

PAAVAI ENGINEERING COLLEGE, NAMAKKAL – 637 018

(AUTONOMOUS)

MASTER OF COMPUTER APPLICATIONS

REGULATIONS 2023

(CHOICE BASED CREDIT SYSTEM)

CURRICULUM & SYLLABUS

SEMESTER I

S.No.	Category	Course	Course Title	L	T	P	C
<b>Theory</b>							
1	FC	PMA23106	Mathematical Foundation of Computer Applications	3	1	0	4
2	PC	CA23101	Advanced Software Engineering Methodologies	3	0	0	3
3	PC	CA23102	Advanced Data Structures and Algorithms	3	0	0	3
4	PC	CA23103	Programming with Java	3	0	0	3
5	PC	CA23104	Computer Communication Networks	3	0	0	3
6	RMC	PEN23101	Research Methodologies and IPR	3	0	0	3
<b>Practical</b>							
7	PC	CA23105	Advanced Data Structures and Algorithms Laboratory	0	0	4	2
8	PC	CA23106	Programming with Java Laboratory	0	0	4	2
9	PC	PEN23102	Communication and Soft Skills Laboratory	0	0	2	1
<b>TOTAL</b>				<b>18</b>	<b>1</b>	<b>10</b>	<b>24</b>

SEMESTER II

S.No.	Category	Course	Course Title	L	T	P	C
<b>Theory</b>							
1	PC	CA23201	Internet of Things	3	0	0	3
2	PC	CA23202	Artificial Intelligence	3	0	0	3
3	PC	CA23203	Advanced Database Management Systems	3	0	0	3
4	PC	CA23204	Cloud Computing	3	0	0	3
5	PC	CA23205	Python Programming	3	0	0	3
6	PE	CA2315*	Professional Elective I	3	0	0	3
<b>Practical</b>							
7	HSC	CA23206	Advanced DBMS Laboratory	0	0	4	2
8	PC	CA23207	Internet of Things Laboratory	0	0	4	2
9	PC	CA23208	Python Programming Laboratory	0	0	4	2
<b>TOTAL</b>				<b>18</b>	<b>0</b>	<b>12</b>	<b>24</b>

## PROFESSIONAL ELECTIVES (PE)

### ELECTIVE I

S.No	Category	Course	Course Title	L	T	P	C
1	PE	CA23151	Web Design	3	0	0	3
2	PE	CA23152	Information Security	3	0	0	3
3	PE	CA23153	Mobile Application Development	3	0	0	3
4	PE	CA23154	Digital Marketing	3	0	0	3
5	PE	CA23155	Professional Ethics in IT	3	0	0	3
6	PE	CA23156	Soft Computing Techniques	3	0	0	3

### BRIDGE COURSES

(For the M.C.A Students admitted under non-Computer Science background category)

(Classes are to be conducted and completed before the start of the class of the Semester;

Examination will be conducted along with End Semester)

### SEMESTER I

S.No	Course	Course Title	L	T	P	C
1	CA23001	Problem Solving and Programming	3	0	0	3
2	CA23002	Operating Systems	3	0	0	3

### SEMESTER II

S.No	Course	Course Title	L	T	P	C
1	CA23003	Network Programming	3	0	0	3
2	CA23004	Computer Organization	3	0	0	3



**OBJECTIVES**

To enable the students to

- understand the concept of sets, relation and functions for designing and solving problems
- understand the basic concepts of combinatorics and graph theory.
- enable students to understand the concepts of Probability and Random Variables.
- apply the small / large sample tests through Tests of hypothesis.
- understand the statistical technique to design of experiments in data analysis.

**UNIT I SET THEORY 12**

Basic definitions - Venn diagrams and set operations - Laws of set theory – principle of inclusion and exclusion. Relations -Properties of relations - Matrices of relations - Closure operations on relations. Functions - Injective, surjective and bijective functions.

**UNIT II GRAPHS 12**

Graphs and graph models – Graph terminology and special types of graphs – Matrix representation of graphs and graph isomorphism – Connectivity – Euler and Hamilton paths.

**UNIT III PROBABILITY AND RANDOM VARIABLES 12**

Probability – Axioms of probability – Conditional probability – Baye's theorem – Random variables – Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Uniform and Normal distributions.

**UNIT IV TESTING OF HYPOTHESIS 12**

Sampling distributions – Type I and Type II errors – Small and Large samples – Tests based on Normal, t, Chi square and F distributions for testing of mean, variance and proportions – Tests for Independence of attributes and goodness of fit.

**UNIT V DESIGN OF EXPERIMENTS 12**

Analysis of variance - Completely randomized design - Random block design (One-way and Two-way classifications) - Latin square design.

**TOTAL PERIODS: 60**

## OUTCOMES

At the end of the course, the students will be able to

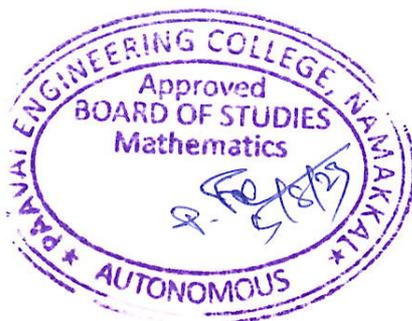
- Explain the concept of sets, relation and functions for designing and solving problems.
- Be aware of a class of functions which transform a finite set into another finite set which relates to input and output functions in computer science.
- Use the ideas of probability and random variables in solving engineering problems.
- Use statistical tests in testing hypothesis on data.
- Use the appropriate statistical technique to design of experiments in data analysis

## REFERENCE BOOKS

1. Kenneth H. Rosen, "Discrete Mathematics and its Applications", 8<sup>th</sup> Edition, McGraw-Hill Education, India, 2019.
2. Narsingh Deo, "Graph Theory with Application to Engineering and Computer Science", Prentice-Hall of India Pvt.Ltd, 2003.
3. Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, 6<sup>th</sup> Edition, (2016), John Wiley & Sons.
4. Oliver C. Ibe, "Fundamentals of Applied probability and Random Processes", Academic Press, Boston, 2014.
5. Johnson R. A. and Gupta C.B., "Miller and Freund's Probability and Statistics for Engineers", Pearson India Education, Asia, 9<sup>th</sup> Edition, New Delhi, 2017.

## CO/PO Mapping:

Mapping of Course Outcomes with Programme Outcomes (3/2/1 indicates strength of correlation) 3- Strong, 2-Medium, 1-Weak														
COs	Programmes Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	1	-	-	-	-	-	-	3	-	-
CO2	3	3	-	-	1	-	-	-	-	-	-	3	-	-
CO3	3	3	-	-	1	-	-	-	-	-	-	3	-	-
CO4	3	3	-	-	1	-	-	-	-	-	-	3	-	-
CO5	3	3	-	-	1	-	-	-	-	-	-	3	-	-



**COURSE OBJECTIVES**

To enable the students to

- impart the knowledge in the field of formal and agile methodologies
- understand the knowledge about the various components of analysis and modeling
- know the functionality of the software design
- design other components using project scheduling
- study the advances of software engineering

**UNIT I      FORMAL AND AGILE METHODOLOGIES      9**

The Nature of software- Software Engineering – Software Process Models – Prescriptive process model–Specialized process model- The Unified Process – Agile Development: Agile Process – Extreme Programming-Other Agile process

**UNIT II      REQUIREMENTS ANALYSIS AND MODELING      9**

Understanding Requirements - Requirements Modeling: Scenario Based Methods-Class Based Methods – Behavior, Patterns, Web/ Mobile Apps.

**UNIT III      SOFTWARE DESIGN      9**

Design Concepts - Architectural Design - Component Level Design - User Interface Design - Pattern Based Design – Web App Design – Mobile App Design.

**UNIT IV      REVIEW TECHNIQUES AND PROJECT SCHEDULING      9**

Review metrics and their use-informal reviews-formal technical reviews-Project scheduling - Risk management - Maintenance-Reengineering: Business Process Reengineering – Software Reengineering - Reverse Engineering –restructuring-Forward Engineering

**UNIT V      ADVANCES IN SOFTWARE ENGINEERING      9**

SPI-SPI process-CMMI-people CMM-SPI Frameworks- Technology Evolution-Observing software Engineering trends- identifying soft trends-Technology directions-Tools related trends- Software engineer's responsibility.

**TOTAL PERIODS      45**

**COURSE OUTCOMES**

At the end of the course the students would be able to

- design software process model
- understand the requirements and modeling
- understand software design
- acquire knowledge about project scheduling
- trace the execution software engineering framework

## REFERENCES

1. Roger S.Pressman, Bruce R.Maxim, "Software Engineering -A Practitioner's Approach", 8th Edition, Tata McGraw Hill, New York, 2020.
2. Pankaj Jalote, "An Integrated Approach to Software Engineering", 3rd Edition, Narosa publications, 2021.
3. Somerville Ian, "Software Engineering", 9th Edition, Pearson Education Asia, Singapore, 2021.
4. Agile Software Development: Principles, Patterns, and Practices" by Robert C. Martin.
5. The Mythical Man-Month: Essays on Software Engineering" by Frederick P. Brooks Jr.

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Mapping of Courses Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO1	1	2	3	1	1	-	-	-	-	-	-	1	1	2
CO2	1	2	3	2	3	-	-	-	-	-	3	2	1	2
CO3	1	1	3	3	2	3	-	3	-		2	1	1	3
CO4	1	1	1	1	-	3	3	3	2	3	3	3	2	2
CO5	2	2	3	3	3	-	-	-	2	-	-	2	2	2



**COURSE OBJECTIVES**

To enable the students to

- understand the linear and non linear data structures available in solving problems
- know about the sorting and searching techniques and its efficiencies
- apply the various algorithm design techniques
- import the data structures and algorithms in real time applications
- analyze the efficiency of algorithm

**UNIT I ROLE OF ALGORITHMS IN COMPUTING AND ANALYSIS 9**

Algorithms – Algorithms as a Technology -Time and Space complexity of algorithms- Asymptotic analysis-Average and worst-case analysis-Asymptotic notation-Importance of efficient algorithms- Recurrences: The Substitution Method – The Recursion- Types

**UNIT II TREE STRUCTURES 9**

Need for non-linear structures – Trees and its representation; Binary Tree – expression trees – Binary tree Traversals; left child right sibling data structures for general trees; applications of trees – Huffman Algorithm - Binary search tree.

**UNIT III BALANCED SEARCH TREES, SORTING AND INDEXING 9**

AVL trees–B-Trees; Sorting–Bubble sort - Quick Sort - Insertion Sort – Heap sort; Hashing - Hashing functions; Collision Resolution Techniques - Separate chaining - Open addressing - Multiple hashing.

**UNIT IV GRAPHS 9**

Definitions – Representation of graph; Graph Traversals - Depth-first traversal – breadth-first traversal; applications of graphs; Topological sort; shortest-path algorithms – minimum spanning tree – Prim's and Kruskal's algorithms; biconnectivity – Euler circuits.

**UNIT V ALGORITHM DESIGN TECHNIQUES 9**

Divide and Conquer – Merge Sort – Binary Search; Greedy Algorithms – Knapsack Problem; Dynamic Programming – Warshall's Algorithm for Finding Transitive Closure; Backtracking – Sum of Subset Problem; Branch and Bound – Travelling Salesman Problem.

**TOTAL PERIODS 45**

**COURSE OUTCOMES**

At the end of the course the students would be able to

- select and apply the data structure to suit any given problem
- design their own data structure according to the applications
- apply the algorithm design techniques to any of the real world problem
- develop any new application with the help of data structures and algorithms
- write efficient algorithm for a given problem and able to analyze its time complexity

## REFERENCES

1. M. A. Weiss, "Data Structures and Algorithm Analysis in C++", Pearson Education Asia, 2021.
2. Tanaenbaum A.S., Langram Y. Augestein M.J "Data Structures using C" Pearson Education
3. Anany Levitin "Introduction to the Design and Analysis of Algorithms" Pearson Education
4. E. Horowitz, S.Sahni and Dinesh Mehta, "Fundamentals of Data structures in C++", University Press, 2020.
5. Reema Thareja, "Data Structures using C", Oxford Press, 2021.

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





**COURSE OBJECTIVES**

To enable the students to

- understand an overview of oops concepts
- know the basics of constructor and inheritance concepts
- learn the knowledge in packages and threads
- develop programs in JDBC and RMI concepts
- practice the web development techniques on client-side

**UNIT I INTRODUCTION TO JAVA 9**

Introduction to java - Features of Java; Object Oriented Concepts – Lexical issues; Data Types – Variables - Arrays – Operators – Control Statements.

**UNIT II CLASSES, OBJECTS AND METHODS 9**

Classes ; Objects ; Constructors ; Overloading Methods – Access Control – Static an Fixed Methods; Inner Class – String Class; Inheritance – Overriding Methods; using Super – Abstract Class

**UNIT III PACKAGES 9**

Packages – Access Protection – Importing Packing; Interfaces – Exception Handling – Throw and Throws; Multi Threading – Synchronization – Messaging; Runnable Interface – Inter Thread Communication.

**UNIT IV JDBC AND RMI 9**

JDBC–Introduction to JDBC and its components – Implementing JDBC in Applet; Introduction to RMI- Structure of RMI – Implementing RMI.

**UNIT V APPLET AND AWT 9**

AWT package – Layouts – Containers; Event Package – Event Model; Garbage Collection; Language Packages.

**TOTAL PERIODS 45**

**COURSE OUTCOMES**

At the end of the course the students would be able to

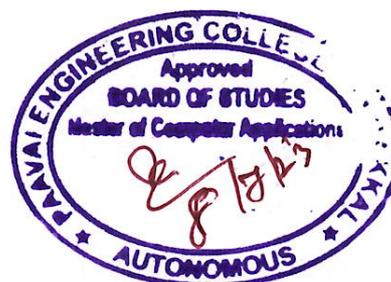
- acquire knowledge about the overview on oops concepts
- explore the basics of constructor and inheritance in of java
- learn in java packages and threads and able to develop programs
- acquire knowledge in JDBC and RMI
- design web development techniques on client-side

## REFERENCES

1. Rajkumar Buyya, S.Thamarai Selvi, Xingchen Chu, "Object-Oriented Programming with Java: Essentials and Applications", 4th Edition, Tata McGraw Hill Education Pvt. Ltd, 2021
2. Herbert Schildt , " Java: The Complete Reference ", Ninth Edition, McGraw-Hill, 2020.
3. Felipe Gutierrez, "Introducing Spring Framework: A Primer" A press, 2021.
4. P.Naughton and H.Schildt, "Java 2 (Complete Reference)" by fourth Edition.
5. Kathy Sierra & Bert Bates, "Head First Servlets & JSP" by O'Reilly publications.

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



**COURSE OBJECTIVES**

To enable the students to

- understand networking concepts and basic communication model
- study the network architectures and components required for data communication
- analyze the function and design strategy of physical, data link, network layer and transport layer
- acquire knowledge of various application protocol standard developed for internet
- learn the flow of information from one node to another node in the network

**UNIT I INTRODUCTION 9**

Data Communications – Networks – Protocols and Standards; Network Models – OSI Model – Layers – TCP/IP Protocol Suite–Addressing; Digital Transmission – Digital-to-Digital Conversion – Analog-to-Digital Conversion; Transmission Modes - Analog Transmission – Digital-to-Analog Conversion – Analog-to-analog Conversion; Transmission Media – Guided and Unguided Media.

**UNIT II DATA LINK LAYER 9**

Error – detection and correction – Parity – LRC – CRC – Hamming code – Flow Control and Error control; stop and wait – go back-N ARQ – selective repeat ARQ; sliding window – HDLC; LAN - IEEE 802.4 - IEEE 802.5 IEEE 802.11; FDDI - SONET – Bridges.

**UNIT III NETWORK LAYER 9**

Internetworks; Circuit Switching- Packet Switching and Datagram approach; IP addressing methods– Subnetting; Routing – Distance Vector Routing – Link State Routing – BGP - Routers.

**UNIT IV TRANSPORT LAYER 9**

Duties of transport layer; Multiplexing – Demultiplexing; Sockets – User Datagram Protocol (UDP) – Transmission Control Protocol (TCP); Congestion Control – Quality of services (QOS) – Integrated Services.

**UNIT V APPLICATIONS 9**

Domain Name Space (DNS) – SMTP – FTP – HTTP; WWW – Security – Cryptography.

**TOTAL PERIODS 45**

**COURSE OUTCOMES**

At the end of the course the students would be able to

- identify the components required to build different types of networks
- understand the functionalities needed for data communication into layers
- choose the required functionality at each layer for given application
- understand the working principles of various application protocols
- acquire knowledge about security issues and services available

## REFERENCES

1. Larry L. Peterson & Bruce S. Davie, "Computer Networks – A systems Approach", 4th Edition, Harcourt Asia / Morgan Kaufmann, 2020.
2. William Stallings, "Data and Computer Communications", 9th Edition, Prentice Hall, 2021.
3. Forouzan, "Data Communication and Networking", 5th Edition, TMH 2021
4. Andrew S.Tannenbaum David J. Wetherall, "Computer Networks" 5th Edition, Pearson Education 2021
5. James F. Kurose, Keith W. Ross, "Computer Networking: A Top-down Approach, Pearson Education Limited, 6th Edition, 2020

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Mapping of Courses Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO3	2	2	3	2	3	-	-	-	-		2	1	1	3
CO4	2	2	2	2	-	-	-	2	-	-	-	-	2	2
CO5	1	2	3	1	-	-	-	1	-	-	-	3	2	3



**COURSE OBJECTIVES**

To enable the students to

- understand the formulation of research problem
- learn about data collection and preparation process
- know the procedures for literature survey
- acquire knowledge on research proposals and research report writing
- be familiar about patent rights

**UNIT I RESEARCH DESIGN 9**

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

**UNIT II DATA COLLECTION AND SOURCES 9**

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

**UNIT III DATA ANALYSIS AND REPORTING 9**

Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

**UNIT IV INTELLECTUAL PROPERTY RIGHTS 9**

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Biodiversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

**UNIT V PATENTS 9**

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filing, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licenses, Licensing of related patents, patent agents, Registration of patent agents.

**TOTAL PERIODS 45**

**COURSE OUTCOMES**

At the end of the course the students would be able to

- identify the components process and design
- understand the functionalities needed for questionnaires and instruments
- choose the required hypotheses testing and measures
- understand the principles intellectual property rights
- acquire knowledge about patents

## REFERENCES

1. Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2021).
2. Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2020.
3. David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2020.
4. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2021.
5. Panneerselvam R., "Research Methodology", 2nd Edition, PHI Learning Private Limited, New Delhi, 2021.

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



**COURSE OBJECTIVES**

To enable the students to

- using the data structures and algorithms in real time applications
- analyze the efficiency of algorithm
- apply the various algorithm design techniques
- analyze the efficiency of algorithm

**LIST OF EXPERIMENTS**

1. Implementation of recursive function for tree traversal and Fibonacci
2. Implementation of Merge Sort
3. Implementation of Quick Sort
4. Implementation of Binary tree traversals
5. Heap Implementation
6. Implementation of hash functions
7. Graph Traversals
8. Spanning Tree Implementation
9. Find the Shortest Path using Dijkstra's Algorithm – Greedy method
10. Warshall's Algorithm for finding transitive closure using Dynamic programming
11. Sum of subset problem using backtracking

**TOTAL PERIODS      60**

**COURSE OUTCOMES**

At the end of the course the students would be able to

- develop any new application with the help of data structures and algorithms
- write efficient algorithm for a given problem
- analyze its time complexity of algorithms
- write backtracking algorithm for a given problem

**CO-PO MAPPING :**

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





**COURSE OBJECTIVES**

To enable the students to

- practice basics of java and String handling
- analyze the exception and multithreading
- analyze the AWT concept
- practice the Layout Manager

**LIST OF EXPERIMENTS**

1. Writing Java programs by making use of class, interface, package etc for the following
  - a. Different types of inheritance study
  - b. Uses of 'this' keyword
  - c. Polymorphism
  - d. Creation of user specific packages
  - e. User specific exception handling
2. Write programs in Java for event handling Mouse and Keyboard events.
3. Write programs in Java to manipulate Text Area, Canvas, Scroll Bars, Frames and Menus using AWT.
4. Write programs in Java using Layout Manager create different applications
5. Create an application using Java Applets.

**TOTAL PERIODS      60**

**COURSE OUTCOMES**

At the end of the course the students would be able to

- develop the static and dynamic java programs
- acquire knowledge about the exception and thread programs
- explore the features and create interactive web pages using applet
- design the Layout Manager in AWT

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



**COURSE OBJECTIVES**

To enable the students to

- develop the ability to speak English effectively
- equip the learners to make effective presentations on topics in engineering and technology
- participate successfully in group discussions
- enhance their creativity

**LIST OF EXPERIMENTS**

1. Self Introduction
2. My Day
3. Spotting the errors
4. Video profile making
5. Job Application with Resume
6. Presentation Skills
  - i. Technical Presentation
  - ii. Non - Technical Presentation
7. Group Discussion
8. Interview Skills

**TOTAL PERIODS 30**

**COURSE OUTCOMES**

At the end of the course the students would be able to

- speak effectively and confidently in English
- attend job interviews with confidence
- write effective job applications with resume
- participate in GD with involvement and confidence

**REFERENCES**

1. Rizvi, Ashraf. M. Effective Technical Communication. Tata McGraw-Hill, New Delhi.2020.
2. Anderson, P.V. "Technical Communication", Thomson Edition, New Delhi, 2020.
3. Dutt, Kiranmai P and Geetha Rajeevan, "Basic Communication Skills", Foundation Books, New Delhi. 2021.
4. Sobana.S, Manivannan. RandImmanuel.G, "Communication and Soft Skills", V K Publications, Sivakasi.2021.

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	-	-	-	-	-	2	-	-	3	3	-	-	-	-
CO2	-	-	-	3	3	-	2	2	3	-	-	-	3	-
CO3	-	-	2	1	3	-	3	3	3	3	2	3	2	3
CO4	-	-	-	2	-	2	-	3	3	3	3	-	2	2



**COURSE OBJECTIVES**

To enable the students to

- learn the basic issues, policy and challenges in the Internet
- understand the components and the protocols in Internet
- build a small low cost embedded system with the internet
- understand the various modes of communications with internet
- learn to manage the resources in the Internet

**UNIT I INTRODUCTION**

9

Definition–phases – Foundations – Policy– Challenges and Issues - identification - security –privacy  
Components in internet of things: Control Units – Sensors – Communication modules –Power Sources  
– Communication Technologies – RFID – Bluetooth – Zigbee – Wifi – Rflinks –Mobile Internet –  
Wired Communication

**UNIT II PROGRAMMING THE MICROCONTROLLER FOR IOT**

9

Basics of Sensors and actuators – examples and working principles of sensors and actuators –Cloud  
computing and IOT – Arduino/Equivalent Microcontroller platform – Setting up the board -  
Programming for IOT – Reading from Sensors Communication: Connecting microcontroller with  
mobile devices – communication through Bluetooth and USB – connection with the internet using wifi  
/ ethernet

**UNIT III RESOURCE MANAGEMENT IN THE INTERNET OF THINGS**

9

Clustering - Software Agents - Data Synchronization - Clustering Principles in an Internet of Things  
Architecture - The Role of Context- Design Guidelines -Software Agents for Object – Data  
Synchronization- Types of Network Architectures - Fundamental Concepts of Agility and Autonomy-  
Enabling Autonomy and Agility by the Internet of Things-Technical Requirements for Satisfying the  
New Demands in Production - The Evolution from the RFID-based EPC Network to an Agent based  
Internet of Things- Agents for the Behavior of Objects

**UNIT IV BUSINESS MODELS FOR THE INTERNET OF THINGS**

9

The Meaning of DiY in the Network Society- Sensor-actuator Technologies and Middleware as a Basis  
for a DiY Service Creation Framework-Device Integration - Middleware Technologies Needed for a  
DiY Internet of Things Semantic Interoperability as a Requirement for DiY Creation -Ontology- Value  
Creation in the Internet of Things -Application of Ontology Engineering in the Internet of Things-  
Semantic Web-Ontology - The Internet of Things  
in Context of EURIDICE – Business Impact

Resource-oriented Architecture and Best Practices-Designing REST ful Smart Things– Webenabling Constrained Devices - The Future Web of Things - Set up cloud environment – send data from microcontroller to cloud – Case studies – Open Source e-Health sensor platform – Be Close Elderly monitoring – Other recent projects.

TOTAL PERIODS 45

### COURSE OUTCOMES

At the end of this course the students will be able to

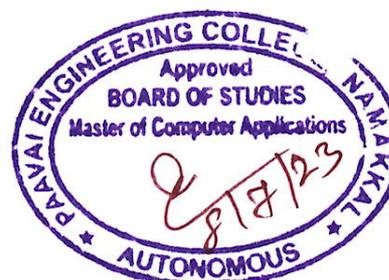
- identify the components of IOT
- design a portable IOT using appropriate boards
- program the sensors and controller as part of IOT
- develop schemes for the applications of IOT in real time scenarios
- establish the communication to the cloud through wifi / Bluetooth

### REFERENCES

1. Charalampos Doukas , Building Internet of Things with the Arduino, Create space, April 2021
2. Dieter Uckelmann et.al, “Architecting the Internet of Things”, Springer, 2021
3. Luigi Atzor et.al, “The Internet of Things: A survey, “, Journal on Networks, Elsevier Publications, October, 2020

### CO-PO MAPPING :

Mapping of Courses Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)													
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	3	2	-	-	-	-	-	-	-	1	2	2
CO2	2	2	2	3	3	-	-	-	-	-	-	2	1	2
CO3	2	2	3	2	3	-	-	-	-		2	1	1	3
CO4	1	2	3	2	-	-	-	2	-	-	-	-	2	2
CO5	2	2	1	2	-	-	-	2	-	-	-	3	2	3



**COURSE OBJECTIVES**

To enable the students to

- know about basic concepts of NLP and Machine Learning
- obtain a thorough knowledge of various knowledge representation schemes
- have an overview of various AI applications
- study about various heuristic and game search algorithms
- know about various expert systems tools and applications

**UNIT I INTRODUCTION 9**

The Foundations of Artificial Intelligence - History of AI - State of the Art - Intelligent Agents: Agents and Environments – Good Behavior – Nature of Environments - Structure of Agents.

**UNIT II PROBLEM SOLVING METHODS 9**

Problem - Solving Agents - Example Problems - Searching for Solutions - Uninformed Search Strategies – Heuristic Functions.

**UNIT III KNOWLEDGE REPRESENTATION 9**

Logic Agents: Knowledge based agents – Wumpus World - Logic - Propositional logic - Syntax and Semantic of FOL - Using FOL - Propositional vs First order inference - Unification and Lifting - Forward chaining - Backward chaining – Resolution.

**UNIT IV PLANNING 9**

Classical Planning: Definitions - Algorithms for Planning as state space search - Planning graphs - Planning and acting in the real world: Time, Schedule and Resources - Hierarchical planning - Planning and acting in Non-deterministic domain – Multiagent planning.

**UNIT V LEARNING 9**

Forms of Learning - Supervised Learning – Learning Decision Trees – Evaluating and Choosing the Best Hypothesis – Theory of Learning – Regression and Classification with Linear Models.

**TOTAL PERIODS 45**

**COURSE OUTCOMES**

At the end of the course the students would be able to

- know how to build simple knowledge-based systems
- apply knowledge representation and machine learning
- solve real world problems
- apply artificial intelligence techniques and solve real time applications
- understand the concept of game playing

## REFERENCES

1. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach (3rd ed.), Pearson Education, 2021.
2. Daugherty, Paul R., and H. James Wilson, "Human + Machine: Reimagining Work in the Age of AI", Harvard Business Review Press, 2020.
3. Joshi Prateek, "Artificial Intelligence with Python", 1st Edition, Packt Publishing Ltd, 2021.
4. R. Akerkar, Introduction to Artificial Intelligence, Prentice-Hall of India, 2020
5. Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, Prentice Hall of India, 2020.

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





**COURSE OBJECTIVES**

To enable the students to

- understand the working principles and query processing of distributed databases
- understand the basics of spatial, temporal and mobile databases and their applications
- distinguish the different types of NoSQL databases
- understand the basics of XML and create well-formed and valid XML documents
- gain knowledge about information retrieval and web search

<b>UNIT I</b>	<b>DISTRIBUTED DATABASES</b>	<b>9</b>
Distributed Systems – Introduction – Architecture – Distributed Database Concepts – Distributed Data Storage – Distributed Transactions – Commit Protocols – Concurrency Control – Distributed Query Processing		
<b>UNIT II</b>	<b>SPATIAL AND TEMPORAL DATABASES</b>	<b>9</b>
Active Databases Model – Design and Implementation Issues - Temporal Databases - Temporal Querying - Spatial Databases: Spatial Data Types, Spatial Operators and Queries – Spatial Indexing and Mining – Applications — Mobile Databases: Location and Handoff Management, Mobile Transaction Models – Deductive Databases - Multimedia Databases.		
<b>UNIT III</b>	<b>NOSQL DATABASES</b>	<b>9</b>
NoSQL – CAP Theorem – Sharding - Document based – MongoDB Operation: Insert, Update, Delete, Query, Indexing, Application, Replication, Sharding–Cassandra: Data Model, Key Space, Table Operations, CRUD Operations, CQL Types – HIVE: Data types, Database Operations, Partitioning – HiveQL – OrientDB Graph database – OrientDB Features.		
<b>UNIT IV</b>	<b>XML DATABASES</b>	<b>9</b>
Structured, Semi structured, and Unstructured Data – XML Hierarchical Data Model – XML Documents – Document Type Definition – XML Schema – XML Documents and Databases – XML Querying – XPath – XQuery		
<b>UNIT V</b>	<b>INFORMATION RETRIEVAL AND WEB SEARCH</b>	<b>9</b>
IR concepts – Retrieval Models – Queries in IR system – Text Preprocessing – Inverted Indexing – Evaluation Measures – Web Search and Analytics – Current trends.		
<b>TOTAL PERIODS</b>		<b>45</b>



## COURSE OUTCOMES

At the end of the course the students would be able to

- design a distributed database system and execute distributed queries
- manage Spatial and Temporal Database systems and implement it in corresponding applications
- use NoSQL database systems and manipulate the data associated with it
- design XML database systems and validate with XML schema
- knowledge of information retrieval concepts on web databases

## REFERENCES

1. Abraham Silberschatz, Henry F Korth, S. Sudharshan, "Database System Concepts", 7th Seventh Edition, McGraw Hill, 2021.
2. R. Elmasri, S.B. Navathe, "Fundamentals of Database Systems", 7th Edition, Pearson Education/Addison Wesley, 2020.
3. Guy Harrison, "Next Generation Databases, NoSQL, NewSQL and Big Data", 5th Edition, A press publishers, 2021
4. Jiawei Han, Micheline Kamber, Jian Pei, "Data Mining: Concepts and Techniques", 3rd Edition, Morgan Kaufmann, 2022.
5. Brad Dayley, "Teach Yourself NoSQL with MongoDB in 24 Hours", Sams Publishing, 1st Edition, 2021.

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

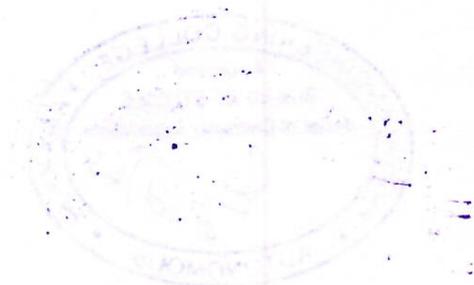


**COURSE OBJECTIVES**

To enable the students to

- introduce the broad perceptive of cloud architecture
- study the features of cloud simulator
- apply different cloud programming model as per need
- design the trusted cloud Computing system
- address the core issues of cloud computing such as security and privacy

<b>UNIT I CLOUD ARCHITECTURE AND MODEL</b>	<b>9</b>
Technologies for Network-Based System; System Models for Distributed and Cloud Computing; NIST Cloud Computing Reference Architecture; Cloud Models: Characteristics – Cloud Services – Cloud models (IAAS, PAAS, SAAS) – Public vs Private Cloud; Cloud Solutions - Cloud ecosystem – Service management; Computing on demand.	
<b>UNIT II VIRTUALIZATION</b>	<b>9</b>
Basics of Virtualization - Types of Virtualization; Implementation Levels of Virtualization – Virtualization Structures; Tools and Mechanisms; Virtualization of CPU, Memory, I/O Devices - Virtual Clusters and Resource management; Virtualization for Data-centre Automation.	
<b>UNIT III CLOUD INFRASTRUCTURE</b>	<b>9</b>
Architectural Design of Compute and Storage Clouds; Layered Cloud Architecture Development; Design Challenges; Inter Cloud Resource Management – Resource Provisioning and Platform Deployment – Global Exchange of Cloud Resources.	
<b>UNIT IV PROGRAMMING MODEL</b>	<b>9</b>
Parallel and Distributed Programming Paradigms; Map Reduce, Twister and Iterative MapReduce – Hadoop Library from Apache; Mapping Applications - Programming Support - Google App Engine, Amazon AWS; Cloud Software Environments -Eucalyptus, Open Nebula, OpenStack, Aneka, CloudSim	
<b>UNIT V SECURITY IN THE CLOUD</b>	<b>9</b>
Security Overview – Cloud Security Challenges and Risks; Software-as-a-Service Security – Security Governance – Risk Management; Security Monitoring – Security Architecture Design – Data Security – Application Security – Virtual Machine Security; Identity Management and Access Control – Autonomic Security.	
<b>TOTAL PERIODS</b>	<b>45</b>



## COURSE OUTCOMES

At the end of the course the students would be able to

- compare the strengths and limitations of cloud computing
- identify the architecture, infrastructure and delivery models of cloud computing
- apply suitable virtualization concept
- choose the appropriate cloud player, Programming Models and approach
- design Cloud Services and Set a private cloud

## REFERENCES

1. Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing, Morgan Kaufmann Publishers, 2021.
2. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management and Security", CRC Press, 2021.
3. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", TMH, 2021.
4. Kumar Saurabh, "Cloud Computing – insights into New-Era Infrastructure", Wiley India, 2021.
5. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud" O'Reilly

## CO-PO MAPPING :

Mapping of Courses Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO1	1	2	1	2	-	-	-	-	-	-	-	1	1	2
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CO3	2	2	2	2	2	-	-	-	-	-	2	1	1	3
CO4	2	1	2	2	-	-	-	2	-	-	-	-	3	2
CO5	1	2	1	2	-	-	-	2	-	-	-	2	2	2



**COURSE OBJECTIVES**

To enable the students to

- acquire knowledge in Python programming
- develop Python programs with conditionals and loops
- learn how to design and programs Python applications
- import to build dictionaries and file handling
- import to build exception and modules

**UNIT I INTRODUCTION TO PYTHON 9**

Introduction to Python – Writing our First Python Program – Data types in python- operators in python - Input and Output-Control Statements: if..else - if..elif - while – for - infinite loops - nested loops - else suite – break – continue –pass – assert – return - comment

**UNIT II FUNCTIONS 9**

Defining a Function–Function Call - Variable Scope and Lifetime – Fruitful Functions – Lambda Functions or Anonymous Functions –Arguments : Formal, Actual, Positional, Keyword, Default & Variable Length Arguments. Local and Global Variables -Recursive Functions – Function Redefinition

**UNIT III STRINGS, LISTS AND TUPLES 9**

Strings: Creating – Functions – Indexing - Slicing – Concatenation- Repetition – Membership – Comparing string – Testing Strings – Searching for substrings – Converting Strings – Stripping Whitespace Characters from a string – Formatting strings. Lists: Creating Lists – Updating - Concatenation - Repetition - Methods – Sorting- Nested Lists. Tuples: Creating - Accessing – Operations – Functions - Nested Tuples - Inserting Elements, Modifying Elements, Deleting Elements from a Tuple

**UNIT IV DICTIONARIES AND FILE HANDLING 9**

Dictionaries: Operations – Methods - Using for Loop with Dictionaries – Sorting the Elements of a Dictionary using Lambdas Introduction

Files: – Types of Files – Opening and Closing Files – Reading and Writing Files- Working with Binary Files -File Positions with Statement - seek() and tell() Methods - Random Accessing of Binary Files - Zipping and Unzipping Files-Command Line Arguments

**UNIT V EXCEPTION HANDLING AND MODULES 9**

Introduction to Errors and Exceptions – Handling Exceptions - Multiple Except Blocks– Multiple Exceptions in a Single Block – Except Block Without Exception – The else cause – Raising Exceptions – Handling Exceptions in Invoked Functions – Built – in and User Defined Exceptions- The try...finally Block – Pre-defined Clean – up Action – Modules –Namespaces - Importing Modules – Module Built-infunctions- Standard Modules: math and dir function Packages in Python – Standard Library Modules

**TOTAL PERIODS 45**

## COURSE OUTCOMES

At the end of the course the students would be able to

- problem solving and programming capability
- construct and execute basic programs in Python
- use string libraries and packages with Python
- construct and execute basic file handling in Python
- use exception and modules in Python

## REFERENCES

1. Dr. R. Nageswara Rao, Core Python Programming, 1st Edition, Dreamtech Press, 2021
2. Robert Sedgewick, Kevin Wayne, Robert Dondero - Introduction to Programming in Python: An Interdisciplinary Approach, Pearson India Education Services Pvt. Ltd., 2021.
3. Daniel Liang Y, —Introduction to Programming using Python, 2nd Edition, Pearson Education, 2021.
4. Wesley J. Chun, —Core Python Programming, 2nd Edition, Pearson Education, 2020.
5. Kenneth A. Lambert, —Fundamentals of Python: First Programs, Cengage Learning, 2020

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Mapping of Courses Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO3	2	2	2	2	2	-	-	-	-	-	2	1	1	3
CO4	2	1	2	2	-	-	-	2	-	-	-	-	3	2
CO5	1	2	1	2	-	-	-	2	-	-	-	2	2	2



**COURSE OBJECTIVES**

To enable the students to

- understand the fundamentals of data models
- understand the fundamentals of database system using ER diagram
- make a study of SQL and relational database design
- make a study of PL/SQL Triggers

**LIST OF EXPERIMENTS**

1. NOSQL Exercises
  - a MongoDB – CRUD operations, Indexing, Sharding
  - b Cassandra: Table Operations, CRUD Operations, CQL Types
  - c HIVE: Data types, Database Operations, Partitioning – HiveQL
  - d OrientDB Graph database – OrientDB Features
2. MySQL Database Creation, Table Creation, Query
3. MySQL Replication – Distributed Databases
4. Spatial data storage and retrieval in MySQL
5. Temporal data storage and retrieval in MySQL
6. Object storage and retrieval in MySQL
7. XML Databases , XML table creation, XQuery FLWOR expression
8. Mobile Database Query Processing using open source DB (MongoDB/MySQL etc)

**TOTAL PERIODS      60**

**COURSE OUTCOMES**

At the end of the course the students would be able to

- understand the concepts of the database and data models
- design a database using ER diagrams
- design a database using Relations and normalize the relations
- develop application using visual basic

**CO-PO MAPPING :**

Mapping of Courses Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO3	2	1	2	2	-	-	-	1	-	-	-	-	2	2
CO4	1	1	3	2	-	-	-	2	-	-	-	1	1	3





**COURSE OBJECTIVES**

To enable the students to

- design applications to interact with sensors
- design and develop IoT application Arduino/Raspberry pi for real world scenario
- enable communication between IoT and cloud platforms
- develop applications using Django Framework

**LIST OF EXPERIMENTS**

1. To study various IoT protocols – 6LowPAN, IPv4/IPv6, Wifi, Bluetooth, MQTT.
2. IoT Application Development Using sensors and actuators (temperature sensor, light sensor, infrared sensor)
3. To study Raspberry Pi development board and to implement LED blinking applications.
4. To develop an application to send and receive data with Arduino using HTTP request
5. To develop an application that measures the room temperature and posts the temperature value on the cloud platform.
6. To develop an application that measures the moisture of soil and post the sensed data over Google Firebase cloud platform.
7. To develop an application for measuring the distance using ultrasonic sensor and post distance value on Google Cloud IoT platform
8. Develop a simple application based on sensors.
9. Develop IoT applications using Django Framework and Firebase/ Bluemix platform.
10. Develop a commercial IoT application.

**TOTAL PERIODS 60**

**COURSE OUTCOMES**

At the end of the course the students would be able to

- understand the various IoT protocols
- test and experiment different sensors for application development
- develop applications using Arduino/Raspberry Pi/ Equivalent boards
- develop applications that would read the sensor data and post it in Cloud

**CO-PO MAPPING :**

Mapping of Courses Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO3	2	1	2	2	-	-	-	1	-	-	-	-	2	2
CO4	1	1	3	2	-	-	-	2	-	-	-	1	1	3



**COURSE OBJECTIVES**

To enable the students to

- acquire knowledge in Python programming
- develop Python programs with conditionals and loops
- learn how to design and programs Python applications
- import to build dictionaries and file handling

**LIST OF EXPERIMENTS**

1. Develop a python code to demonstrate different types of operators.
2. Develop a python code to demonstrate the use of control structures.
3. Implement the python code to demonstrate
  - a. with built-in –function
  - b. with user-defined-function
  - c. using recursion
  - d. using lambda function
4. Demonstrate the python program using Strings
5. Develop a python code to implement a built in function of Lists
6. Implement the python code to perform Dictionaries
7. Implement the python code to perform Tuples
8. Demonstrate the python program using File handling
9. Write python code to manipulate date and time using datetime module and calendar module
10. Develop a program using exception handling

**TOTAL PERIODS      60**

**COURSE OUTCOMES**

At the end of the course the students would be able to

- problem solving and programming capability
- construct and execute basic programs in Python
- use string libraries and packages with Python
- construct and execute basic file handling in Python

**CO-PO MAPPING :**

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



**COURSE OBJECTIVES**

To enable the students to

- understand the concepts and architecture of the World Wide Web
- understand and practice markup languages
- understand and practice embedded dynamic scripting on client-side Internet Programming
- understand and practice web development techniques on client-side
- understand and practice web development techniques on server-side

**UNIT I INTRODUCTION TO WWW 9**

Understanding the working of Internet-Web Application Architecture-Brief history of Internet-Web Standards – W3C-Technologies involved in Web development – Protocols-Basic Principles involved in developing a website-Five Golden Rules of Web Designing

**UNIT II UI DESIGN 9**

SVG- Iframes - HTML5 Video and Audio tags - CSS Specificity - Box model - Margins, padding and border – Inline and block elements - Structuring pages using Semantic Tags - Positioning with CSS: Positions, Floats, z-index – CSS with CSS Preprocessors: SASS

**UNIT III ADVANCED UI WITH CSS3 9**

Layouts with CSS Grids Flexbox– Responsive web design with media queries - Advanced CSS Effects – Gradients, opacity, box-shadow - CSS3 Animations: Transforms and Transitions - CSS Frameworks: Bootstrap

**UNIT IV JAVA SCRIPT 9**

JavaScript Events - Modifying CSS of elements using JavaScript- Javascript Classes- Introduction to JQuery – JQuery Selectors - Using JQuery to add interactivity - JQuery Events-Modifying CSS with JQuery -Adding and removing elements with JQuery-AJAX with JQuery-Animations with JQuery (hide, show, animate, fade methods, Slide Method)

**UNIT V SERVER-SIDE PROGRAMMING WITH PHP 9**

PHP basic syntax-PHP Variables and basic data structures-Using PHP to manage form submissions- File Handling -Cookies and Sessions with PHP-Working with WAMP and PHPMYADMIN- Establishing connectivity with MySQL using PHP

**TOTAL PERIODS 45**



## COURSE OUTCOMES

At the end of the course the students would be able to

- create a basic website using HTML and Cascading Style Sheets
- create websites with complex layouts
- add interactivity to websites using simple scripts
- design rich client presentation using AJAX
- add business logic to websites using PHP and databases

## REFERENCES

1. David Flanagan, "JavaScript: The Definitive Guide", 7th Edition, O'Reilly Publications, 2020
2. Danny Goodman, "Dynamic HTML: The Definitive Reference: A Comprehensive Resource for XHTML, CSS, DOM, JavaScript", O'Reilly Publications, 3rd Edition, 2020
3. Robin Nixon; "Learning PHP, MySQL, JavaScript & CSS: A Step-by-Step Guide to Creating Dynamic Websites", O'Reilly Publications, 2nd Edition, 2021
4. David Sawyer McFarland, "CSS: The Missing Manual", O'Reilly Publications, 4th edition, 2021
5. Keith J Grant; "CSS in Depth", Manning Publications. 1st Edition, 2021

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



**COURSE OBJECTIVES**

To enable the students to

- understand the basics of cryptography algorithms
- learn to find the vulnerabilities in programs and to overcome them,
- know the different kinds of security threats in networks and its solution
- exposed the different kinds of security threats in databases and solutions available
- study about the models and standards for security

**UNIT I ELEMENTARY CRYPTOGRAPHY 9**

Terminology and Background – Substitution Ciphers – Transpositions; Making Good Encryption Algorithms-Data Encryption Standard- AES Encryption Algorithm – Public Key Encryption; Cryptographic Hash Functions – Key Exchange – Digital Signatures – Certificates.

**UNIT II PROGRAM SECURITY 9**

Secure programs – Non-malicious Program Errors – Viruses – Targeted Malicious code – Controls Against Program Threat; Control of Access to General Objects – User Authentication – Good Coding Practices; Open Web Application Security Project Flaws – Common Weakness Enumeration Most Dangerous Software Errors.

**UNIT III SECURITY IN NETWORKS 9**

Threats in networks – Encryption – Virtual Private Networks – PKI – SSH – SSL – IPSec – Content Integrity; Access Controls – Wireless Security – Honeypots – Traffic Flow Security – Firewalls; Intrusion Detection Systems – Secure e-mail.

**UNIT IV SECURITY IN DATABASES 9**

Security requirements of database systems – Reliability and Integrity in databases; Redundancy – Recovery – Concurrency/ Consistency – Monitors – Sensitive Data; Types of disclosures – Inference-finding and confirming SQL injection.

**UNIT V SECURITY MODELS AND STANDARDS 9**

Secure SDLC – Secure Application Testing – Security architecture models; Trusted Computing Base – Bell- LaPadula Confidentiality Model; Biba Integrity Model – Graham-Denning Access Control Model – Harrison -Ruzzo-Ulman Model; Secure Frameworks – COSO – COBIT – Compliances – PCI DSS; Security Standards - ISO 27000 family of standards – NIST.

**TOTAL PERIODS 45**

## COURSE OUTCOMES

At the end of the course the students would be able to

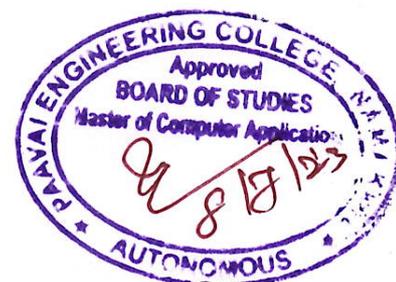
- apply cryptographic algorithms for encrypting and decryption for secure data transmission
- understand the importance of digital signature for secure e-documents exchange
- understand the program threats and apply good programming practice
- get the knowledge about the security services available for internet and web applications
- understand data vulnerability and trusted computing

## REFERENCES

1. Amerding, T (2021) 'The 15 worst data security breaches of the 21st Century', CSO, 15.
2. Itami, H. and Roehl, T. (2020) Mobilizing Invisible Assets, Harvard, Harvard University Press.
3. Pew Research Center (2021) the State of the News Media 2021.
4. Protalinski, E. (2021) 'Belgian rail firm SNCB Europe sees 1.5m customer details leaked, but fails to take responsibility'.
5. The Art of Deception: Controlling the Human Element of Security" by Kevin D. Mitnick and William L. Simon

## CO-PO MAPPING :

Mapping of Courses Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO4	2	2	2	2	-	-	-	3	-	-	-	-	2	2
CO5	1	2	1	3	-	-	-	2	-	-	-	2	2	3





**COURSE OBJECTIVES**

To enable the students to

- understand the need and characteristics of mobile applications
- design the right user interface for mobile applications
- understand the design issues in the development of mobile applications
- understand the development procedure for mobile applications
- develop mobile applications using various tools and platforms

<b>UNIT I INTRODUCTION</b>	<b>9</b>
Mobile Application Model – Infrastructure and Managing Resources – Mobile Device Profiles – Frameworks and Tools	
<b>UNIT II USER INTERFACE</b>	<b>9</b>
Generic UI Development - Multimodal and Multichannel UI –Gesture Based UI – Screen Elements and Layouts – Voice XML.	
<b>UNIT III APPLICATION DESIGN</b>	<b>9</b>
Memory Management – Design Patterns for Limited Memory – Workflow for Application development – Java API – Dynamic Linking – Plugins and rule of thumb for using DLLs – Multithreading in Java - Concurrency and Resource Management.	
<b>UNIT IV MOBILE OS</b>	<b>9</b>
Mobile OS: Android, iOS – Android Application Architecture – Understanding the anatomy of a mobile application - Android basic components –Intents and Services – Storing and Retrieving data – Packaging and Deployment – Security and Hacking.	
<b>UNIT V APPLICATION DEVELOPMENT</b>	<b>9</b>
Communication via the Web – Notification and Alarms – Graphics and Multimedia: Layer Animation, Event handling and Graphics services – Telephony – Location based services	
<b>TOTAL PERIODS</b>	<b>45</b>

**COURSE OUTCOMES**

At the end of the course the students would be able to

- understand the basics of mobile application development frameworks and tools
- develop a UI for mobile applications
- design mobile applications that manage memory dynamically
- build applications based on mobile OS like Android, iOS
- build location based services

## REFERENCES

1. Reto Meier, Ian Lake, "Professional Android", 4th Edition, Wrox, 2020.
2. Zigurd Mednieks, Laird Dornin, G. Blake Meike, Masumi Nakamura, "Programming Android", O'Reilly, 2nd Edition, 2021.
3. Alasdair Allan, "Learning iOS Programming", O'Reilly, 3rd Edition, 2021.
4. Bill Phillips, Chris Stewart, Brian Hardy, and Kristin Marsicano, Android Programming: The Big Nerd Ranch Guide, 4th Edition, 2021.
5. Christian Keur, Aaron Hillegass, iOS Programming: The Big Nerd Ranch Guide, 6th Edition, O'Reilly, 2020.

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



**COURSE OBJECTIVES**

To enable the students to

- understand the difference between Traditional Marketing and digital Marketing
- understand and analyze the search engine functions
- develop a deep knowledge about the Digital marketing platforms
- analyze inbuilt tools for digital Marketing
- develop the theoretical aspects of creating a website

<b>UNIT I INTRODUCTION TO DIGITAL MARKETING</b>	<b>9</b>
What is Digital Marketing- Need of Digital Marketing-Digital Marketing Platforms – Understanding digital marketing process- Difference between Traditional Marketing and digital Marketing- tools of Digital marketing - Advantage of Digital Marketing-Digital Marketing Manager Role and functions - How we use both Digital & Traditional Marketing	
<b>UNIT II WEBSITE &amp; SEARCH ENGINE</b>	<b>9</b>
Website –Hosting and Domain– Different platforms for website creation- Introduction to SERP-What are search engines- How search engines work- Major functions of a search engine- What are keywords -Different types of keywords- Google keyword planner tool.	
<b>UNIT III MISC TOOLS- GOOGLE WEBMASTER TOOLS</b>	<b>9</b>
Site Map Creators- Browser-based analysis tools-Page Rank tools-pinging & indexing tools- Dead links identification tools- Open site explorer Domain information/ whois tools- Quick sprout	
<b>UNIT IV LEAD MANAGEMENT &amp; DIGITAL MARKETING</b>	<b>9</b>
Web to lead forms- Web to case forms- Lead generation techniques- Leads are everywhere- Social media and lead gen Inbuilt tools for Digital Marketing- Ip Tracker- CPC reduction (in case of paid ads) Group posting on Social Media platforms	
<b>UNIT V TRENDING DIGITAL MARKETING SKILLS</b>	<b>9</b>
Search- Engine Optimization (SEO)-Search Engine Marketing(SEM).-Social Media Marketing/Optimization- Email Marketing. Website : Product Marketing- Content Writing. Marketing the created content online Copywriting- Blogging- Local Marketing. Google Ad Words - Campaign Management- PPC Advertising- Affiliate Marketing. Mobile and SMS Marketing- Marketing Automation-Web Analytics- Growth Hacking	
<b>TOTAL PERIODS</b>	<b>45</b>



## COURSE OUTCOMES

At the end of the course the students would be able to

- gain insight on the concept of digital marketing and the role of a digital manager
- understand and administer the website and the search engines
- understand how to use MISC and Google Webmaster tools
- understand the concepts of lead management and digital marketing
- gain knowledge on the latest digital marketing trends

## REFERENCES

1. Chaffey, D. (2021). Digital marketing strategy, Implementation and Practice. Pearson
2. Chaffey, D., & Smith, P. R. (2020). Digital marketing excellence: planning, optimizing and integrating online marketing. Taylor & Francis.
3. Kaufman, I., & Horton, C. (2020). Digital marketing: Integrating strategy and tactics with values.
4. Royle, J., & Laing, A. (2020). The digital marketing skills gap: Developing a Digital Marketer Model for the communication industries.
5. Dodson, I. (2021). The art of digital marketing: the definitive guide to creating strategic, targeted, and measurable online campaigns. John Wiley & Sons.

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



**COURSE OBJECTIVES**

To enable the students to

- understand the concepts of computer ethics in the work environment
- understand the threats in computing environment
- understand the intricacies of accessibility issues
- ensure safe exits when designing the software projects
- analyze the social networking concept

**UNIT I INTRODUCTION TO ETHICS**

9

Definition of Ethics- Right, Good, Just- The Rational Basis of Ethics -Theories of Right: Intuitionist vs. End-Based vs. Duty-Based -Rights, Duties, Obligations -Theory of Value - Conflicting Principles and Priorities -The Importance of Integrity -The Difference Between Morals, Ethics, and Laws -Ethics in the Business World - Corporate Social Responsibility - Creating an Ethical Work Environment -Including Ethical Considerations in Decision Making

**UNIT II ETHICS IN INFORMATION TECHNOLOGY, INTERNET CRIME**

9

IT Professionals - Are IT Workers Professionals- Professional Relationships That Must Be Managed - Professional Codes of Ethics - Professional Organizations - Certification - IT Professional Ethics, Three Codes of Ethics, Management Conflicts. The Reveton Ransomware Attacks -IT Security Incidents: A Major Concern - Why Computer Incidents Are So Prevalent - Types of Exploits -Types of Perpetrators-Federal Laws for Prosecuting Computer Attacks- Implementing Trustworthy Computing -Risk Assessment - Establishing a Security Policy - Educating Employees and Contract Workers

**UNIT III FREEDOM OF EXPRESSION, PRIVACY**

9

First Amendment Rights -Obscene Speech-Defamation -Freedom of Expression: Key Issues - Controlling Access to Information on the Internet -Strategic Lawsuit Against Public Participation (SLAPP)-Anonymity on the Internet-Hate Speech- Privacy Protection and the Law- Information Privacy- Privacy Laws, Applications, and Court Rulings-Key Privacy and Anonymity Issues- Data Breaches -Electronic Discovery- Consumer Profiling- Workplace Monitoring -Advanced Surveillance Technology

**UNIT IV FREEDOM OF EXPRESSION, INTELLECTUAL PROPERTY RIGHTS**

9

Intellectual Property Rights-Copyrights-Copyright Term - Eligible Works -Fair Use Doctrine - Software Copyright Protection -Copyright Laws and the internet-Copyright and Piracy-Patents- -Software Patents - Cross-Licensing Agreements -Trade Secrets-Trade Secret Laws -Employees and Trade Secrets-Key Intellectual Property Issues-Plagiarism -Reverse Engineering-Open Source Code- Competitive Intelligence - Trademark Infringement -Cyber squatting

**UNIT V SOCIAL NETWORKING ETHICS AND ETIQUETTES**

9

Social Networking Web Site- Business Applications of Online Social Networking-Social Network Advertising-The Use of Social Networks in the Hiring Process-Social Networking Ethical Issues -Cyber bullying- Online Virtual Worlds-Crime in Virtual Worlds-Educational and Business Uses of Virtual Worlds

**TOTAL PERIODS 45**

## COURSE OUTCOMES

At the end of the course the students would be able to

- examine situations and to internalize the need for applying ethical principles, values to tackle various situations
- develop a responsible attitude towards the use of computers as well as the technology
- envision the societal impact on the products/ projects they develop in their career
- understand the code of ethics and standards of computer professionals
- analyze professional responsibility and empower access to information in the workplace

## REFERENCES

1. Caroline Whitback, "Ethics in Engineering Practice and Research", Cambridge University Press, 2nd Edition 2021.
2. George Reynolds, "Ethics in Information Technology", Cengage Learning, 6th Edition 2018.
3. Barger, Robert. (2020). Computer ethics: A case-based approach. Cambridge University Press 1st Edition.
4. John Weckert and Douglas Adeney, Computer and Information Ethics, Greenwood Press, First Edition 2020.
5. Penny Duquenoy, Simon Jones and Barry G Blundell, "Ethical, legal and professional issues in computing", Middlesex University Press, First Edition 2020.

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



**COURSE OBJECTIVES**

To enable the students to

- gain knowledge of soft computing theories and its fundamentals
- design a soft computing system required to address a computational task
- learn and apply artificial neural networks, fuzzy sets and fuzzy logic and genetic algorithms in problem solving and use of heuristics based on human experience
- introduce the ideas of fuzzy sets, fuzzy logic and to become familiar with neural networks that can learn from available examples and generalize to form appropriate rules for inferencing systems
- familiarize with genetic algorithms and other random search procedures while seeking global optimum in self – learning situations

**UNIT I FUZZY COMPUTING**

8

Basic Concepts of Fuzzy Logic, Fuzzy Sets and Crisp Sets, Fuzzy Set Theory and Operations, Properties of Fuzzy Sets, Fuzzy and Crisp Relations, Fuzzy to Crisp Conversion Membership Functions, Interference in Fuzzy Logic, Fuzzy If – Then Rules, Fuzzy Implications and Fuzzy Algorithms, Fuzzification and Defuzzification, Fuzzy Controller, Industrial Applications.

**UNIT II FUNDAMENTALS OF NEURAL NETWORKS**

9

Neuron, Nerve Structure and Synapse, Artificial Neuron and its Model, Activation Functions, Neural Network Architecture: Single Layer and Multilayer Feed Forward Networks, Recurrent Networks. Various Learning Techniques; Perception and Convergence Rule, Auto-Associative and Hetero-Associative Memory

**UNIT III BACKPROPAGATION NETWORKS**

10

Back Propagation Networks) Architecture: Perceptron Model, Solution, Single Layer Artificial Neural Network, Multilayer Perceptron Model; Back Propagation Learning Methods, Effect of Learning Rule Co – Efficient ;Back Propagation Algorithm, Factors Affecting Backpropagation Training, Applications

**UNIT IV COMPETITIVE NEURAL NETWORKS**

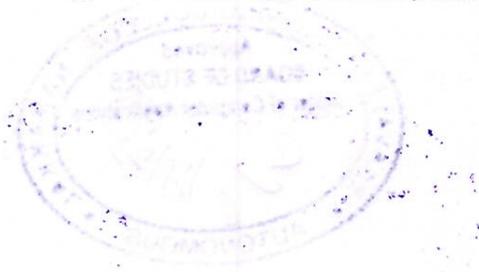
9

Kohonen's Self Organizing Map – SOM Architecture, learning procedure – Application; Learning Vector Quantization – learning by LVQ; Adaptive Resonance Theory – Learning procedure – Applications.

**UNIT V GENETIC ALGORITHM**

9

Basic Concepts, Working Principle, Procedures of GA, Flow Chart of GA, Genetic Representations, (Encoding) Initialization and Selection, Genetic Operators, Mutation, Generational Cycle, Applications

**TOTAL PERIODS 45**

## COURSE OUTCOMES

At the end of the course the students would be able to

- identify and describe soft computing techniques and their roles in building intelligent machines
- recognize the feasibility of applying a soft computing methodology for a particular problem
- apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems
- apply genetic algorithms to optimization problems
- design neural networks to pattern classification and regression problems using a soft computing approach

## REFERENCES

1. J.S.R. Jang, C.T. Sun and E. Mizutani, "Neuro – Fuzzy and Soft Computing", Pearson Education, 2020.
2. S. Rajasekaran and G.A. VijayalakshmiPai, "Neural Networks, Fuzzy Systems and Evolutionary Algorithms: Synthesis and Applications", PHI Learning, 2nd Edition, 2021.
3. S. N. Sivanandam, S. N. Deepa, "Principles of Soft Computing", Third Edition, Wiley, 2020.
4. Simon Haykin, "Neural Networks and Learning Machines", Pearson, 3rd Edition, 2020.
5. Timothy Ross, "Fuzzy Logic with Engineering Applications", Wiley Publications, 4th Edition 2021.

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





## BRIDGE COURSES

### SEMESTER I

CA23001

PROBLEM SOLVING AND PROGRAMMING

3 0 0 3

#### COURSE OBJECTIVES

To enable the students to

- understand the programming concepts
- learn the programming paradigms
- gain the concept of problem solving techniques
- design the programming fundamentals
- learn the recursive programming paradigms

#### UNIT I INTRODUCTION TO PROGRAMMING 9

Introduction to computing – building blocks for simple programs – problem to program – Decision structures – loop structures – problem analysis – programming style – documentation and testing.

#### UNIT II PROGRAMMING PARADIGMS 9

Procedural – functional – recursive – rule-based – structured programming.

#### UNIT III PROBLEM SOLVING TECHNIQUES 9

Programming life cycle phases – problem solving – implementation – maintenance – pseudo code representation – flow charts - algorithms – algorithmic efficiency – complexity of algorithms.

#### UNIT IV C PROGRAMMING FUNDAMENTALS 9

Structured program development – Data types – operators – expressions – control flow – arrays and pointers – functions – Input – output statements – storage classes.

#### UNIT V ADVANCED FEATURES 9

Strings - Recursion – structures – unions – bit manipulations – enumerations – file processing – fundamental data structures.

**TOTAL PERIODS 45**

#### COURSE OUTCOMES

At the end of the course the students would be able to

- recognize the basics of programming concepts
- Develop a structured programming
- envision the societal impact on the problem solving techniques
- understand the code of C programs
- analyze the advanced concepts of C programs

## REFERENCES

1. Kernigan Brian W., and Dennis M. Ritchie, "The C Programming Language", Second Edition, Prentice Hall, 2021.
2. Deitel and Deitel, "C How to program", Prentice Hall, 2021.
3. Cormen, Leiserson, Rivest, Stein "Introduction to algorithms", McGraw Hill publishers, 2022

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



**COURSE OBJECTIVES**

To enable the students to

- understand the operating system concepts
- learn the process synchronization
- gain the concept of memory management
- understand the concept of disk scheduling
- learn the operating system case studies

<b>UNIT I INTRODUCTION</b>	<b>9</b>
Introduction – Operating Systems and services – Processes – CPU Scheduling approaches	
<b>UNIT II PROCESS SYNCHRONIZATION</b>	<b>9</b>
Process synchronization – Semaphores – Deadlocks – Handling deadlocks – Multithreading	
<b>UNIT III MEMORY MANAGEMENT</b>	<b>9</b>
Memory management – Paging – Segmentation – Virtual Memory – Demand paging – Replacement Algorithms	
<b>UNIT IV DISK SCHEDULING</b>	<b>9</b>
Disk Scheduling approaches – File systems – Design issues – User interfaces to file systems – I/O device management.	
<b>UNIT V CASE STUDIES</b>	<b>9</b>
Case study – Design and implementation of the UNIX OS, Process model and structure – Memory management – File system – UNIX I/O management and device drivers – Windows – System components – Process Management – Memory management – File Systems – Networking	
<b>TOTAL PERIODS</b>	<b>45</b>

**COURSE OUTCOMES**

At the end of the course the students would be able to

- apply the fundamentals of operating systems
- develop the process synchronization
- design the paging and segmentation
- demonstrate the disk scheduling algorithms
- analyze the Unix I/O management

## REFERENCES

1. Abraham Silberschatz Peter B. Galvin, G. Gagne, "Operating System Concepts", Sixth Edition, Addison Wesley Publishing Co., 2021.
2. M. J. Bach, "Design Of The Unix Operating System", Pearson Education.
3. Willam-Stalling "Operating System" Fourth Edition, Pearson Education, 2021.

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



**COURSE OBJECTIVES**

To enable the students to

- understand interprocess and inter-system communication
- study the socket programming in its entirety
- analyze the usage of TCP/UDP / Raw sockets
- acquire knowledge of Socket Options
- learn the UDP sockets

<b>UNIT I INTRODUCTION</b>	<b>9</b>
Overview of UNIX OS - Environment of a UNIX process - Process control – Process relationships Signals – Interprocess Communication- overview of TCP/IP protocols	
<b>UNIT II ELEMENTARY TCP SOCKETS</b>	<b>9</b>
Introduction to Socket Programming –Introduction to Sockets – Socket address Structures – Byte ordering functions – address conversion functions – Elementary TCP Sockets – socket, connect, bind, listen, accept, read, write , close functions – Iterative Server – Concurrent Server.	
<b>UNIT III APPLICATION DEVELOPMENT</b>	<b>9</b>
TCP Echo Server – TCP Echo Client – Posix Signal handling – Server with multiple clients – boundary conditions: Server process Crashes, Server host Crashes, Server Crashes and reboots, Server Shutdown – I/O multiplexing – I/O Models – select function – shutdown function – TCP echo Server (with multiplexing) – poll function – TCP echo Client (with Multiplexing)	
<b>UNIT IV SOCKET OPTIONS</b>	<b>9</b>
Socket options – getsockopt and setsockopt functions – generic socket options – IP socket options – ICMP socket options – TCP socket options	
<b>UNIT V ELEMENTARY UDP SOCKETS</b>	<b>9</b>
Elementary UDP sockets – UDP echo Server – UDP echo Client – Multiplexing TCP and UDP sockets	
<b>TOTAL PERIODS</b>	<b>45</b>

**COURSE OUTCOMES**

At the end of the course the students would be able to

- identify the components of network model
- develop the TCP sockets
- design the required functionality of signals
- understand the working principles of socket options
- acquire knowledge about UDP sockets

## REFERENCES

1. W. Richard Stevens, B. Fenner, A.M. Rudoff, "Unix Network Programming – The Sockets Networking API", 3rd edition, Pearson, 2020.
2. W. Richard Stevens, S.A Rago, "Programming in the Unix environment", 2nd edition, Pearson, 2021.

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



**COURSE OBJECTIVES**

To enable the students to

- impart the knowledge in the field of digital fundamentals
- understand the knowledge about the various components of a computer and its internals
- know the functionality of the computer hardware with basic gate
- design other components using combinational and sequential logic
- study the importance of the hardware-software interface

<b>UNIT I</b>	<b>DIGITAL FUNDAMENTALS</b>	<b>9</b>
Number Systems and Conversions – Boolean Algebra and Simplification – Minimization of Boolean Functions – Karnaugh Map, Logic Gates – NAND – NOR Implementation.		
<b>UNIT II</b>	<b>COMBINATIONAL AND SEQUENTIAL CIRCUITS</b>	<b>9</b>
Design of Combinational Circuits – Adder / Subtractor – Encoder – Decoder – MUX / DEMUX – Comparators, Flip Flops – Triggering – Master – Slave Flip Flop – State Diagram and Minimization – Counters – Registers.		
<b>UNIT III</b>	<b>BASIC STRUCTURE OF COMPUTERS</b>	<b>9</b>
Functional units – Basic operational concepts – Bus structures – Performance and Metrics – Instruction and instruction sequencing – Hardware – Software Interface – Addressing modes – Instructions – Sets – RISC and CISC – ALU design – Fixed point and Floating point operation.		
<b>UNIT IV</b>	<b>PROCESSOR DESIGN</b>	<b>9</b>
Disk Processor basics – CPU Organization – Data path design – Control design – Basic concepts – Hard wired control – Micro programmed control – Pipeline control – Hazards – Super scalar operation.		
<b>UNIT V</b>	<b>MEMORY AND I/O SYSTEM</b>	<b>9</b>
Memory technology – Memory systems – Virtual memory – Caches – Design methods – Associative memories – Input/Output system – Programmed I/O – DMA and Interrupts – I/O Devices and Interfaces.		
<b>TOTAL PERIODS</b>		<b>45</b>

**COURSE OUTCOMES**

At the end of the course the students would be able to

- design digital circuits by simplifying the boolean functions
- understand the organization and working principle of computer hardware components
- understand mapping between virtual and physical memory
- acquire knowledge about multiprocessor organization and parallel processing
- trace the execution sequence of an instruction through the processor

## REFERENCES

1. Morris Mano, "Digital Design", Prentice Hall of India, 2021.
2. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, Firth Edition, "Computer Organization", Tata McGraw Hill, 2020.
3. William Stallings, "Computer Organization and Architecture – Designing for Performance", Sixth Edition, Pearson Education, 2020.

## CO-PO MAPPING :

Mapping of Courses Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)													
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	3	2	-	-	-	-	-	-	-	1	2	2
CO2	1	2	2	2	3	-	-	-	-	-	-	2	1	2
CO3	2	2	1	2	2	-	-	-	-	-	2	2	2	2
CO4	2	1	2	2	-	-	-	1	-	-	-	-	2	2
CO5	1	1	3	2	-	-	-	2	-	-	-	1	1	3

