create and build Artifacts- Dependency Management-Installation of Gradle- understanding build using Gradle.

UNIT III	CONTINUOUS INTEGRATION USING JENKINS AND BAMBOO	9

Install & Configure Jenkins - Jenkins Architecture Overview- creating a Jenkins Job- Configuring a Jenkins job- Adding Plugins to Jenkins- Configuring Jenkins to work with Java- Git- and Maven- Creating a Jenkins Build and Jenkins workspace – Bamboo and its role in CI/CD – Bamboo Architecture – Setting up a Bamboo Server and configuring Agents – Atlassian Tools – JIRA – Bitbucket.

UNIT IV	CONFIGURATION MANAGEMENT USING ANSIBLE	9

Ansible Introduction- Installation-Ansible master/slave configuration- YAML basics-Ansible Modules- Ansible Inventory files- Ansible playbooks- Ansible Roles- and ad-hoc commands in Ansible.

UNIT V	BUILDING DevOps PIPELINES USING AZURE	9

Create GitHub Account, Create Repository- Create Azure Organization- Create a new pipeline- Build a sample code- Modify azure-pipelines- YAML file.

	TOTAL PERIODS	45

COURSE OUTCOMES		
At the end of the course, the students will be able to		BT MAPPED (Highest Level)
CO1	understand different actions performed through Version control tools like Git.	Understanding (K2)

CO2	build continuous integration, Testing and Deployment in Jenkins by automating test cases using Maven & Gradle.	Analyzing (K4)
CO3	ability to perform automated continuous deployment.	Applying (K3)
CO4	ability to do configuration management using Ansible.	Applying (K3)
CO5	understand to leverage cloud-based DevOps tools using Azure DevOps.	Analyzing (K4)

TEXT BOOKS

1. Roberto Vormittag, "A Practical Guide to Git and GitHub for Windows Users: From Beginner to Expert in Easy Step-By-Step Exercises", Second Edition, Kindle Edition, 2016.
2. Jason Cannon, "Linux for Beginners: An Introduction to the Linux Operating System and Command Line", Kindle Edition, 2014.

REFERENCES

1. Hands-On Azure DevOps: Cicd Implementation For Mobile, Hybrid, And Web Applications Using Azure DevOps And Microsoft Azure: CICD Implementation for DevOps and Microsoft Azure (English Edition) Paperback – 1 January 2020 by Mitesh Soni.
2. Jeff Geerling, "Ansible for DevOps: Server and configuration management for humans", First Edition, 2015.
3. David Johnson, "Ansible for DevOps: Everything You Need to Know to Use Ansible for DevOps", Second Edition, 2016.
4. Mariot Tsitoara, "Ansible 6. Beginning Git and GitHub: A Comprehensive Guide to Version Control, Project Management, and Teamwork for the New Developer", Second Edition, 2019.

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CO2	1	2	-	3	-	1	-	-	-	-	-	2	-	2
CO3	3	-	1	2	2	-	-	-	-	-	2	1	-	2
CO4	2	2	-	3	-	-	-	2	-	-	-	-	-	2
CO5	3	1	2	1	2	-	-	1	-	-	-	2	-	2

VERTICAL – III
DATA CENTER TECHNOLOGIES

CI23351	DATA WAREHOUSING AND DATA MINING	3	0	0	3

COURSE OBJECTIVES

This course will enable the students to

1.	understand the design and implementation of a data store.
2.	acquire knowledge on data and various preprocessing techniques.
3.	study the various correlation based frequent patterns mining in large datasets.
4.	learn various classifiers in data mining.
5.	understand the data mining techniques and methods to be applied on large datasets.

UNIT I	DATA WAREHOUSING	9

Data warehouse - Basic Concept, Modeling, Design and usage; Implementation - Data cube Computation Methods, Data Generalization by Attribute, Oriented Induction Approach.

UNIT II	DATA MINING	9

Introduction - Kinds of Data and Patterns, Major Issues in Data Mining, Statistical Description of Data, Measuring Data Similarity and Dissimilarity; Data preprocessing - Data Cleaning, Data Integration, Data Transformation Data Reduction; Data Discretization- Concept Hierarchy Generation.

UNIT III	ASSOCIATION RULE MINING	9

Basic concepts-Frequent Item set Mining Methods, A priori algorithm; A Pattern Growth Approach for Mining Frequent Item sets; Mining Various Kinds of Association Rules; Correlation Analysis; Constraint Based Association Mining.

UNIT IV	CLASSIFICATION	9

Basic Concepts- Decision Tree Induction, Bayes Classification Methods, Rule Based Classification, Classification by Back propagation, Support vector machines, Associative Classification, Lazy Learners, Other Classification Methods, Prediction.

UNIT V	CLUSTERING AND DATA MINING APPLICATIONS	9

Cluster analysis, Partitioning Methods, Hierarchical Methods, Density Based Methods, Grid Based Methods, Model Based Clustering Methods, Clustering High Dimensional Data, Constraint Based Clustering Analysis -Outlier Analysis; Data Mining Applications - Financial Data Analysis, Science and Engineering, Intrusion Detection and Prevention.

	TOTAL PERIODS	45

COURSE OUTCOMES

At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	understand the design of a data warehouse.	Applying (K3)
CO2	apply preprocessing techniques.	Analyzing (K4)

CO3	analyze the various correlation based frequent patterns mining in large datasets.	Applying (K3)
CO4	compare and contrast the various classifiers.	Analyzing (K4)
CO5	apply clustering techniques and methods to large datasets.	Understanding (K2)

TEXT BOOKS

1. Jiawei Hanand Micheline Kamber,- Data Mining Concepts and Techniques, 3rd Edition, Elsevier, 2012
2. Parteek Bhatia – Data Mining and Data Warehousing Principles and Practical Techniques, Cambridge University Press, 2019

REFERENCES

1. Alex Berson and Stephen J.Smith,"Data Warehousing, Data Mining & OLAP", Tata McGraw Hill Edition, 35th Reprint 2016.
2. K.P.Soman, Shyam Diwakar and V.Ajay,"Insight into Data Mining Theory and Practice", Eastern Economy Edition, Prentice Hall of India, 2006.
3. Ian H.Witten and Eibe Frank,"Data Mining: Practical Machine Learning Tools and Techniques", Elsevier, Second Edition.
4. Sam Anahory and Dennis Murray, "Data Warehousing in the Real World", Pearson, 2006.

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CO3	3	3	3	2	2	-	-	-	-	-	-	3	3	2
CO4	3	3	2	2	1	-	-	-	-	-	-	3	3	2
CO5	3	2	2	1	-	-	-	-	-	-	-	3	3	2

CI23352	EDGE COMPUTING	3	0	0	3

COURSE OBJECTIVES

This course will enable the students to

1.	learn about an overview of the Edge Computing.
2.	implement edge routing and protocols techniques.
3.	apply various topologies of cloud and fog.
4.	perform cloud pipeline using modeling framework.
5.	apply various security schemes for manipulation and storage service.

UNIT I EDGE COMPUTING — 9

Edge purpose and definition; Edge use cases; Edge hardware Architectures; Operating Systems- Operating system choice points, Typical boot process, Operating system tuning; Edge platforms; Use cases for edge computing.

UNIT II EDGE ROUTING AND PROTOCOLS — 9

Edge Routing And Networking - TCP/IP network functions at the edge, Edge level network security, Software defined networking; Edge to Cloud Protocols – MQTT, MQTT-SN, Constrained application protocol, STOMP, AMQP.

UNIT III CLOUD AND FOG TOPOLOGIES

Topologies - Cloud service model, Public, Private and Hybrid cloud, The OpenStack cloud architecture, Constrained of cloud architectures for IoT; Fog Computing – The Hadoop philosophy for fog computing, OpenFog reference architecture, EdgeX.

UNIT IV DATA ANALYTICS AND MACHINE LEARNING IN THE EDGE — 9

Basic data analytics in IOT- Top-level cloud pipeline, Rules Engines, Ingestion – streaming, processing and data lakes, Complex even processing, Lambda architecture, Sector Usecases; Machine learning in IoT – History of AI and machine learning milestones machine learning models, classification, Regression, Random Forest, Bayesian models, CNN.

UNIT V IOT AND EDGE SECURITY — 9

Edge Security – Cyber Security, Anatomy of IoT cyber-attacks, Physical and hardware security, Shell security, Cryptography, Software defined perimeter, Blockchains and crypto currencies in IoT, Government regulations and intervention, IoT security best practices.

TOTAL PERIODS — 45

COURSE OUTCOMES

At the end of this course, students will be able to		**BT MAPPED (Highest Level)**
CO1	understand the concepts of Edge Computing	Understanding (K2)

CO2	analyze Edge Routing and Networking Protocols	Analyzing (K4)
CO3	design cloud and Fog architecture in real world environment	Applying (K3)
CO4	train a ML model in IoT and Edge Computing platform	Analyzing (K4)
CO5	design and Implement Edge-Based secured Solutions	Applying (K3)

TEXT BOOKS

1. Perry Lea "IoT and Edge Computing for Architects", Second Edition, Publisher: Packet Publishing, 2020.
2. Rajkumar Buyya , Satish Narayana Srirama , "Fog and Edge Computing: Principles and Paradigms", Wiley, 2019.

REFERENCES

1. Rajkumar Buyya, Satish Narayana Srirama "Fog and Edge Computing: Principles and Paradigms" wiley publication, 2019.
2. James Broberg,Andrzej M. Goscinski Rajkumar Buyya, "Cloud Computing: Principles and Paradigms", Wiley, 2011.
3. Deepak Gupta (Editor), Aditya Khamparia (Editor) " Fog, Edge, and Pervasive Computing in Intelligent IoT Driven Applications", Wiley-IEEE Press,2020.
4. Imad M. Abbadi "Cloud Management and Security", Wiley-IEEE Press,2014.

CO-PO MAPPING:

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CO1	3	2	2	1	-	-	-	-	-	-	-	2	3	2
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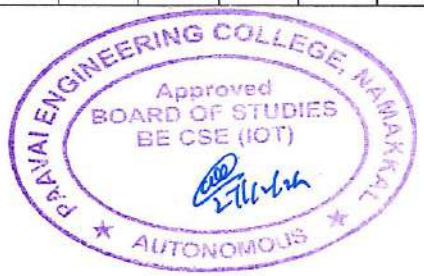
CO3	3	3	3	2	2	-	-	-	-	-	-	3	3	2
CO4	3	3	2	2	1	-	-	-	-	-	-	3	3	2
CO5	3	2	2	1	-	-	-	-	-	-	-	3	3	2



CI23353	CLOUD SERVICES MANAGEMENT	3	0	0	3

COURSE OBJECTIVES

This course will enable the students to

1.	introduce Cloud Services Management terminology, definition & concepts
2.	compare and contrast cloud service management with traditional IT service management.
3.	identify strategies to reduce risk and eliminate issues associated with adoption of cloud
4.	select appropriate structures for designing, deploying and running cloud-based services
5.	illustrate the benefits and drive the adoption of cloud-based services to solve real world issue

UNIT I	CLOUD SERVICE MANAGEMENT FUNDAMENTALS	9

Cloud Ecosystem, The Essential Characteristics, Basics of Information Technology Service Management and Cloud Service Management, Service Perspectives, Cloud Service Models, Cloud Service Deployment Models

UNIT II	CLOUD SERVICES STRATEGY	9

Cloud Strategy Fundamentals, Cloud Strategy Management Framework, Cloud Policy, Key Driver for Adoption, Risk Management, IT Capacity and Utilization, Demand and Capacity matching, Demand Queueing, Change Management, Cloud Service Architecture

UNIT III	CLOUD SERVICE MANAGEMENT

Cloud Service Reference Model, Cloud Service LifeCycle, Basics of Cloud Service Design, Dealing with Legacy Systems and Services, Benchmarking of Cloud Services, Cloud Service Capacity Planning, Cloud Service Deployment and Migration, Cloud Marketplace, Cloud Service Operations Management

UNIT IV	CLOUD SERVICE ECONOMICS	9

Pricing models for Cloud Services, Freemium, Pay Per Reservation, Pay per User, Subscription based Charging, Procurement of Cloud-based Services, Capex vs Opex Shift, Cloud service Charging, Cloud Cost Models

UNIT V	CLOUD SERVICE GOVERNANCE AND VALUE	9

IT Governance Definition, Cloud Governance Definition, Cloud Governance Framework, Cloud Governance Structure, Cloud Governance Considerations, Cloud Service Model Risk Matrix, Understanding Value of Cloud Services, Measuring the value of Cloud Services, Balanced Scorecard, Total Cost of Ownership

	TOTAL PERIODS	45

COURSE OUTCOMES

At the end of this course, students will be able to		BT MAPPED (Highest Level)
CO1	understand the Service Management Fundamentals.	Understanding(K2)

CO2	understand Cloud Service Management Strategies.	Understanding(K2)
CO3	identify the Services of Cloud Technologies.	Understanding(K2)
CO4	select Appropriate Tools for Cloud Service Economics.	Analyzing(K4)
CO5	evaluate and optimize Cloud Governance for efficiency and effectiveness.	Analyzing(K4)

TEXT BOOKS

1. Enamul Haque, "Cloud Service Management and Governance: Smart Service Management in Cloud Era", Enel Publications.
2. Thomas Erl, Ricardo Puttini, Zaigham Mohammad, "Cloud Computing: Concepts, Technology & Architecture", 2013.

REFERENCES

1. Thomas Erl, Robert Cope, Amin aserpour, "Cloud Computing Design Patterns".
2. Praveen Ayyappa, "Economics of Cloud Computing", LAP Lambert Academic Publishing.
3. Rajkumar Buyya, Christian Vechhiola, S.Thamarai Selvi, "Mastering Cloud Computing Foundations and Applications Programming".
4. Rajkumar Buyya, James Broberg, Andrzej , "Cloud Computing: Principles and Paradigms", Wiley India Publications 2011.

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CO4	3	3	2	2	1	-	-	-	-	-	-	3	3	2
CO5	3	2	2	1	-	-	-	-	-	-	-	3	3	2

CI23354	STORAGE TECHNOLOGIES	3	0	0	3

COURSE OBJECTIVES

This course will enable the students to

1.	characterize the functionalities of logical and physical components of storage.
2.	describe various storage networking technologies
3.	identify different storage virtualization technologies
4.	discuss the different backup and recovery strategies
5.	understand common storage management activities and solutions

UNIT I	STORAGE SYSTEMS	9

Introduction to Information Storage: Data and its types, Information storage, Key characteristics of data center and Evolution of computing platforms. Information Lifecycle Management. Third Platform Technologies: Cloud computing and its essential characteristics Cloud services and cloud deployment models, Big data analytics, Social networking and mobile computing. Data Center Environment: Building blocks of a datacenter, Computer systems and compute virtualization and Software-defined data center.

UNIT II	INTELLIGENT STORAGE SYSTEMS AND RAID	9

RAID, Types of intelligent storage systems, RAID comparison, RAID levels, Components of an intelligent storage system, Components, addressing, and performance of hard disk drives and solid-state drives.

UNIT III	STORAGE NETWORKING TECHNOLOGIES AND VIRTUALIZATION	9

Block-Based Storage System, File-Based Storage System, Object-Based and Unified Storage. Fibre Channel SAN: Software-defined networking, FC SAN components and architecture, FC SAN topologies, link aggregation, and zoning, Virtualization in FC SAN environment. Internet Protocol SAN: ISCSI protocol, network components, and connectivity, Link aggregation, switch aggregation, and VLAN, FCIP protocol, connectivity, and configuration.

UNIT IV	BACKUP, ARCHIVE AND REPLICATION	9

Introduction to Business Continuity, Backup architecture, Backup targets and methods, Data deduplication, Cloud-based and mobile device backup, Data archive, Uses of replication and its characteristics, Computer based, storage-based, and network-based replication, Data migration, Disaster Recovery as a Service.

UNIT V	SECURING STORAGE INFRASTRUCTURE	9

Information security goals, Storage security domains, Threats to a storage infrastructure, Security controls to protect a storage infrastructure, Governance, risk, and compliance, Storage infrastructure management functions, Storage infrastructure management processes.

	TOTAL PERIODS	45

COURSE OUTCOMES

At the end of this course, students will be able to		BT MAPPED (Highest Level)
CO1	demonstrate the fundamentals of information storage management and	Applying(K3)

	various models of Cloud infrastructure services and deployment.	
CO2	illustrate the usage of advanced intelligent storage systems and RAID	Applying(K3)
CO3	interpret various storage networking architectures - SAN, including storage subsystems and virtualization	Applying(K3)
CO4	examine the different role in providing disaster recovery and remote replication technologies	Analyzing(K4)
CO5	infer the security needs and security measures to be employed in information storage management.	Analyzing(K4)

TEXT BOOKS

1. EMC Corporation, Information Storage and Management, Wiley, India.
2. Jon Tate, Pall Beck, Hector Hugo Ibarra, Shanmuganathan Kumaravel and Libor Miklas, Introduction to Storage Area Networks, Ninth Edition, IBM - Redbooks, December 2017.
3. Ulf Troppens, Rainer Erkens, Wolf gang Mueller-Friedt, Rainer Wolafka, Nils Haustein, Storage Networks Explained, Second Edition, Wiley,2009.

REFERENCES

1. Alex Berson and Stephen J.Smith,"Data Warehousing, Data Mining & OLAP", Tata McGraw– Hill Edition,35th Reprint 2016.
2. K.P.Soman, Shyam Diwakar and V.Ajay,"Insight into Data Mining Theory and Practice", Eastern Economy Edition, Prentice Hall of India, 2006.
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CO4	3	3	2	2	1	-	-	-	-	-	-	3	3	2
CO5	3	2	2	1	-	-	-	-	-	-	-	3	3	2

CI23355	IOT PLATFORMS AND SYSTEM DESIGN	3	0	0	3

COURSE OBJECTIVES

This course will enable the students to

1.	explain the key requirements for implementing IoT with Arduino Uno and Raspberry Pi development boards.
2.	describe the Node-RED tool and python code for designing the IoT applications in Raspberry PI.
3.	understand IoT security issues and concerns to create awareness.
4.	learn programming languages like C, Java, and Python.
5.	learn about real-world use cases of IoT systems.

UNIT I	IMPLEMENTING IOT WITH ARDUINO	9

Introduction to Arduino Platforms, Arduino Uno architecture, IDE setup, importing Arduino boards in Arduino IDE tool, Installation of Arduino libraries, Basics of Embedded C Programming, Interfacing of Sensors and Actuators with Arduino Uno.

UNIT II	IMPLEMENTING IoT WITH RASPBERRY Pi (RPi)	9

Basic functionality of RPi board, RPi GPIO pins, Reading the datasheet of RPi setting up the board by installing OS, first boot and basic configuration of Rpi, Basic Linux Commands, Accessing RPi remotely using networking tools, Interfacing Interfacing of Sensors and Actuators with RPi.

UNIT III	NODE-RED TOOL ON Rpi	9

Prerequisite for Node-RED, Installing and upgrading Node-RED, Running Node-RED app locally and as a service on network, auto-start on boot, opening the editor, installation of various libraries for Node-RED, Creation and deployment of flows, Case studies on debug window, HTTP server, chart, gauge, slider, dashboard form, etc.

UNIT IV	PYTHON PROGRAMMING	9

Introduction to Python programming language: Python Programming Environment, Python Expressions, Strings, Functions, Data types in python, flow control, conditional statement, Loops, importing libraries.

UNIT V	SECURITY ARCHITECTURE IN IoT	9

Introduction, Security Requirements in IoT Architecture, Security in Enabling Technologies, Security Concerns in IoT Applications, Security Requirements in IoT, Insufficient Authentication/Authorization, Insecure Access Control, Threats to Access Control, Privacy, and Availability , Attacks Specific to IoT

	TOTAL PERIODS	45

COURSE OUTCOMES		
At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	use Arduino Uno for designing the IoT applications.	Understanding (K2)
CO2	illustrate use of Raspberry Pi for designing the IoT applications	Applying (K3)
CO3	develop an IoT system with Node-RED tool using Raspberry Pi	Understanding (K2)
CO4	develop the logic for Python Programming.	Understanding (K2)
CO5	understand IoT security systems.	Applying (K3)

TEXT BOOKS

1. Programming the Raspberry Pi: Getting Started with Python, Simon Monk, 3rd Edition, Tata McGraw Hill Publication. 2021.
2. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press,2017.

REFERENCES

1. Programming Arduino: Getting started with sketches, 2 ndEdition,Simon Monk, ISBN: 978 1259641633, Tata McGraw Hill Publication.
2. Exploring Raspberry Pi: Interfacing to the real world with Embedded Linux, Derex Molly, 1st Edition, ISBN: 978-1119188681, Wiley Publication,2016.
3. Arduino Programming in 24 hours, Richard Blum, 1 st Edition, ISBN: 978-0672337123, Sams Teach Yourself Publishing.2014.
4. Aditya Gupta, "The IoT Hacker"s Handbook: A Practical Guide to Hacking the Internet of Things", ISBN: 1484242998, Apress publisher, 2019.

CO-PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	1	-	-	-	1	-	-	2	3	1
CO2	3	3	3	3	1	-	-	-	2	-	-	2	3	1
CO3	3	3	3	3	2	-	-	-	3	-	-	2	1	2
CO4	3	2	3	2	3	-	-	-	3	-	-	2	2	3
CO5	3	2	2	2	2		-	-	2	-	-	2	2	2

CI23356	SOFTWARE DEFINED NETWORKS	3	0	0	3

COURSE OBJECTIVES	
This course will enable the students to	
1.	understand the need for SDN and its data plane operations
2.	understand the functions of control plane
3.	comprehend the migration of networking functions to SDN environment
4.	explore various techniques of network function virtualization
5.	comprehend the concepts behind network virtualization

UNIT I	SDN: INTRODUCTION	9
Evolving Network Requirements–The SDN Approach–SDN architecture-SDN Data Plane, Control plane and Application Plane.		

UNIT II	SDN DATA PLANE AND CONTROL PLANE	9
Data Plane functions and protocols – Open Flow Protocol – Flow Table – Control Plane Functions - Southbound Interface, Northbound Interface–SDN Controllers - Open Day light		

UNIT III	SDN APPLICATIONS	9
SDN Application Plane Architecture – Network Services Abstraction Layer – Traffic Engineering – Measurement and Monitoring – Security – Data Center Networking.		

UNIT IV	NETWORK FUNCTION VIRTUALIZATION	9
Network Virtualization - Virtual LANs – Open Flow VLAN Support - NFV Concepts – Benefits and Requirements – Reference Architecture.		

UNIT V	NFV FUNCTIONALITY	9
NFV Infrastructure – Virtualized Network Functions – NFV Management and Orchestration – NFV Use cases – SDN and NFV.		

	TOTAL PERIODS	45

COURSE OUTCOMES		
At the end of this course, the student will be able to		BT MAPPED (Highest Level)
CO1	describe the motivation behind SDN	Analyzing (K4)
CO2	identify the functions of the data plane and control plane	Understanding (K2)
CO3	design and develop network applications using SDN	Applying (K3)
CO4	orchestrate network services using NFV	Understanding (K2)
CO5	explain various use cases of SDN and NFV	Applying (K3)

TEXT BOOKS

1. William Stallings,"Foundations of Modern Networking :SDN, NFV, QoE, IoT and Cloud". Pearson Education, 1st Edition, 2015.
2. KenGray, Thomas D.Nadeau, "Network Function Virtualization", Morgan Kauffman,2016

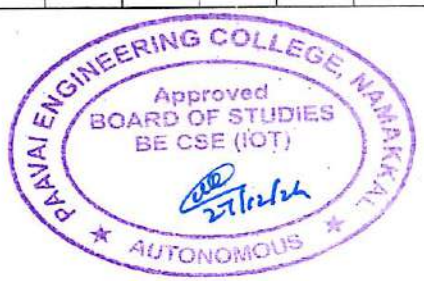
REFERENCES

1. ThomasD Nadeau, KenGray," SDN: Software Defined Networks", O'Reilly Media,2013.
2. FeiHu, "Network Innovation through OpenFlow and SDN: Principles and Design",1st Edition, CRC Press, 2014
3. Paul Goransson,Chuck Black Timothy Culver,"Software Defined Networks: A Comprehensive Approach", 2nd Edition, Morgan Kaufmann Press, 2016.
4. OswaldCoker,SiamakAzodolmolky,"Software-DefinedNetworkingwithOpenFlow",2nd Edition, O'Reilly Media, 2017

CO-PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	-	-	-	1	-	-	2	3	1
CO2	3	3	3	3	1	-	-	-	2	-	-	2	3	1
CO3	3	3	1	3	2	-	-	-	3	-	-	2	1	2
CO4	3	2	3	2	3	-	-	-	3	-	-	2	2	3
CO5	3	2	2	2	2		-	-	2	-	-	2	2	2



CI23357	VIRTUALIZATION	3	0	0	3

COURSE OBJECTIVES	
This course will enable the students to	
1.	analyze the basic concepts of virtualization technology to derive the best practice model for deploying cloud-based applications.
2.	create an application by utilizing cloud platforms such as Amazon Web Services and Windows Azure.
3.	identify major security and privacy problems in cloud computing environment.
4.	apply the ability to use the architecture of cloud, service and delivery models.
5.	implement the key enabling technologies that help in the development of cloud.

UNIT I	UNDERSTANDING VIRTUALIZATION	9

Describing Virtualization - Microsoft Windows Drives Server Growth - Explaining Moore's Law Understanding the Importance of Virtualization - Examining Today's Trends - Virtualization and Cloud Computing - Understanding Virtualization Software Operation - Virtualizing Servers Virtualizing Desktops - Virtualizing Applications.

UNIT II	HYPERVISORS	9

Describing a Hypervisor -Exploring the History of Hypervisors -Understanding Type 1 Hypervisors - Type 2 Hypervisors - Role of a Hypervisor -Holodecks and Traffic Cops -Resource Allocation -Comparing Today's Hypervisors -VMware ESX -Citrix Xen -Microsoft Hyper-V - Other Solutions.

UNIT III	VIRTUAL MACHINES	9

Introduction to Virtual Machine - CPUs in a Virtual Machine -Memory in a Virtual Machine - Network Resources in a Virtual Machine - Storage in a Virtual Machine -Understanding How a Virtual Machine Works - Working with Virtual Machines -Virtual Machine Clones -Templates - Snapshots -OVF –Containers.

UNIT IV	CREATION OF VIRTUAL MACHINES & CONFIGURATIONS	9

Understanding Configuration Options-Installing Windows on a Virtual Machine- Installing Linux on a Virtual Machine-Installing VirtualBox Guest Additions- Managing CPUs for a Virtual Machine Configuring VM CPU Options-Managing Storage for a Virtual Machine- Managing Networking for a Virtual Machine- Copying a Virtual Machine- Managing Additional Devices in Virtual Machines

UNIT V	AVAILABILITY AND APPLICATIONS IN A VIRTUAL MACHINE	9

Increasing Availability-Protecting a Virtual Machine-Protecting Multiple Virtual Machines- Protecting Data Centres - Examining Virtual Infrastructure Performance Capabilities -Deploying Applications in a Virtual Environment-Understanding Virtual Appliances and vApps -Open Stack and Containers.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of the course, the students will be able to		BT MAPPED (Highest Level)
CO1	analyze the concept of virtualization and its properties.	Analyzing (K4)
CO2	apply different forms of virtualization.	Applying (K3)
CO3	implement various architectures for implementing virtualization methods.	Applying (K3)
CO4	create virtual machines and installing various operating systems.	Analyzing (K4)
CO5	evaluate the performance of the virtual machines and deployed applications.	Analyzing (K4)

TEXT BOOKS

1. Matthew Portney, Virtualization Essentials, John Wiley & Sons, Second Edition, 2016.
2. Kailash Jayaswal, Jagannath Kallakurchi,Donald J.Houde,Dr.devan Shah, "Cloud Computing Black Book", Dreamtech press, 2015.

REFERENCES

1. Rajkumar Buyya, Christian Vecchiola and Thamarai Selvi S, "Mastering in Cloud Computing", McGraw Hill Education, (India) Private Limited, 2013.
2. Bernard Golden, Amazon Web Services for Dummies, John Wiley & Sons, First Edition, 2013.
3. Rittinghouse, John W., and James F. Ransome, "Cloud Computing: Implementation, Management and Security", CRC Press, 2017.
4. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice)", O'Reilly, 2009.

CO-PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes(POs)												PSOs	
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CO1	1	3	2	2	1	-	-	-	1	-	-	2	3	1
CO2	3	2	3	3	1	-	-	-	2	-	-	2	3	1
CO3	3	3	3	1	2	-	-	-	3	-	-	2	1	2
CO4	3	2	3	2	3	-	-	-	3	-	-	2	2	3
CO5	3	2	2	2	2		-	-	2	-	-	2	2	2

VERTICAL - IV

NETWORKS & SECURITY

CI23451	CRYPTOGRAPHY AND NETWORK SECURITY	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the fundamental concepts of cryptographic systems.
2.	apply symmetric and asymmetric encryption techniques.
3.	study public-key cryptography principles, algorithms like RSA and ECC, digital signatures, and key distribution mechanisms.
4.	explore network and internet security protocols such as SSL, TLS, HTTPS, and secure email and DNS mechanisms.
5.	understand emerging security trends including endpoint security, IoT security, and AI applications in intrusion detection

UNIT I	FOUNDATIONS OF CRYPTOGRAPHY	9

Introduction - Cybersecurity, Information Security and Network Security - Security Attacks – Security Services – Security Mechanisms – OSI Security Architecture – Cryptography – Network Security – Trust and Trustworthiness - Classical Encryption Techniques – Symmetric, Substitution and Transposition Ciphers – Rotor Machines – Cryptanalysis.

UNIT II	SYMMETRIC CIPHERS AND BLOCK CIPHERS	9

Block Cipher – Traditional Block Cipher Structure – The Data Encryption Standard – Block Cipher Design Principles. Advanced Encryption Standard: Structure – Key Expansion Algorithm - Block Cipher Operation - Triple DES – Mode of Operation - Stream Ciphers – RC4 - LFSR – Case Study: Lightweight Cryptography concepts - Lightweight Ciphers for IoT (PRESENT, SPECK).

UNIT III	PUBLIC-KEY CRYPTOGRAPHY	9

Introduction to Number Theory – Modular Arithmetic – Euler's Theorem – Principles of Public-key Cryptosystems - RSA Algorithm – Diffie-Hellman Key Exchange – Elliptic Curve Cryptography (ECC) –Hash Functions and Applications - SHA-512 – HMAC - Digital Signatures – DSA – Key Management – Symmetric, Asymmetric and Public Key Distribution – X.509 Certificates.

UNIT IV	NETWORK AND INTERNET SECURITY	9

Message Authentication Requirements and Functions – IP Security overview and policy– Secure Socket Layer (SSL) – Web Security Considerations – Transport Layer Security (TLS) - HTTPS – Wireless and Mobile device Security - Email Security – Internet Mail Architecture – Email Threats - S/MIME – DNSSEC – Pretty Good Privacy.

UNIT V	EMERGING TRENDS IN NETWORK SECURITY	9

Network Endpoint security – Firewall – Intrusion Detection System – DDOS attack - Cloud Security – IoT Security. Case Study: Security of Big Data Analytics – Security of Smart City – Artificial Intelligence Security – AI for Intrusion Detection System.

	TOTAL PERIODS	45

COURSE OUTCOMES		
At the end of this course, students will be able to		**BT Mapped (Highest Level)**
CO1	explain the fundamentals of security services, attacks, and classical encryption techniques including substitution and transposition.	Understanding (K2)
CO2	apply block cipher principles such as DES and AES and implement lightweight encryption algorithms for IoT applications.	Applying (K3)
CO3	apply number theory and cryptographic principles to implement RSA, ECC, and digital signature algorithms.	Applying (K3)
CO4	understand the functioning of network-level security protocols like TLS, HTTPS, S/MIME, and DNSSEC.	Understanding (K2)
CO5	analyze the impact of emerging security threats such as DDOS and identify AI-based solutions in smart city and big data security contexts.	Analyzing (K4)

TEXT BOOKS

1. William Stallings, "Cryptography and Network Security: Principles and Practice", 8th Edition, Pearson Education, 2023.
2. Sarhan M. Musa, "Network Security and Cryptography: A Comprehensive Guide to Network Protection and Encryption Techniques", Mercury Learning and Information, Packt, 1st Edition, 2024.

REFERENCES

1. Charles P. Pfleeger and Shari Lawrence Pfleeger, "Security in Computing", 5th Edition, Pearson Education, 2022.
2. Behrouz A. Forouzan, "Cryptography and Network Security", 3rd Edition, McGraw Hill, 2023.
3. Niels Ferguson, Bruce Schneier, and Tadayoshi Kohno, "Cryptography Engineering", Wiley, 2021.
4. Jonathan Katz, Yehuda Lindell, "Introduction to Modern Cryptography", second edition, Chapman & Hall Book, CRC Press, 2011.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1	1	-	1	-	-	-	1	3	1
CO2	3	3	3	2	1	-	-	1	-	-	-	2	3	2
CO3	3	3	3	3	2	-	-	1	-	-	-	2	3	2
CO4	3	2	2	2	2	2	-	-	-	-	-	3	3	1
CO5	2	2	2	3	3	3	1	-	-	-	-	3	3	3

CI23452	MOBILE AD HOC NETWORKS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	understand the fundamentals of ad hoc wireless networks and analyze various MAC layer protocols suited for such networks.
2	explore and classify routing protocols based on their design strategies and applicability in MANETs.
3	learn about transport protocol challenges in ad hoc environments and study QoS frameworks and enhancements.
4	study energy management strategies, power-aware routing mechanisms, and mobility models in ad hoc networks.
5	understand cross-layer design approaches, applications of MANETs, and recent technological advancements including integration with IoT, AI, and blockchain.

UNIT I	INTRODUCTION AND MAC PROTOCOLS	9

Ad hoc Wireless Networks – Cellular vs Ad hoc Wireless Networks - Characteristics and applications of Ad Hoc Networks – Issues in Ad Hoc Wireless Networks – Need for Medium Access – Classification of MAC Protocols - Contention-Based MAC Protocols with Reservation Mechanisms (MACA, MACA-BI) – Multiple Channel MAC Protocols – Power-Aware MAC Protocols.

UNIT II	ROUTING PROTOCOLS	9

Design issues of Routing Protocols – Classification of Routing Protocols – Proactive Routing Protocols – Hybrid Routing Protocols – Classification of Multicast Routing Protocols – QoS Routing.

UNIT III	TRANSPORT PROTOCOLS AND QOS	9

Transport Protocols: Challenges and design goals – TCP performance – Ad hoc Transport Protocols – Quality of service: challenges – Classification of QoS Solutions – QOS extension to AODV Protocol - QoS Frameworks – INSIGNIA and INORA.

UNIT IV	ENERGY MANAGEMENT AND MOBILITY MODELS	9

Energy Management schemes – Energy-efficient routing protocols – Transmission Power control – AODV: LEAR, PAR and LPR - Mobility Models – Limitations of Random Waypoint Model - Geographic Restrictions.

UNIT V	APPLICATIONS AND RECENT DEVELOPMENTS	9

Cross-Layer Design – Definition – Principle – Architecture – Approach – Performance objectives – Protocols. PAN - Applications and Opportunities – Challenges - Recent Developments – Case Study: Integration of MANETs with IoT - Blockchain and AI in MANET Security - Simulation and Performance Evaluation Tools: OMNeT++/GloMoSim.

	TOTAL PERIODS	45

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	understand the characteristics, applications, and MAC protocols used in ad hoc wireless networks.	Understanding (K2)
CO2	apply appropriate routing protocols based on design constraints in mobile ad hoc wireless networks.	Applying (K3)

CO3	address the challenges in mobility, QoS, and energy constraints and propose solutions.	Analyzing (K4)
CO4	analyze the role of MANETs in IoT systems, VANETs, and UAV networks.	Analyzing (K4)
CO5	discuss link layer protocols, wireless technologies, and network security techniques and incorporate into IoT environments.	Understanding (K2)

TEXT BOOKS

1. C. Siva Ram Murthy, B. S. Manoj, "Ad Hoc Mobile Wireless Networks: Principles, Protocols, and Applications", Pearson Education, 2004.
2. Carlos de Morais Cordeiro, Dharma Prakash Agrawal, "Ad Hoc & Sensor Networks Theory and Applications", World Scientific, 2006.

REFERENCES

1. Charles E. Perkins, "Ad Hoc Networking", Addison-Wesley, 2001.
2. Ian F. Akyildiz et al., "Wireless Sensor Networks: A Survey", Computer Networks, 2002.
3. Mohammad Ilyas, "The Handbook of Ad Hoc Wireless Networks", CRC Press, 2002.
4. Holger Karl and Andreas Willig," Protocols and Architectures for Wireless Sensor Networks", Wiley, 2005.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
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CO's	Programme Outcomes PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	-	2	-	-	-	-	-	1	1	3	3
CO2	3	2	2	2	2	1	1	-	1	2	2	1	3	2
CO3	3	3	2	2	1	1	-	-	1	-	-	1	2	3
CO4	3	3	3	2	1	1	-	2	2	-	-	1	3	3
CO5	3	3	2	2	-	-	-	-	-	-	-	1	2	2

CI23453	NETWORK SECURITY	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand fundamental principles, models, and standards in network security.
2.	learn principles to secure user authentication and describe identity management techniques.
3.	analyze secure communication protocols for confidentiality and integrity.
4.	evaluate access control and cloud security mechanisms
5.	explore system-level defenses and emerging security paradigms.

UNIT I	INTRODUCTION TO NETWORK SECURITY	9

Security concepts – CIA triad – OSI Security Architecture – Security attacks, services, and mechanisms – Attack surfaces and attack trees – Security design principles – Overview of security standards and security policy frameworks.

UNIT II	USER AUTHENTICATION AND IDENTITY MANAGEMENT	9

User authentication principles – Remote user authentication – Kerberos protocol – X.509 Certificates – Certificate Authorities – Public Key Infrastructure (PKI) – Federated Identity Management – Single Sign-On (SSO).

UNIT III	SECURE COMMUNICATION PROTOCOLS	9

Web and transport-layer security – TLS Protocol, HTTPS – Secure Shell (SSH) – IPsec Protocol: ESP, AH, IKE – Virtual Private Networks (VPNs) – Email security protocols: S/MIME and PGP – DNS Security: DNSSEC, SPF, DKIM, DMARC.

UNIT IV	NETWORK ACCESS CONTROL AND CLOUD SECURITY	9

Network Access Control (NAC) – IEEE 802.1X and EAP – Authentication protocols (EAP-TLS, PEAP, etc.) – RADIUS and Diameter – Cloud computing models – Cloud security risks and mitigation – Security-as-a-Service (SecaaS) – Cloud governance and compliance.

UNIT V	SYSTEM SECURITY AND FIREWALLS	9

Types of malware: viruses, worms, trojans, rootkits, APTs – Intrusion detection and prevention systems (IDS/IPS) – Snort, Suricata – Password security and authentication flaws – Firewall types and deployment models – Packet filtering, Stateful inspection, Application-layer firewalls – Overview of Zero Trust Architecture and IoT security issues – Case studies: Smart Home breach, Mirai Botnet.

	TOTAL PERIODS	45

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	understand fundamental security concepts and models in modern networks.	Understanding (K2)
CO2	apply secure authentication and identity management techniques.	Applying (K3)
CO3	analyze and configure network and wireless security mechanisms.	Analyzing(K4)

CO4	discuss network access control and security challenges in cloud computing.	Understanding (K2)
CO5	explore emerging security paradigms Zero Trust and IoT security.	Understanding (K2)

TEXT BOOKS

1. William Stallings, "Network Security Essentials: Applications and Standards", Sixth Edition, Pearson, 2017.
2. Behrouz A. Forouzan, "Cryptography and Network Security", 1st Edition, McGraw-Hill.

REFERENCES

1. Behrouz A. Forouzan, "Introduction to Cryptography and Network Security", McGraw-Hil.
2. William Stallings, "Cryptography and Network Security: Principles and Practice", 7th Edition, Pearson.
3. Perrig, D., & Szewczyk, R., "Security and Privacy in Internet of Things (IoT)", IEEE Journals, Springer chapters.
4. Joseph Migga Kizza, "Guide to Computer Network Security", Springer International Publishing, 2024.

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CO2	3	2	2	-	2	-	-	-	-	-	-	-	-	-
CO3	3	2	2	2	1	-	-	-	-	-	-	-	-	2
CO4	3	2	2	2	2	-	-	-	-	-	-	-	-	2
CO5	3	3	3	3	2	1	1	-	-	-	-	-	-	3

CI23454	CYBER SECURITY	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand modern cybersecurity principles, threats, and defenses.
2.	classify attackers, malware, and social engineering techniques.
3.	understand cryptographic principles and forensic techniques for secure and lawful digital investigation.
4.	explore mobile, cloud, and IoT-related cybersecurity challenges.
5.	explain AI-Blockchain-enabled cybersecurity models.

UNIT I	INTRODUCTION TO CYBERSECURITY	9

Cybersecurity Fundamentals – CIA Triad (Confidentiality, Integrity, Availability) – Threats: Malware, Viruses, Trojans, Bots – Ransomware – Vulnerabilities and Attack Surfaces – Passive/Active Attacks – Insider Threats – Cyber Kill Chain – Defense in Depth – Real-Time Case Studies: Mirai, WannaCry.

UNIT II	MALWARE, ATTACKS, AND SOCIAL ENGINEERING	9

Classification of Hackers – Threat Actors: Script Kiddies, Hacktivists, Cybercriminals, State Actors – Malware: Rootkits, Logic Bombs, Keyloggers – Phishing, Spear Phishing, Social Engineering – Command & Control (C2) – Honeypots – Incident Response and Cyber Ethics.

UNIT III	CRYPTOGRAPHY AND CYBER FORENSICS	9

Basic Cryptography – Symmetric & Asymmetric Encryption – Hashing – Digital Signatures – Steganography – IoT Crypto Basics – Cyber Laws (IT Act India, GDPR) – Ethics – Digital Forensics Tools – Evidence Collection – Chain of Custody – Investigation Tools (Autopsy, FTK).

UNIT IV	CLOUD, MOBILE, AND NETWORK SECURITY	9

Mobile & IoT Vulnerabilities – App, OS, Network Layer Issues – QR/NFC/OTP Exploits – Cloud Threats: DoS, API Hacking – Zero Trust & IAM – VPNs – TLS/SSL – Wi-Fi Security (WPA2/WPA3) – Real-World Breaches – Network Security Basics (Firewall, IDS, VPN).

UNIT V	AI/ML, BLOCKCHAIN, AND IoT SECURITY	9

IoT Device Security – Secure Communication Protocols (MQTT, CoAP) – Blockchain for IoT – Smart Contracts – AI in Threat Detection – Behavior Anomaly Detection – AI/Blockchain Case Studies: Smart City, e-Health, Surveillance, Smart Grid.

	TOTAL PERIODS	45

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	explain the core concepts of cybersecurity and emerging threats.	Understanding (K2)
CO2	identify various malware, threat actors, and social engineering techniques to support ethical incident response.	Understanding (K2)
CO3	apply encryption and forensic tools to ensure data security, evidence integrity, and legal compliance.	Applying (K3)

CO4	analyze vulnerabilities in mobile, cloud, and IoT platforms.	Analyzing (K4)
CO5	design secure AI/Blockchain-enabled IoT Systems.	Applying (K3)

TEXT BOOKS

1. Chuck Easttom, "Computer Security Fundamentals", Pearson, 5th Edition, 2023.
2. James Graham, Richard Howard, Ryan Olson, "Cyber Security Essentials", CRC Press, 2011

REFERENCES

1. William Stallings, "Network Security Essentials: Applications and Standards", Pearson, 6th Edition.
2. CyBOK Consortium, "The Cyber Security Body of Knowledge (CyBOK)", v1.0.
3. Nancy R. Mead Carol C. Woody, "Cyber Security Engineering A Practical Approach for Systems and Software Assurance", Addison Wesley, 2017.
4. Fei Hu, "Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations ", CRC Press, 2016.

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CO3	3	2	2	-	-	-	-	-	-	-	-	2	3	2
CO4	3	3	2	-	-	-	-	-	-	-	-	2	3	2
CO5	3	3	3	-	-	-	-	-	-	-	-	2	3	2

CI23455	PRIVACY AND SECURITY IN IOT	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1. know the state-of-the-art methodologies in Cyber Physical system.
2. understand cryptographic primitives, privacy protection, and trust frameworks in IoT
3. explore the Privacy Preservation and Trust Models in Internet of Things (IoT).
4. organize and analyze the concept of Internet of Things Security.
5. plan and design IoT security and lightweight cryptographic based application.

UNIT I	CYBER PHYSICAL SYSTEMS AND INTERCONNECTION OF THREATS	9

IoT and cyber-physical systems, IoT security (vulnerabilities, attacks, and countermeasures), security engineering for IoT development, IoT security lifecycle. Network Robustness of Internet of Things-Sybil Attack Detection in Vehicular Networks- Malware Propagation and Control in Internet of Things- Solution-Based Analysis of Attack Vectors on Smart Home Systems.

UNIT II	CRYPTO FOUNDATIONS	9

Block ciphers, message integrity, authenticated encryption, hash functions, Merkle trees, elliptic curves cryptography (ECC), public-key crypto (PKI), signature algorithms – Lightweight Cryptography - Applications of cryptographic primitives in resource-constrained IoT devices.

UNIT III	PRIVACY PRESERVATION FOR IOT	9

Privacy Preservation Data Dissemination- Privacy Preservation Data Dissemination- Social Features for Location Privacy Enhancement in Internet of Vehicles- Lightweight and Robust Schemes for Privacy Protection in Key Personal IoT Applications: Mobile WBSN and Participatory Sensing.

UNIT IV	TRUST MODELS FOR IOT	9

Authentication in IoT- Computational Security for the IoT- Privacy-Preserving Time Series Data Aggregation- Secure Path Generation Scheme for Real-Time Green Internet of Things- Security Protocols for IoT Access Networks- Framework for Privacy and Trust in IoT- Policy-Based Approach for Informed Consent in Internet of Things.

UNIT V	IOT SECURITY BASED APPLICATIONS	9

Security and Impact of the Internet of Things (IoT) on Mobile Networks- Networking Function Security-IoT Networking Protocols, Secure IoT Lower Layers, Secure IoT Higher Layers, Secure Communication Links in IoTs, Back-end Security -Secure Resource Management, Secure IoT Databases, Security Products-Existing Test bed on Security and Privacy of IoTs, Commercialized Products.

	TOTAL PERIODS	45

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	identify the areas of cyber security for the Internet of Things.	Remembering (K1)

CO2	explain different Internet of Things technologies and their applications.	Understanding (K2)
CO3	develop an IoT Model and transform into business	Applying (K3)
CO4	customize real time data for IoT applications.	Applying (K3)
CO5	solve IoT security problems using light weight cryptography.	Analyzing (K4)

TEXT BOOKS

1. Hu, Fei. "Security and privacy in Internet of things (IoTs): Models, Algorithms, and Implementations", 1st edition, CRC Press, 2016.
2. Russell, Brian, and Drew Van Duren, "Practical Internet of Things Security", 1st edition, Packt Publishing Ltd, 2016.

REFERENCES

1. Whitehouse O, "Security of things: An implementers' guide to cyber-security for internet of things devices and beyond", 1st edition, NCC Group, 2014.
2. DaCosta, Francis, and Byron Henderson, "Rethinking the Internet of Things: a scalable approach to connecting everything", 1st edition, Springer Nature, 2013.
3. Souvik Pal, Vicente García Díaz, Dac-Nhuong Le, "IoT Security and Privacy Paradigm", 1st Edition, CRC Press, 2022.
4. Dr. Lalit Kumar Sagar, Dr. Rolly Gupta, Mr. Mukesh Kumar, "The Benefits of Privacy and Security in IoT: A Comprehensive Guide", IIP Iterative International Publishers, 2024.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO2	2	2	-	-	-	-	-	-	-	-	-	-	2	2
CO3	3	2	3	-	-	-	-	-	-	-	-	-	3	2
CO4	2	-	3	-	-	-	-	-	-	-	-	-	2	2
CO5	3	3	2	2	-	-	-	-	-	-	-	-	3	2

CI23456	ETHICAL HACKING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1. understand the basics of computer-based vulnerabilities
2. explore different foot printing, reconnaissance and scanning methods
3. expose the enumeration and vulnerability analysis methods.
4. understand hacking options available in Web and wireless applications
5. explore the options for network protection.

UNIT I INTRODUCTION 9

Ethical Hacking Overview - Role of Security and Penetration Testers- Penetration-Testing Methodologies- Laws of the Land - Overview of TCP/IP- The Application Layer - The Transport Layer - The Internet Layer - IP Addressing - Network and Computer Attacks - Malware - Protecting Against Malware Attacks - Intruder Attacks - Addressing Physical Security

UNIT II FOOT PRINTING, RECONNAISSANCE AND SCANNING NETWORKS 9

Footprinting Concepts - Footprinting through Search Engines, Web Services, Social Networking Sites, Website, Email - Competitive Intelligence - Footprinting through Social Engineering - Footprinting Tools - Network Scanning Concepts - Port-Scanning Tools - Scanning Techniques - Scanning Beyond IDS and Firewall.

UNIT III ENUMERATION AND VULNERABILITY ANALYSIS 9

Enumeration Concepts - NetBIOS Enumeration – SNMP, LDAP, NTP, SMTP and DNS Enumeration - Vulnerability Assessment Concepts - Desktop and Server OS Vulnerabilities - 152 Windows OS Vulnerabilities - Tools for Identifying Vulnerabilities in Windows- Linux OS Vulnerabilities- Vulnerabilities of Embedded OSs.

UNIT IV SYSTEM HACKING 9

Hacking Web Servers - Web Application Components- Vulnerabilities - Tools for Web Attackers and Security Testers Hacking Wireless Networks - Components of a Wireless Network – Wardriving Wireless Hacking - Tools of the Trade.

UNIT V NETWORK PROTECTION SYSTEMS 9

Access Control Lists. - Cisco Adaptive Security Appliance Firewall - Configuration and Risk Analysis Tools for Firewalls and Routers - Intrusion Detection and Prevention Systems - Network-Based and Host-Based IDSs and IPSs - Web Filtering - Security Incident Response Teams – Honeypots.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to		**BT Mapped (Highest Level)**
CO1	express knowledge on basics of computer-based vulnerabilities.	Remembering(K1)
CO2	acquire the knowledge of different foot printing, reconnaissance and scanning methods.	Understanding (K2)

CO3	demonstrate the enumeration and vulnerability analysis methods	Applying (K3)
CO4	gain knowledge on hacking options available in Web and wireless applications	Applying (K3)
CO5	acquire knowledge on the options for network protection.	Analyzing(K4)

TEXT BOOKS

1. Michael T. Simpson, Kent Backman, and James E. Corley, "Hands-On Ethical Hacking and Network Defense", Course Technology, Delmar Cengage Learning, 2010.
2. Patrick Engebretson, "The Basics of Hacking and Penetration Testing", SYNGRESS, Elsevier, 2013.

REFERENCES

1. Georgia Weidman, Penetration Testing: A Hands-On Introduction to Hacking, 2nd Edition, No Star h Press, 2023.
2. Justin Seitz, "Black Hat Python: Python Programming for Hackers and Pentesters", 2014.
3. Dafydd Stuttard and Marcus Pinto, "The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws", 2011.
4. Allen Harper, Shon Harris, Jonathan Ness, "Chris Eagle, Gideon Lenkey, and Terron Williams Gray Hat Hacking: The Ethical Hacker's Handbook", Mc Graw Hill, 2011.

CO-PO MAPPING:

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CO's	Programme Outcomes PO's												PSO's	
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CO1	3	1	3	2	1	-	-	-	1	1	-	2	3	3
CO2	3	3	3	3	3	-	-	-	2	2	-	1	3	2
CO3	3	3	2	3	1	-	-	-	3	2	-	-	2	2
CO4	3	1	2	2	3	-	-	-	1	3	-	-	2	2s
CO5	1	3	2	3	2	-	-	-	2	3	-	2	3	3

CI23457	DIGITAL AND MOBILE FORENSICS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1. understand the fundamental concepts of digital forensics, including the investigation process, professional conduct, and workstation setup.
2. learn the methods and techniques of data acquisition, including contingency planning and acquisition tools.
3. know the procedures for processing digital crime and incident scenes, ensuring evidence is correctly identified, collected, and preserved.
4. use the current tools and techniques used in digital forensics, including handling graphics files and understanding data compression.
5. discuss the principles of digital forensic validation, including email and social media investigations, focusing on data integrity and validation techniques.

UNIT I	DIGITAL FORENSICS INVESTIGATIONS AND WORKSTATIONS	9

An overview of Digital forensics- Preparing for Digital investigations- Maintaining Professional Conduct-Preparing a Digital Forensics Investigation-Procedures for Private Sector High Tech Investigations-Understanding Data Recovery Workstations and Software-Conducting an Investigation- Understanding Forensics Lab Accreditation Requirements-Determining the Physical Requirements for a Digital Forensics Lab-Selecting a Basic Forensic Workstation.

UNIT II	DATA ACQUISITION	9

Understanding Storage Formats for Digital Evidence-Determining the Best Acquisition Method-Contingency Planning for Image Acquisitions-Using Acquisition Tools-Validating Data Acquisitions-Performing RAID Data Acquisitions-Using Remote Network Acquisition Tools-Using Other Forensics Acquisition Tools.

UNIT III	PROCESSING CRIME AND INCIDENT SCENES	9

Identifying Digital Evidence – Collecting Evidence in Private Sector Incident Scenes –Processing Law Enforcement Crime Scenes – Preparing for a Search –Securing a Computer Incident or Crime Scene –Seizing Digital Evidence at the Scene –Storing Digital Evidence –Obtaining a Digital Hash –Reviewing a Case.

UNIT IV	CURRENT TOOLS AND GRAPHIC FILES	9

Evaluating Digital Forensics Tool Needs-Digital Forensics Software Tools-Digital Forensics Hardware Tools-Validating and Testing Forensics Software-Recognizing a Graphics File-Understanding Data Compression-Identifying Unknown File Formats.

UNIT V	DIGITAL FORENSIC VALIDATION AND E-MAIL INVESTIGATIONS	9

Determining What Data to Collect and Analyze-Validating Forensic Data-Addressing Data Hiding Techniques-Exploring the Role of E-mail in Investigations-Exploring the Roles of the Client and Server in E-mail-Investigating E-mail Crimes and Violations - Understanding E-mail Servers-Using Specialized E-mail Forensics Tools-Applying Digital Forensics Methods to Social Media Communications.

	TOTAL PERIODS	45

COURSE OUTCOMES		
At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	explain the principles of digital forensics and professional conduct during the investigation process	Understanding (K2)
CO2	discuss the most effective data acquisition methods, tools, and techniques for different types of digital evidence	Understanding (K2)
CO3	identify, collect, and preserve digital evidence in line with legal and forensic standards.	Applying (K3)
CO4	classify digital forensic tools, especially in relation to graphics files and data compression, to identify and examine digital evidence.	Applying (K3)
CO5	justify forensic data in email and social media investigations, applying appropriate tools and techniques	Analyzing(K4)

TEXT BOOKS

1. Nelson Bill, Phillips Amelia and Steuart Christopher, "Guide to Computer Forensics and Investigations", 6th Edition, Cengage Learning, 2018.
2. Nhien-An Le-Khac, Kim-Kwang Raymond Choo, "Cyber and Digital Forensic Investigations", Springer, 2020.

REFERENCES

1. Oettinger, W, "Learn Computer Forensics", Packt Publishing, 2020.
2. Marjie BritzMarjie Britz, "Computer Forensics and Cyber Crime: An Introduction", Pearson Education India; third edition, 2013.
3. Bill Nelson, Amelia Phillips, Christopher Steuart, "Guide to Computer Forensics and Investigations: Processing Digital Evidence", Fifth Edition, Cengage Learning, 2015.
4. Linda Volonino, Reynaldo Anzaldua, "Computer Forensics for Dummies", Wiley Publishing, Inc., 2008.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's

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CO's	Programme Outcomes PO's												PSO's	
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CO1	3	1	3	2	1	-	-	-	1	1	-	3	3	3
CO2	3	3	3	3	3	-	-	-	2	2	-	2	3	2
CO3	3	3	2	3	1	-	-	-	3	2	-	1	3	2
CO4	3	1	2	2	3	-	-	-	1	3	-	2	2	2
CO5	1	3	2	3	2	-	-	-	2	3	-	3	3	3

VERTICAL - V
DESIGN AND ARCHITECTURE

CI23551	IOT DEVICE PROGRAMMING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	develop logical IoT system designs using Python programming.
2.	program Arduino boards to control sensors and actuators.
3.	interface IoT devices with physical sensors and actuators.
4.	enable communication between IoT devices and external systems.
5.	integrate IoT devices with cloud platforms for data and control.

UNIT I	IOT SYSTEMS - LOGICAL DESIGN USING PYTHON	9

Introduction, Motivation for using python, python date type and data structures, Control flow, functions, modules, packages, file handling, date/time operations, classes, python packages of interest for IoT- JSON, XML, HTTPLib & URLLib, SMTPLib - example program

UNIT II	RASPBERRY PI PROGRAMMING	9

Basic building blocks of an IoT device, Exemplary device, about the raspberry pi board, interface raspberry pi board: IOT physical Servers and cloud offering – Introduction to cloud storage models and communication APIs, WAMP, python web application framework. Programming Raspberry pi with python – interfacing of LED and LDR, Controlling of LED.

UNIT III	CONNECTING TO THE PHYSICAL WORLD	9

Data Simulation - Simulating Sensors and Actuators, Integrating and representing of Sensing and Actuation Simulation Within Your Application Design, Create Data Containers to Support Data Collection and Actuation: Data Emulation - Emulating Sensors and Actuators, Programming Exercises, Integrating Sensing and Actuation Emulation Within Your Application Design.

UNIT IV	CONNECTING TO OTHER THINGS	9

MQTT Integration–Overview and Python Client, About MQTT, Adding MQTT to Your Applications: MQTT Integration–Java Client: CoAP Server Implementation – About CoAP, CoAP Client Integration, Edge Integration - Security Exercises, Functional Exercises, Programming Exercises.

UNIT V	CONNECTING TO THE CLOUD	9

Integrating with Various Cloud Services – concepts, integrating with an IoT Cloud Service Provider (CSP), Taming the IoT - IoT Ecosystem Enablers: case studies - Home Environment Monitoring and Temperature Adjustment, Garden Monitoring and Water Adjustment, Pond Quality Monitoring.

	TOTAL PERIODS	45

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	ability to design and implement IoT logic using Python.	Applying (K3)
CO2	skill to write and deploy Arduino code for hardware control.	Applying (K3)
CO3	competence in interfacing IoT devices with real-world sensors and actuators.	Analyzing (K4)

CO4	capability to establish communication between IoT devices and networks.	Analyzing (K4)
CO5	proficiency in integrating IoT systems with cloud services for management and analytics.	Applying (K3)

TEXT BOOKS

1. Andy King, "Programming the Internet of Things: An Introduction to Building Integrated, Device-to-Cloud IoT Solutions", Published by O'Reilly Media, Inc., first edition, 2021.
2. Arshdeep bahga, Vijay Madisetti,, "Internet of Things", University Press(india) private limited, 2015.

REFERENCES

1. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress, 2016
2. Sudip Misra, Chandana Roy, Anadarup Mukherjee, "Introduction to Industrial Internet of Things and Industry 4.0", CRCPress, 2021
3. Niels Ferguson, Bruce Schneier, and Tadayoshi Kohno, "Cryptography Engineering", Wiley, 2021.
4. Vangelis Angelakis, "Designing, Developing, and Facilitating Smart Cities Urban Design to IoT Solutions", Springer, 2019.

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CO1	3	3	-	-	-	-	-	-	-	-	-	-	3	2
CO2	3	3	3	1	3	-	-	-	-	-	-	-	2	2
CO3	3	3	3	3	3	-	-	-	-	-	-	2	3	2
CO4	3	3	3	3	3	-	-	-	-	-	-	2	3	2
CO5	3	3	3	3	3	-	-	-	-	-	-	3	3	2

CI23552	SERVICE ORIENTED ARCHITECTURE	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	explain fundamentals, and key technologies of SOA and web services.
2.	learn the principles of service orientation and SOA extensions like orchestration and choreography.
3.	explore WS-* standards such as WS-Security, WS-Policy, and Reliable Messaging.
4.	understand the service life cycle, service composition, and process modelling using BPEL.
5.	gain insights into microservices, containerization, and cloud-native SOA patterns.

UNIT I	INTRODUCTION	9

Introduction: Concepts of Distributed Computing, XML, Fundamental of SOA, evolution of SOA. Web Services Fundamental and Standard: Web Services: Definition, Architectures and Standards. Directory services, SOAP, REST WSDL, UDDI.

UNIT II	SOA AND WS-* EXTENSION	9

Principles of Service-Oriented Architecture- Service- orientation and object- orientation, SOA Standards Stack, SOA with Web Services, Key Principles of SOA. SOA and WS-* Extension: Message Exchange Pattern, Coordination, Atomic Transactions, Business Activities, Orchestration, Choreography.

UNIT III	WS TECHNOLOGIES AND STANDARDS	9

WS-Addressing, WS- Reliable Messaging, WS-Policy (including WS-Policy Attachments and WS-Policy Assertions), WS-Metadata Exchange, WS-Security (including XML-Encryption, XML- Signature, and SAML).

UNIT IV	PRINCIPLES OF SERVICE-ORIENTED COMPUTING	9

RPC versus Document Orientation, Service Life Cycle, Service Creation, Service Design and Build, Service Deployment, Publish Web service using UDDI, Service Discovery, Service Selection, Service Composition, Service Execution and Monitoring, Service Termination, Service Composition and Modeling Business Processes with Business Process Execution Language (BPEL).

UNIT V	ADVANCED SOA AND MODERN ARCHITECTURAL PATTERNS	9

Introduction to Microservices Architecture – Definition of microservices, Microservices vs Monolithic Architecture, Benefits and Challenges, Design Principles and patterns - Containerization & Orchestration with Kubernetes - Cloud-Native SOA - Service Mesh Architecture.

	TOTAL PERIODS	45

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	explain the basic concepts of SOA and core web service technologies.	Understanding (K2)
CO2	describe key SOA principles and advanced coordination mechanisms in services.	Understanding (K2)
CO3	apply WS-* standards in the design and development of secure, interoperable services.	Applying (K3)

CO4	analyze the service life cycle and model composite services using BPEL.	Analyzing (K4)
CO5	compare microservices and monolithic architectures and identify modern SOA patterns.	Applying (K3)

TEXT BOOKS

1. Thomas Erl, "Service Oriented Architecture: Concepts, Technology, and Design", Pearson education, 2015.
2. Chris Richardson, "Microservices Patterns: With Examples in Java", 1st Edition, Manning Publications, 2019.

REFERENCES

1. Munindar P. Singh and Michael N. Huhns, "Service-Oriented Computing: Semantics, Processes, Agents", John Wiley & Sons, Ltd., 2005
2. Mark D. Hansen, "SOA Using Java™ Web Services".
3. Thomas Erl, "Web service contract Design & Versioning for SOA", PHI.
4. Rajbalasubhramaniam, "SOA with .NET", Prentice Hall.

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CO's	Programme Outcomes PO's												PSO's	
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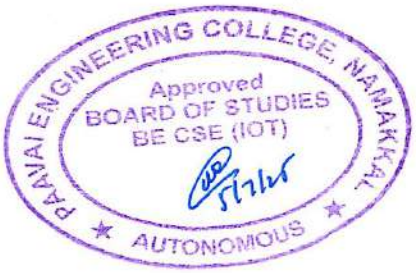
CO1	3	2	1	-	-	-	-	-	-	-	-	-	3	1
CO2	1	2	2	-	-	-	2	-	-	-	-	-	2	3
CO3	1	1	3	-	2	-	2	-	-	-	-	2	1	3
CO4	1	2	3	-	2	-	2	-	-	-	-	-	1	3
CO5	2	1	1	-	1	-	2	-	2	-	-	2	2	2



CI23553	UI AND UX DESIGN	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand to do user research, persona mapping, customer journey mapping.
2.	design of interactive products Methods of interaction design Tools for interaction design.
3.	design wireframes on paper and translate paper concepts into digital wireframes.
4.	apply and practice the techniques involved in designing digital wireframes using various UI elements.
5.	implement the process of conducting usability tests Learning steps for digital products.

UNIT I **USER-CENTERED DESIGN PROCESS** **9**

Scripting Languages - HTML, CSS - Fundamentals of graphics design, principles of visual design - Overview of UI UX Design - Overview of the UX Design Process - Difference between User Interface (UI) vs User Experience (UX) - Defining problem and vision statement - Persona creation - Primary and Secondary persona - Requirement definition - Creative ideation - Brainstorming and ideation techniques - Scenarios and functionality extraction - Information Architecture - Task flows – Wireframe design.

UNIT II **FUNDAMENTALS OF UI, HEURISTICS, AND INTERACTION DESIGN** **9**

Design Principles for UX and UI Design - UI Elements-Patterns - Material Design (Google) and Human Interface Design (Apple) guidelines - Interaction Principles Interaction Behaviour - Master the Brand Platforms Style Guides - Comments and current UI patterns - Understand problems and design solutions for e-commerce, social media, message, data, and dashboard design.

UNIT III **ELEMENTARY SKETCHING** **9**

Principles of Sketching - Core Responsive Design - Wireframing vs Wireflows - Click through Wireframing Prototyping - Wireflow Creation - Work with different tools - Figma – Low-High Fidelity Design: Inclusive Design and Designing for Accessibility - Building High-Fidelity Mockups - Designing Efficiently with Tools - Interaction Patterns – Designing animations and interactions.

UNIT IV **UNDERSTAND STYLE GUIDES, ELEMENTS, PROTOTYPING** **9**

Building a Design System - Style guides, color palette, fonts, grid, iconography, UI elements, photography or imagery, and illustration - Use of grids in UI design - Design animations and interaction patterns for key UI elements.

UNIT V **USABILITY EVALUATION AND PRODUCT DESIGN** **9**

Type of usability evaluation - Qualitative Quantitative evaluation - Guerilla testing, A/B Testing, Unmoderated remote usability testing, Card sorting, Session recording, think aloud Think aloud Introduction and advantages - Designing evaluation protocol - Conducting usability evaluation study - Conduct Usability Test explicit - Synthesize Test Findings - Practices in corporate World.

TOTAL PERIODS	**45**

COURSE OUTCOMES		
At the end of this course, students will be able to		**BT Mapped (Highest Level)**
CO1	explain the principles of user-centered design, UI vs UX, personas, and wireframe creation.	Understanding (K2)
CO2	apply design heuristics and interaction principles for different digital platforms and interface types.	Understanding (K2)
CO3	design responsive wireframes and interactive prototypes using tools like Figma while ensuring accessibility.	Applying (K3)
CO4	develop a structured design system with cohesive style guides and interaction patterns for consistent UI design.	Applying (K3)
CO5	analyze the usability through qualitative and quantitative testing techniques and synthesize findings to improve product design and user experience.	Analyzing (K4)

TEXT BOOKS

1. Norman, Donald A. The Design of Everyday Things. Basic Books, 2002. ISBN: 9780465067107.
2. Nielsen, Jakob. Usability Engineering. Morgan Kaufmann, 1993. ISBN: 9780125184069.

REFERENCES

1. Mullet, Kevin, and Darrell Sano, "Designing Visual Interfaces Communication Oriented Techniques", Prentice Hall, 1994. ISBN 9780133033892.
2. Wilbent. O. Galitz," The Essential Guide to User Interface Design", John Wiley Sons, 2001.
3. Alan Cooper, "The Essential of User Interface Design", Wiley Dream Tech Ltd.,2002.
4. Ben Sheiderman, "Design the User Interface", Pearson Education, 1998.

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	Programme Outcomes PO's												**PSO's**	
CO's	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
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CO2	2	2	3	2	2	-	-	-	-	-	-	-	2	2
CO3	2	2	2	2	3	-	-	-	-	-	-	-	2	2
CO4	2	3	2	2	1	-	-	-	-	-	-	-	2	2
CO5	2	3	3	2	1	-	-	-	-	-	-	-	2	2

CI23554	3D DESIGN PRINCIPLES AND PATTERNS	3	0	0	3

COURSE OBJECTIVES:

To enable the students to

1.	understand the fundamental concepts and sensory aspects of 3D design, including form, context, and materials.
2.	learn core elements and principles of three-dimensional design, such as form, space, balance, and rhythm.
3.	analyze various 3D fabrication techniques and the interplay of structure, utility, and style.
4.	describe digital representation methods for 3D objects and modeling, including curves, surfaces, and geometry
5.	apply transformations and viewing techniques essential for 3D graphics and interactive applications.

UNIT I	INTRODUCTION TO 3D DESIGN	9

Introduction – Form Organization – Design definition – Looking: Attentive observation, comparison, connections – Touch: Tactile sensation – Context: Shaping force, site specific – Learning – Ideas and Approaches: Process – Tools – Transformation – variation and deformation – Conceptual strategies – Problem solving – Sketching, Model making and prototyping.

UNIT II	ELEMENTS OF 3D DESIGN & PRINCIPLES	9

Form – Cube – Mass and Space – Line – Plane: 2D Element – Convention of 2D to 3D – Surface Qualities: Texture, Color – Chromatic Luminosity – Time and Motion. 3D Design Principles: Unity and Variety – Repetition: Visual and structural, Modularity – Pattern - Rhythm – Illusion of Motion – Balance - Symmetry and Asymmetry – Harmony – Proximity – Emphasis – Proportion – Scale.

UNIT III	3D FABRICATION	9

Structure: Structural Principles – Structural Economy – Tension and Compression – Joinery – Transformers-Functions: Utility – Design and compared art – Form and Functions – Style: Signature and Typology. Basic forming: Additive, Subtractive, constructive – The Found Object: Readymade – Bridging Art and Life – Hybrid Form – Industrial Methods: The Machine Aesthetic – Replication Technologies.

UNIT IV	3D OBJECT REPRESENTATIONS	9

Three Dimensional Concepts - Three-Dimensional Object Representations – Polygon Surfaces - Curved lines and surfaces, Quadric surfaces, Blobby objects, Spline Representations and Interpolation methods, Bezier and B-Spline curves and surfaces, Beta and Rational Splines, Conversion and Display. Sweep Representations - Constructive solid Geometry methods - Fractal Geometry methods.

UNIT V	3D GEOMETRIC TRANSFORMATION	9

Three Dimensional Geometric Transformations – Translation, Rotation, Scaling, Reflection, Shear, Composite Transformations, Transformation functions, Coordinate Transformations - Three-Dimensional Viewing – pipeline, coordinates, projections, volumes and projection transformations, Clipping, Viewing Functions.

	TOTAL PERIODS	45

COURSE OUTCOMES		
At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	describe 3D design, including form, tactile perception, context, and sketch-based ideation.	Understanding (K2)
CO2	explain the elements and principles of 3D design such as unity, variety, balance, rhythm, and scale.	Understanding (K2)
CO3	list and discuss various fabrication techniques and structural principles involved in 3D construction and material usage	Understanding (K2)
CO4	use geometric modeling techniques and digital tools to represent 3D objects using surfaces, curves, and forms.	Applying (K3)
CO5	analyze 3D transformations and viewing operations to evaluate and improve digital design outputs.	Analyzing (K4)

TEXT BOOKS

1. Stephen Pentak, Richard Roth, "Design Basics 3D", Cengage Learning, 8th Edition, 2013.
2. Shaun Foster, David Halbstein "Integrating 3D Modeling, Photogrammetry and Design", Springer,2014.

REFERENCES

1. Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides, "Design Patterns Elements of Reusable Object-Oriented Software" Addison Wesley, 2009.
2. Hearn Donald and Baker M. Pauline, "Computer Graphics C Version", 2nd Edition, Pearson Education,2010.
3. Samit Bhattacharya, "Computer Graphics", Oxford University Press, ISBN13:978-0-19-809619-1, 2015.
4. Dassault Systèmes, "Fundamentals of 3D Design and Simulation", SOLIDWORKS Education Edition, 2021.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	-	-	-	-	-	-	-	-	-	2	1
CO2	3	2	3	1	-	-	-	-	-	-	-	-	2	1
CO3	2	3	2	2	2	-	-	-	-	-	-	-	3	2
CO4	3	2	3	2	3	-	-	-	-	-	-	-	3	3
CO5	3	2	3	3	3	-	-	-	-	-	-	-	3	3

CI23555	CLOUD COMPUTING	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	understand the fundamental concepts and principles of Cloud Computing and its ecosystem
2.	trace the evolution of Cloud Computing from traditional and distributed computing paradigms.
3.	recognize Cloud Computing as a next-generation computing model and its deployment, service models.
4.	learn virtualization technologies and their role in cloud infrastructure.
5.	explore cloud programming models, software environments, and security governance in cloud systems.

UNIT I	INTRODUCTION TO CLOUD COMPUTING AND SYSTEM MODELS	9

Evolution of Cloud Computing – Principles of parallel and distributed computing – Cloud characteristics and elasticity – Cloud service models (IaaS, PaaS, SaaS) – Deployment models (public, private, hybrid, community clouds) – Cloud ecosystem – Computing on demand – Case Study: cloud-based AI services.

UNIT II	VIRTUALIZATION TECHNOLOGIES	9

Basics of virtualization – Types: full, para-virtualization, hardware-assisted, containerization – Implementation levels and virtualization structures – Virtualization of CPU, memory, I/O devices – Virtual clusters and resource management – Hypervisors and tools (Xen, KVM, VMware, Docker) – Virtualization for data center automation and disaster recovery - Case Study: Virtualized IoT gateway in smart agriculture.

UNIT III	CLOUD ARCHITECTURE AND INFRASTRUCTURE	9

Layered cloud architecture - NIST reference model – Compute and storage cloud infrastructure – Cloud storage models and providers - Resource provisioning and platform deployment – Quality of service, security considerations - Case Study: Cloud AI accelerators (GPU/TPU).

UNIT IV	CLOUD PROGRAMMING AND SOFTWARE ENVIRONMENTS	9

Parallel and distributed programming paradigms: MapReduce, Twister, Hadoop ecosystem – Cloud programming support and SDKs (Google App Engine, Amazon AWS) – Cloud software environments: Eucalyptus, OpenNebula, OpenStack, Aneka, CloudSim – Serverless computing and microservices architecture - Case Study: cloud ML frameworks (TensorFlow on Cloud).

UNIT V	CLOUD SECURITY AND GOVERNANCE	9

Cloud security overview – Cloud Security risks and challenges – SaaS security considerations – Security governance and risk management – Security auditing and monitoring – Data security and encryption – Application security – Identity management and access control – SLA and compliance in cloud environments - Case Study: AI-driven intrusion detection in healthcare IoT.

	TOTAL PERIODS	45

COURSE OUTCOMES		
At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	explain the fundamental concepts, characteristics, and system models of Cloud Computing.	Understanding (K2)
CO2	apply virtualization technologies and middleware concepts to design efficient cloud-based systems.	Applying (K3)
CO3	design cloud-based service models and storage solutions suitable for diverse applications.	Applying (K3)
CO4	analyze the architecture and infrastructure of cloud systems, including resource provisioning and security.	Analyzing (K4)
CO5	discuss cloud security challenges and governance mechanisms to ensure secure cloud operations.	Understanding (K2)

TEXT BOOKS

1. Rajkumar Buyya, James Broberg, and Andrzej M. Goscinski, "Cloud Computing: Principles and Paradigms", 2nd Edition, Wiley.
2. Thomas Erl, Zaigham Mahmood, Ricardo Puttini, "Cloud Computing: Concepts, Technology & Architecture", First Edition, Prentice Hall, 2013.

REFERENCES

1. Arshdeep Bahga, Vijay Madisetti, "Cloud Computing: A Hands-On Approach", 1st Edition, VPT, 2014.
2. Vishal Lall, "Virtualization and Cloud Computing with VMware", 4th Edition, Wiley, 2019.
3. Ray J. Rafaels, "Cloud Computing: From Beginning to End", 1st Edition, CreateSpace Independent Publishing Platform, 2017.
4. John W. Rittinghouse, James F. Ransome, "Cloud Computing: Implementation, Management, and Security", 3rd Edition, CRC Press, 2017.

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CO's	Programme Outcomes PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	2	-	-	-	-	-	-	2	3	3
CO2	3	3	2	2	2	-	-	-	-	-	-	2	3	2
CO3	2	2	2	-	3	1	-	-	-	-	-	2	3	2
CO4	3	2	2	2	2	2	3	-	-	-	-	2	3	2
CO5	2	3	3	3	2	2	3	-	-	-	-	3	3	3

CI23556	ARCHITECTING SMART IOT DEVICES	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the architectural overview of the Internet of Things (IoT).
2.	acquire skills on data acquisition and communication in IoT.
3.	understand the threats of IoT.
4.	understand and apply Real-Time Operating Systems (RTOS) in embedded IoT systems.
5.	use modern tools and platforms and identify IoT physical devices for various applications.

UNIT I **DESIGN PRINCIPLES OF IOT** **9**

Design principles and characteristics of connected devices – Functional blocks of IoT – IoT enabling technologies – IoT levels and deployment templates – IoT communication models and APIs – Data acquisition and management in IoT – Cloud and edge computing in IoT – System architecture and analytics.

UNIT II **PROTOTYPING THE EMBEDDED DEVICES FOR IOT** **9**

System hardware platforms – Sensors, actuators, and transducers – Device interfaces – Prototyping embedded boards (Raspberry Pi, BeagleBone Black) – Wireless sensor networks – Radio modules (Bluetooth, ZigBee, Wi-Fi) – Gateways and connectivity – Embedded software components.

UNIT III **EMBEDDED PROGRAMMING FOR IOT** **9**

Programming tools for IoT – C and Python programming for embedded systems – Interfacing peripherals – GPIO, I2C, SPI, UART – Sensor data acquisition – File handling and data logging – Case studies: Temperature controller, Smart irrigation system – Debugging and code optimization techniques.

UNIT IV **EMBEDDED RTOS** **9**

RTOS concepts – Multitasking and task scheduling – Real-time operating system (RTOS) structure – RTOS services, signals, and semaphores – Timers and interrupt handling – RTOS case studies (e.g., Nucleus SE, FreeRTOS) – Power management in RTOS-based systems.

UNIT V **TOOLS FOR IOT** **9**

Development tools: Chef, Puppet, NETCONF, YANG – IoT cloud platforms (AWS IoT, Azure IoT Hub) – Open source middleware and APIs – Physical IoT devices: pcDuino, BeagleBone, Cubieboard – Domain-specific IoT examples (Smart Home, Industrial IoT, Smart Cities) – Security and privacy in IoT.

TOTAL PERIODS **45**

COURSE OUTCOMES

At the end of this course, students will be able to		**BT Mapped (Highest Level)**
CO1	understand how the IoT is different from traditional systems.	Understanding (K2)
CO2	demonstrate the revolution of internet in mobile and cloud.	Applying (K3)
CO3	examine the architecture and operation of IoT.	Analyzing (K4)
CO4	explore various tools and programming paradigms for IoT applications	Applying (K3)
CO5	understand the building blocks of IoT and security aspects.	Understanding (K2)

TEXT BOOKS

1. Raj Kamal, "Internet of Things, Architecture and Design Principles", 1st edition, McGraw Hill Education, 2017.
2. Arsheep Baga and Vijay Madisetti, "Internet of Things: A Hands-On Approach", 1st Edition, Universities press, 2015.

REFERENCES

1. David Etter, "IoT (Internet of Things Programming): A simple and fast way of Learning IoT", Kindle edition, 2016.
2. Fei HU, "Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations", 1st Edition, CRC Press, 2016.
3. Dieter Uckelmann, Mark Harrison, Florian Michahelles, "Architecting the Internet of Things", Springer, 2011.
4. DaCosta, Francis, and Byron Henderson, "Rethinking the Internet of Things: a scalable approach to connecting everything", 1st edition, Springer Nature, 2013.

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CO's	Programme Outcomes PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	3	2	1	-	-	-	-	-	-	2	3	3
CO2	3	3	3	3	3	-	-	-	-	-	-	1	3	2
CO3	3	3	2	3	1	-	-	-	-	-	-	-	2	2
CO4	3	1	2	2	3	-	-	-	-	-	-	-	2	2
CO5	1	3	2	3	2	-	-	-	-	-	-	2	3	3

CI23557	DYNAMIC PARADIGM IN IOT	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1. explore the role of the cloud in Internet of Things deployment.
2. introduce the usage of different machine learning algorithms on IoT Data.
3. explore data analytics and data visualization on IoT Data.
4. explore design issues and working principles of security measures and various standards for secure communication in IoT.
5. develop the ability to integrate IoT with Dev-ops.

UNIT I	IOT AND CLOUD	9

Cloud Computing Concept–Grid/SOA and Cloud Computing– Cloud Middleware NIST's SPI Architecture and Cloud Standards– The Cloud of Things– The Internet of Things and Cloud Computing - The Cloud of Things Architecture–Four Deployment Models–Foundational Technological Enabler Cloud Providers and Systems – Microsoft Azure IoT–Amazon Web Services– Google's cloud IoTs.

UNIT II	IOT AND MACHINE LEARNING	9

Advantages of IoT and Machine Learning Integration– Implementation of Supervised Algorithm–Regression (Linear and Logistic) – SVM for IoT–Neural Network on case study: Agriculture and Io T– Smart Home etc. Regression–SVM.

UNIT III	IOT AND DATA ANALYTICS	9

Defining IoT Analytics–IoT Analytics challenges– IoT analytics for the cloud–Microsoft Azure overview– Strategies to organize Data for IoT Analytics– Linked Analytics Data Sets–Managing Data lakes– Dash boarding– Designing visual analysis for IoT data–creating a dashboard –creating and visualizing alerts–Study real time –case study on IoT Analytics.

UNIT IV	IOT AND IT'S SECURITY	9

Cyber security vernacular Attack and threat terms– Defense terms, Anatomy of IoT cyber-attacks – Mirai, Stuxnet–Chain Reaction, Physical and hardware security– Root of Trust–Network stack – Transport Layer Security– Software defined perimeter– Software-Defined Perimeter architecture – OWASP – Existing Security attacks and its prevention methods

UNIT V	IOT AND DEVOPS	9

Introduction to DevOps– DevOps application – business scenarios– DevOps process – Source Code Management (SCM)– Code review–Configuration Management– Build management–DevOps frameworks– DevOps maturity life cycle–DevOps maturity map– DevOps progression

	TOTAL PERIODS	45

COURSE OUTCOMES		
At the end of this course, students will be able to		**BT Mapped (Highest Level)**
CO1	identify the need for the cloud in IoT deployment and describe different Cloud provider's architecture	Understanding (K2)
CO2	use and correlate machine learning techniques on IoT Data	Understanding (K2)
CO3	apply IoT analytics and data visualization	Applying (K3)
CO4	explain the need of security measures in the Internet of Things	Understanding (K2)
CO5	apply the knowledge of Dev-ops in IoT applications	Applying (K3)

TEXT BOOKS

1. Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", CRC Publication.
2. Andrew Minteer, "Analytics for the Internet of Things (IoT)", Packt Publication 2017.

REFERENCES

1. Gautam Shroff, "Enterprise Cloud Computing", Cambridge,2010.
2. Joakim Verona, "Practical Dev-Ops", Packt Publication, 2016.
3. Raj Kamal, Internet of Things, "Architecture and Design Principles", 1st edition, McGraw Hill Education, May 2017.
4. Arsheep Baga and Vijay Madisetti, "Internet of Things: A Hands-On Approach", 1st Edition, Universities press, 2015.

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CO1	3	1	3	2	1	-	-	-	-	-	-	3	3	3
CO2	3	3	3	3	3	-	-	-	-	-	-	2	3	2
CO3	3	3	2	3	1	-	-	-	-	-	-	1	3	2
CO4	3	1	2	2	3	-	-	-	-	-	-	2	2	2
CO5	1	3	2	3	2	-	-	-	-	-	-	3	3	3

VERTICAL - VI

EMERGING TECHNOLOGIES

CI23651	IOT AUTOMATION	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	explore the evolution and impact of automation and digitization on industries and society.
2.	understand the basic principles and components of system architecture in automation.
3.	integrate and utilize an authorization service for secure communication in automation systems.
4.	integrate IoT-based solutions for efficient and intelligent automation systems.
5.	analyze the core components involved in industrial plant monitoring systems.

UNIT I	INTRODUCTION AND ARCHITECTURE	9
Towards industrial and societal automation and digitization: The need for new technology, Automation system architectures, Current trends in automations systems, Future automation system requirements, IoT and SoS, The local automation cloud approach.		
UNIT II	**THE ARROWHEAD FRAMEWORK ARCHITECTURE**	**9**
Architecture fundamentals, definitions, Documentation structure, Arrowhead Framework architecture – ServiceRegistry system, Authorization system, Orchestration system, Application systems, Deployment procedure for a local cloud, Translation system.		
UNIT III	**APPLICATION SYSTEM AND SERVICES**	**9**
Design and implementation – Introduction, Application service design - Control application design, Demo system, Implementation – simple producer, consumer, Authorization service consumer. Deployment of a local cloud, Arrowhead Framework tools.		
UNIT IV	**ENGINEERING OF IOT AUTOMATION SYSTEMS**	**9**
Introduction, Engineering of an Arrowhead compatible multi-domain facility, Component-based engineering methodology, Safety and security, Engineering scenarios - Efficient deployment of a large number of IoT sensors, PLC device monitoring.		
UNIT V	**APPLICATION SYSTEM DESIGN**	**9**
Introduction, energy optimization - Optimization's based on a virtual market of energy, Context aware streets: Maintenance - Data structure, Plant monitoring system components: High security – Introduction, Smart maintenance use case, Authentication and certification service.		
	TOTAL PERIODS	**45**

COURSE OUTCOMES		
At the end of this course, students will be able to		**BT Mapped (Highest Level)**
CO1	understand the growing need for new technologies in driving industrial and societal automation and digitization.	Understanding (K2)
CO2	understand the fundamentals of automation architecture, including key definitions and documentation structures.	Understanding (K2)
CO3	utilize Arrowhead Framework tools for efficient service registration, orchestration, and monitoring in automation systems.	Understanding (K2)
CO4	apply component-based engineering methodologies for scalable and maintainable system development.	Applying (K3)
CO5	understand energy-efficient and secure IoT application systems with smart maintenance and authentication features.	Understanding (K2)

TEXT BOOKS

1. Jerker Delsing, "IoT Automation: Arrowhead Framework", 1st Edition, CRC Press, 2017.
2. Oscar Carlsson, "Engineering of IoT Automation Systems", Lulea University of Technology, Graphic Production 2017.

REFERENCES

1. Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat, "Industrial Internet of Things: Cyber manufacturing System", 1st Edition, Springer Cham, 2016.
2. Ismail Butun, "Industrial IoT Challenges, Design Principles, Applications, and Security", 1st Edition, Springer Cham, 2021.
3. Zaigham Mahmood, Richard Hill, "The Internet of Things in the Industrial Sector", Computer Communication Networks, Springer, 2011.
4. Jonathan Katz, Yehuda Lindell, "Introduction to Modern Cryptography", second edition, Chapman & Hall Book, CRC Press, 2011.

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CO's	Programme Outcomes PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	-	1
CO2	2	1	-	-	-	-	-	-	-	-	-	1	-	1
CO3	3	2	1	-	1	-	-	-	-	-	1	1	2	1
CO4	2	1	-	-	-	-	-	-	-	-	-	1	-	1
CO5	3	2	1	-	1	-	-	-	-	-	1	1	2	1

CI23652	VIRTUAL REALITY AND AUGMENTED REALITY	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand to provide a foundational understanding of Virtual Reality, core hardware and software components and the geometry of virtual environments.
2.	analyse to explore the behavior of light, optical systems, and the physiology and perception of human vision relevant to immersive Virtual Reality experiences.
3.	apply to equip students with the knowledge of visual rendering techniques, motion perception, and tracking systems essential for building immersive and responsive Virtual Reality applications.
4.	understand and Apply the fundamentals of Augmented Reality (AR), its types, tools, technical aspects, and real-world applications using Unity, Vuforia, and ARToolkit.
5.	analyse the students in creating an interactive Augmented Reality Solar System using Unity, Vuforia, and markerless tracking techniques.

UNIT I	VIRTUAL REALITY: CONCEPTS, COMPONENTS, AND SPATIAL MODELLING	9

Introduction: define Virtual Reality- Modern VR Experiences-History Repeats; Bird's-Eye View: Hardware-Software-Human Physiology and Perception; The Geometry of Virtual Worlds: Geometric Models - Changing Position and Orientation- Axis-Angle Representations of Rotation- Viewing Transformations- Chaining the Transformations.

UNIT II	VISUAL FOUNDATIONS FOR VIRTUAL REALITY: LIGHT, OPTICS, AND HUMAN PERCEPTION	9

Light and Optics: Basic Behavior of Light- Lenses- Optical Aberrations- The Human Eye- Cameras- Displays; The Physiology of Human Vision: From the Cornea to Photoreceptors- From Photoreceptors to the Visual Cortex- Eye Movements- Implications for VR; Visual Perception: Perception of Depth- Perception of Motion- Perception of Color- Combining Sources of Information.

UNIT III	VIRTUAL REALITY SYSTEMS: RENDERING, MOTION DYNAMICS, AND TRACKING TECHNOLOGIES	9

Visual Rendering: Ray Tracing and Shading Models- Rasterization- Correcting Optical Distortions- Improving Latency and Frame Rates- Immersive Photos and Videos; Motion in Real and Virtual Worlds: Velocities and Accelerations- The Vestibular System- Physics in the Virtual World- Mismatched Motion and Vection Tracking: Tracking 2D Orientation- Tracking 3D Orientation- Tracking Position and Orientation- Tracking Attached Bodies- 3D Scanning of Environments.

UNIT IV	AUGMENTED REALITY: PRINCIPLES, TOOLS, AND APPLICATIONS	9

Augment Your World: Define augmented reality- Types of AR targets- Technical issues in relation to augmented reality - Applications of augmented reality; Setting Up Your System : Installing Unity - Introduction to Unity - Using Cameras in AR- Getting and using Vuforia - Getting and using ARToolkit

UNIT V	AR SOLAR SYSTEM: DEVELOPMENT AND DEPLOYMENT USING UNITY AND VUFORIA	9
AR Solar System: The project plan- Setting up the project - Building the earth- Building an earth-moon system - Animating the moon orbit- Orbiting the sun- Adding the other planets - Using VuMark targets (Vuforia)- Building and running - Markerless building and running.		
	TOTAL PERIODS	45

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	understand the gain of ability to explain VR concepts and apply geometric transformations to create realistic and interactive virtual worlds.	Understanding (K2)
CO2	apply the students will understand impact of VR design and will apply this knowledge to enhance realism and user comfort in virtual environments.	Analyzing (K4)
CO3	apply the students who will be able to implement efficient rendering methods, understand motion dynamics, and enhance VR interaction and realism.	Applying (K3)
CO4	apply the design and develop basic AR applications using industry-standard tools and understand the technical challenges and use cases of AR systems.	Applying (K3)
CO5	analyse how to build, animate, and deploy a complete AR-based solar system model with marker-based and markerless tracking using Vuforia and Unity.	Analyzing (K4)

TEXT BOOKS

1. Steven M. LaValle, "Virtual Reality", University of Oulu, M. LaValle 2020.
2. Jonathan Linowes, Krystian Babilinski, "Augmented Reality for Developers" Packt Publisher, 2017.

REFERENCES

1. Charles Palmer, John Williamson, "Virtual Reality Blueprints: Create compelling VR experiences for mobile", Packt Publisher, 2018.
2. Dieter Schmalstieg, Tobias Hollerer, "Augmented Reality: Principles & Practice", Addison Wesley, 2016.
3. John Vince, "Introduction to Virtual Reality", Springer-Verlag, 2004.
4. William R. Sherman, Alan B. Craig, "Understanding Virtual Reality – Interface, Application, Design", Morgan Kaufmann, 2003.

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CO1	3	2	2	1	2	-	-	-	2	2	1	2	2	1
CO2	3	2	2	1	2	-	-	-	2	2	2	3	3	1
CO3	3	2	2	2	2	-	-	-	2	2	1	2	3	2
CO4	3	3	3	2	2	-	-	-	2	2	2	3	3	2
CO5	3	3	3	2	2	-	-	-	2	3	3	3	3	3

CI23653	FOG AND EDGE COMPUTING	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	understand the concepts, architecture, and fundamentals of fog and edge computing.
2.	analyze the key components, platforms, and technologies enabling fog computing.
3.	design paradigms and programming models for fog computing.
4.	learn security, privacy, and resource management issues in fog and edge computing.
5.	apply fog computing concepts to real-world IoT and smart applications.

UNIT I	INTRODUCTION TO FOG AND EDGE COMPUTING	9

Introduction- Biological neural network – Artificial Neural Network (ANN): Basic models of ANN, Important terminologies of ANN – McCulloch-Pitts neuron – Linear separability – Hebb Network – Perceptron networks – Back Propagation Networks (BPN)- Architecture, Training Algorithm.

UNIT II	FOG COMPUTING PLATFORMS AND TECHNOLOGIES	9

Fog Computing Architecture Models - Edge Node Federation and Resource Management - IoT–Fog–Cloud System Design - Challenges in Resource Allocation, Heterogeneity - Deployment Models and Use Cases.

UNIT III	NETWORK SLICING, ORCHESTRATION, AND MIDDLEWARE	9

Fog nodes and edge devices – 5G and Network Slicing for Fog/Edge - Communication and networking protocols – Virtualization and containerization techniques - Lightweight Virtualization (Containers vs VMs) - Software Defined Networking (SDN) and NFV in Edge Computing - Orchestration and Management of Edge Nodes - Middleware Design for Fog-Edge Systems.

UNIT IV	OPTIMIZATION AND SECURITY IN FOG AND EDGE COMPUTING	9

Optimization Strategies: Placement, Scheduling, Latency - Cost and Energy Trade-offs - Predictive Analytics in Edge Environments - Data Management Models in Fog - Security threats in fog and edge environments – Data encryption, integrity, and confidentiality – Privacy-preserving mechanisms – Trust management – Authentication protocols – Resource and service orchestration - ML-Based Approaches for Intrusion Detection.

UNIT V	REAL-WORLD APPLICATIONS AND FUTURE DIRECTIONS	9

Big Data Analytics at the Edge - Healthcare Monitoring and Emergency Systems - Smart Transportation and Surveillance Applications - Edge AI and federated learning – Real-time data processing – Testing and Simulation of Fog Applications (Intro to iFogSim) - Legal and Ethical Aspects (Data Sovereignty, GDPR) - Research Trends.

	TOTAL PERIODS	45

COURSE OUTCOMES		
At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	explain the key principles and motivations of Fog and Edge computing for IoT applications	Understanding (K2)

CO2	describe Fog architectures and evaluate edge resource management and federation techniques.	Understanding (K2)
CO3	illustrate the orchestration and virtualization methods using SDN/NFV and containerized middleware	Applying(K3)
CO4	analyze performance optimization, data processing, and security strategies in Fog/Edge environments	Analyzing(K4)
CO5	summarize real-world Fog applications, testing methods, and legal/ethical considerations	Understanding (K2)

TEXT BOOKS

1. Rajkumar Buyya and Satish Narayana Srirama, "Fog and Edge Computing: Principles and Paradigms", Wiley, 2019.
2. Amir M. Rahmani et al., Fog Computing in the Internet of Things: Intelligence at the Edge, Springer, 2018.

REFERENCES

1. Flavio Bonomi et al., "Fog Computing and Its Role in the Internet of Things", MCC Workshop, 2012.
2. John W. Rittinghouse, James F. Ransome, "Cloud Computing: Implementation, Management, and Security", 3rd Edition, CRC Press, 2017.
3. Honbo Zhou, The Internet of Things in the Cloud: A Middleware Perspective, CRC Press, 2012.
4. Mahmud H., Buyya R., Ramamohanarao K., "Latency-aware Application Module Management for Fog Computing Environments", ACM Transactions, 2019.

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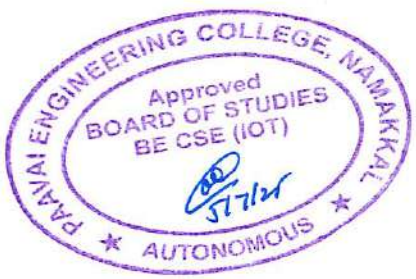
CO1	3	2	1	1	-	-	-	-	-	-	-	-	2	1
CO2	3	3	2	1	-	-	-	-	-	-	-	-	2	2
CO3	3	3	3	2	-	-	-	-	-	2	-	-	3	2
CO4	3	2	2	3	-	-	-	-	-	2	-	-	3	?
CO5	3	3	3	2	-	-	-	-	-	2	-	-	3	3



CI23654	DEEP LEARNING	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	introduce the basic concepts of machine learning.
2.	study the concepts of deep Networks.
3.	understand dimensionality reduction techniques, autoencoders, and modern convolutional network designs.
4.	study optimization methods and generalization techniques of deep learning.
5.	analyze the case studies of deep learning techniques.

UNIT I	INTRODUCTION	9

Introduction to Machine Learning - Linear models (SVMs, Perceptrons, and logistic regression) – Introduction to Neural Nets: What a shallow network computes- Training a network: loss functions, back propagation and stochastic gradient descent- Neural networks as universal function approximates.

UNIT II	DEEP NETWORKS	9

History of Deep Learning - A Probabilistic Theory of Deep Learning- Back propagation and regularization, batch normalization - VC Dimension and Neural Nets - Deep Vs Shallow Networks - Convolutional Networks - Generative Adversarial Networks (GAN), Semi-supervised Learning.

UNIT III	DIMENTIONALITY REDUCTION	9

Linear (PCA, LDA) and manifolds, metric learning - Auto encoders and dimensionality reduction in networks - Introduction to Convnet - Architectures – AlexNet, VGG, Inception, ResNet - Training a Convnet: weights initialization, batch normalization, hyper parameter optimization.

UNIT IV	OPTIMIZATION AND GENERALIZATION	9

Optimization in Deep Learning – Non-convex optimization for deep networks- Stochastic Optimization- Generalization in neural networks- Spatial Transformer Networks- Recurrent networks, LSTM – Recurrent Neural Network Language Models- Word-Level RNNs & Deep Reinforcement Learning - Computational & Artificial Neuroscience.

UNIT V	CASE STUDY AND APPLICATIONS	9

Imagenet - Detection-Audio WaveNet - Natural Language Processing Word2Vec - Joint Detection- Bioinformatics- Face Recognition- Scene Understanding- Gathering Image Captions.

	TOTAL PERIODS	45

COURSE OUTCOMES		
At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	understand the basics of machine learning and shallow neural networks	Understanding (K2)
CO2	explain deep networks of CNNs, GANs, and deep learning techniques applied in semi-supervised learning.	Understanding (K2)

CO3	use dimensionality reduction and convolutional architectures like AlexNet, VGG, ResNet	Applying (K3)
CO4	implement optimization and regularization techniques in deep learning, including RNNs and LSTM.	Applying (K3)
CO5	distinguish various case studies and its applications.	Analyzing (K4)

TEXT BOOKS

1. Cosma Rohilla Shalizi, "Advanced Data Analysis from an Elementary Point of View", 2015.
2. Deng and Yu, "Deep Learning: Methods and Applications", Now Publishers, 2013.

REFERENCES

1. Seth Weidman, "Deep Learning from Scratch", O'Reilly, 2019, ISBN: 978-9352139026
2. Anotonio Gulli, "TensorFlow 1.x Deep Learning Cookbook", Packt Publishing, 2017, ISBN: 978-1788293594.
3. Sudharsan Ravichandiran, "Hands-On Deep Learning Algorithms with Python", Packt Publishing, 2019.
4. Ian Good fellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2016.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

	Programme Outcomes PO's												PSO's	
CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	-	1	-	-	-	-	-	2	2	2
CO2	3	2	1	2	-	2	-	-	-	-	-	2	2	2
CO3	3	3	2	1	-	2	-	-	-	-	-	2	2	3
CO4	3	1	1	1	-	3	-	-	-	-	-	2	3	2
CO5	2	3	2	1	-	1	-	-	-	-	-	2	2	2

CI23655	MACHINE LEARNING TECHNIQUES	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	introduce the foundational concepts of human and machine learning, types of learning, and practical applications.
2.	know data collection, pre-processing, transformation, and dimensionality reduction in ML.
3.	develop machine learning models, their selection, training, evaluation, and tuning using proper validation methods.
4.	construct meaningful features, select relevant attributes, and manage high-dimensional data problems.
5.	introduce advanced learning paradigms such as rule-based, reinforcement, and explanation-based learning.

UNIT I	INTRODUCTION TO MACHINE LEARNING	9

Overview of Human Learning and Intelligence -- Introduction to Machine Learning: definition, scope, differences between traditional programming and machine learning - Types of Machine Learning: Supervised, Unsupervised and Reinforcement Learning – Applications of Machine Learning – Tools and Technology for Machine Learning.

UNIT II	DATA AND MODEL PREPARATION	9

Machine Learning activities: Data Collection, Preprocessing, Modeling, Evaluation - Types of Data: Qualitative and Quantitative – Structure of Data – Data quality and remediation – Data Pre-processing: Dimensionality Reduction(PCA) – Feature Sub set selection.

UNIT III	MODELLING AND EVALUATION	9

Selecting a Model: Predictive vs Descriptive Models – Supervised Learning Algorithms (Classification and Regression) - Training Techniques: Holdout method, Cross-validation, Bootstrap - Model representation and interpretability - Underfitting and Overfitting, Bias-Variance Trade-off- Evaluating Model Performance – Unsupervised Learning: Clustering.

UNIT IV	FEATURE ENGINEERING AND SELECTION	9

Feature - Feature engineering Techniques - feature Transformation – Construction and extraction - Feature selection: Issues in high-dimensional data – key drivers – measure of feature relevance and redundancy - overall feature selection process and approaches.

UNIT V	ADVANCED LEARNING	9

Regularization - L1 (Lasso), L2 (Ridge), ElasticNet – Preventing Overfitting - Convex Learning Problems and optimization – SVM and Kernel Methods – Boosting Algorithm – VC dimension – PAC Learning –Explanation Base Learning – FOCL Algorithm – Reinforcement Learning – Task – Q-Learning – Temporal Difference Learning.

	TOTAL PERIODS	45

COURSE OUTCOMES		
At the end of this course, students will be able to		**BT Mapped (Highest Level)**
CO1	explain the fundamental concepts of machine learning, types of learning paradigms, and their real-world applications.	Understanding (K2)
CO2	organize and prepare raw data through preprocessing, dimensionality reduction, and feature selection techniques.	Applying(K3)
CO3	select and train appropriate supervised or unsupervised models and evaluate model performance effectively.	Analyzing(K4)
CO4	describe engineer features and select relevant subsets from high-dimensional datasets to improve learning accuracy.	Understanding (K2)
CO5	explain core theoretical principles including PAC learning, VC dimension, reinforcement, and rule-based learning.	Understanding (K2)

TEXT BOOKS

1. I.A.Dhotre, "Machine Learning", Technical Publication, first edition, July 2021.
2. Shai Shalev, Shwartz and Shai Ben-David "Understanding Machine Learning: From Theory to Algorithms", Cambridge University press, 2014

REFERENCES

1. Elaine Rich, Kevin Knight and Shivashankar B. Nair, "Artificial Intelligence", 3rd Edition, Tata McGraw–Hill, 2019.
2. Saikat Dutt, Subramanian Chandramouli and Amit Kumar Das, "Machine Learning", 1st Edition, Pearson Education, 2019.
3. Deepak Khemani, "A First Course in Artificial Intelligence", 1st Edition, McGraw Hill Education, India, 2017.
4. Tom M. Mitchell, "Machine Learning", Indian Edition, McGraw Hill Education, 2017

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CO1	3	2	2	1	-	-	-	-	-	-	-	-	2	1
CO2	3	3	3	2	2	-	-	-	-	-	-	-	3	2
CO3	3	3	3	2	2	-	-	-	-	-	-	-	3	3
CO4	3	3	3	3	3	-	-	-	-	-	-	-	3	3
CO5	3	2	3	2	2	-	-	-	-	-	-	-	3	3

CI23656	NATURAL LANGUAGE PROCESSING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the fundamentals of language models,
2.	understand and implement word embeddings
3.	develop an understanding of deep learning architectures
4.	learn how machine translation systems work
5.	explore the ethical implications of NLP technologies

UNIT I	WORDS AND THEIR STATISTICAL MODELS	9

Regular Expressions – Words – Corpora – Text Normalization – Minimum Edit Distance. N-Gram Language Models – N-Grams – Evaluating Language Models – Generalizations and Zeros – Smoothing – Kneser-Ney Smoothing – Huge Language Models – Backoff – Perplexity Vs. Entropy. Naive-Bayes Classifiers –Naive-Bayes As Language Model – Evaluation – Test Set and Cross Validation – Statistical Significance Testing.

UNIT II	VECTORS AND EMBEDDINGS	9

Lexical Semantics – Vector Semantics – Words and Vectors – Cosine for measuring similarity – TF-IDF: weighing terms in vectors – pointwise Mutual Information (PMI) – Applications of TF-IDF and PPMI – Word2Vec – Visualizing embeddings – Bias and Embeddings – Evaluating vector models. Neural Network Language Models – Units – XOR problem – Feed Forward Neural Networks – Training Neural Nets.

UNIT III	SEQUENCE LABELING AND DEEP LEARNING ARCHITECTURES	9

English word classes –Part-of-Speech (PoS) Tagging – Named Entities and Named Entities Tagging – HMM PoS – Conditional Random Fields – Evaluation of Named Entity Recognition. Deep Learning Architectures for sequence modeling – Recurrent Neural Networks – Managing contexts in RNNs: LSTMs and GRUs

UNIT IV	MACHINE TRANSLATION (MT) AND ENCODER-DECODER MODELS	9

Language divergences and Typology – The Encode-Decoder model –Encoder-Decoder with RNNs – Attention – Beam Search – Encoder-Decoder with Transformers –Practical details on building MT systems – MT evaluation – Bias and ethical issues.

UNIT V	PRACTICAL NLP SYSTEMS	9

Question Answering: Information Retrieval – IR based Factoid Question Answering – Entity Linking – Knowledge based Question Answering – Using Language Models for Question Answering – Classic QA models – Evaluation of factoid answers. Chatbots and Dialogue systems – Chatbots – GUS: a simple frame-based dialogue system – Evaluating dialogue systems

	TOTAL PERIODS	45

COURSE OUTCOMES		
At the end of this course, students will be able to		**BT Mapped (Highest Level)**
CO1	explain formal and statistical models for word processing	Understanding (K2)
CO2	develop word vector embeddings for a given language.	Applying (K3)
CO3	utilize deep learning architectures for modeling sequences in NLP	Applying (K3)
CO4	make use of encoder-decoders models to build Machine Translation systems.	Applying (K3)
CO5	build question answering and chatbots for practical applications	Applying (K3)

TEXT BOOKS

1. Daniel Jurafsky and James H. Martin, "Speech and Language Processing", 3rd Edition, Pearson Education, New Delhi, 2020.
2. Christopher Manning and Hinrich Schuetze," Foundations of Statistical Natural Language Processing", 1st Edition, MIT Press, London, 2000.

REFERENCES

1. Richard M Reese, "Natural Language Processing with Java", O.Reilly Media. 2015.
2. Nitin Indurkhya and Fred J. Damerau, "Handbook of Natural Language Processing", Second Edition, T Chapman and Hall/CRC Press, 2010.
3. Ewan Steven Bird, Klein and Edward Loper, "Natural Language Processing with Python", First Edition, O_Reilly Media, 2009.
4. Tanveer Siddiqui, U.S. Tiwary, "Natural Language Processing and Information Retrieval", Oxford University Press, 2008.

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CO3	3	2	1	-	-	-	-	-	-	2	-	-	3	3
CO4	3	2	1	-	-	-	-	-	-	2	-	-	3	3
CO5	3	2	1	-	-	-	-	-	-	3	-	-	3	2

CI23657	SOCIAL NETWORK SECURITY	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the fundamentals of the Semantic Web and the evolution of the Social Web.
2.	learn various models and representations of social network data using semantic techniques.
3.	apply ontological frameworks to aggregate and reason over social data.
4.	explore semantic-based tools and technologies for building web applications with social features
5.	analyze and visualize scientific and community-based semantic social networks.

UNIT I	FUNDAMENTALS OF SOCIAL NETWORKING	9

Introduction to Semantic Web- Limitations of current Web- Development of Semantic Web- Emergence of the Social Web- Social Network analysis- Development of Social Network Analysis- Key concepts and measures in network analysis: The Global structure of Networks, The Macro-structure of social networks, personal networks.

UNIT II	WEB DATA AND SEMANTICS IN SOCIAL NETWORK APPLICATIONS	9

Electronic sources for network analysis: Electronic discussion networks, Blogs and online communities, Web-based networks, Knowledge Representation on the Semantic Web: Ontologies and their role in the Semantic Web- Ontology languages for the Semantic Web - Comparison to the Unified Modelling Language (UML)- The Web Ontology Language (OWL)- Comparison to the Entity/Relationship (E/R) model and the relational model

UNIT III	MODELLING AND AGGREGATING SOCIAL NETWORK DATA	9

State-of-the-art in network data representation- Ontological representation of social individuals- Aggregating and reasoning with social network data: Representing identity, On the notion of equality, determining equality, Reasoning with instance equality, Evaluating smushing, Advanced representations

UNIT IV	DEVELOPING SOCIAL-SEMANTIC APPLICATIONS	9

Building Semantic Web applications with social network features- The generic architecture- Sesame- Elmo-GraphUtil- Flink: the social networks of the Semantic Web community- openacademia: distributed, semantic-based publication management- Differences between survey methods and electronic data extraction

UNIT V	SEMANTIC-BASED SOCIAL NETWORK ANALYSIS IN THE SCIENCES	9

Methodology-Data acquisition- Representation- storage and reasoning- Visualization and Analysis- Structural and cognitive effects on scientific performance- Case studies: Ontology emergence in del.icio.us, Community-based ontology extraction from Web pages

	TOTAL PERIODS	45

COURSE OUTCOMES		
At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	understand the concepts of the Semantic Web, Social Web, and key principles of social network analysis.	Understanding (K2)
CO2	apply ontology languages (OWL, RDF) and Semantic Web principles to represent social networks.	Applying (K3)
CO3	discuss the model, aggregate process, and reason over social data using ontological representation.	Applying (K3)
CO4	develop semantic-based social web applications using tools such as Sesame, Elmo, and GraphUtil.	Applying (K3)
CO5	analyze semantic-based social network data in academic and web-based case studies.	Analyzing(K4)

TEXT BOOKS

1. Peter Mika, "Social Networks and the Semantic Web", First Edition, Springer 2007.
2. David Easley, Jon Kleinberg, "Networks, Crowds, and Markets: Reasoning about a Highly Connected World", First Edition, Cambridge University Press, 2010

REFERENCES

1. Jérôme Baton, Rik Van Bruggen, "Learning Neo4j 3.x Second Edition" Packt publishing, 2017.
2. BorkoFurht, "Handbook of Social Network Technologies and Application", First Edition, Springer, 2010.
3. Easley D. Kleinberg J., "Networks, Crowds, and Markets, Reasoning about a Highly Connected World", Cambridge University Press, 2010.
4. Jackson, Matthew O., Social and Economic Networks, Princeton University Press, 2008.

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CO3	3	3	2	3	3	-	-	-	-	2	-	-	3	2
CO4	3	2	3	2	3	-	-	-	-	2	-	-	2	3
CO5	3	2	2	2	3	-	-	-	-	2	-	-	2	2