M.E. Degree

in

COMPUTER SCIENCE AND ENGINEERING

CURRICULUM & SYLLABUS (CBCS)

(For students admitted from the Academic Year 2022-2023)

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

St. XAVIER'S CATHOLIC COLLEGE OF ENGINEERING

CHUNKANKADAI, NAGERCOIL – 629 003.

KANYAKUMARI DISTRICT, TAMIL NADU, INDIA

St. Xavier's Catholic College of Engineering

VISION
To be an institution of eminence of optimal human development, excellent engineering education and pioneering research towards developing a technically-empowered humane society
MISSION
To transform the (rural) youth into top class professionals and technocrats willing to serve local and global society with ethical integrity, by providing vibrant academic experience of learning, research and innovation and stimulating opportunities to develop personal maturity and professional skills, with inspiring and high caliber faculty in a quality and serene infrastructural environment

Inconsonance to the vision of our College,

An engineering graduate we form would be a person with optimal human development, i.e. physical, mental, emotional, social and spiritual spheres of personality. He/she would be an ethical, social responsible and patriotic person.

Academically, he/ she would acquire enhanced knowledge in cutting edge technologies he/she would adapt to new technologies and solve problems that the society is in need of. Also they would serve the industry in middle or upper-level management.

He/she would carry out research and development work to solve practical problems and present it as a technical report. He/she would own his/her own organization/industry and become entrepreneur in his/her specialized area of interest.

As he/she would possess leadership, management skills, critical thinking, problem solving skills and good communication ability he/she would opt for teaching profession and create better engineers to serve the society.

I. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

I	Develop proficiency as a computer science engineer with an ability to solve a wide range of computational problems and have sustainable development in industry or any other work environment.
II	Analyze and adapt quickly to new environments and technologies, gather new information, and work on emerging technologies to solve multidisciplinary engineering problems.
III	Possess the ability to think analytically and logically to understand technical problems with computational systems for a lifelong learning which leads to pursuing research.
IV	Adopt ethical practices to collaborate with team members and team leaders to build technology with cutting edge technical solutions for computing systems.
V	Model a computer based automation system and design algorithms that explore the understanding of the tradeoffs involved in digital transformation.

II. PROGRAMME OUTCOMES (POs)

PO#	Programme Outcomes
1	An ability to independently carry out research/investigation and development work to solve practical problems.
2	An ability to write and present a substantial technical report/document.
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
4	Efficiently design, build and develop system application software for distributed and centralized computing environments in varying domains and platforms.
5	Design solutions for real world problems by communicating and effectively working with professionals in various engineering fields.
6	Pursue research orientation for a lifelong professional development in computer and automation arenas.

PEO's – PO's MAPPING:

PEO	PROGRAMME OUTCOMES					
	1	2	3	4	5	6
I	3	-	3	3	2	1
II	3	-	2	3	2	-
III	3	-	2	2	1	3
IV	1	2	-	2	2	-
V	2	-	-	1	-	-

PROGRAMME ARTICULATION MATRIX

Year	Sem	Course Code	PO					
			1	2	3	4	5	6
I	I	MA22102	3	-	1	-	2	-
		CP22101	3	3	-	-	-	-
		CP22102	2	2	2	2	2	1
		RM22101	-	2	3	-	-	2
		CP22103	3	3	1	-	-	-
		CP22104	3	3	2	-	-	3
I	II	CP22201	2	2	2	2	1	1
		CP22202	2	1	2	1	2	2
		CP22203	2	3	-	2	2	1
		CP22204	3	2	3	-	-	-
		CP22205	3	3	-	3	-	-
		RM22201	2	-	3	3	-	-
II	III	CP22301	2	3	3	3	2	3
		CP22302	3	3	3	3	3	-
II	IV	CP22401	3	3	3	3	3	3

CURRICULUM

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY COURSES								
1.	MA22102	Applied Probability and Statistics for Computer Engineers	FC	3	1	0	4	4
2.	CP22101	Advanced Data Structures and Algorithms	PCC	3	0	0	3	3
3.		Professional Elective I	PEC	3	0	0	3	3
4.	RM22101	Research Methodology	RMC	2	0	0	2	2
THEORY COURSES WITH PRACTICAL COMPONENT								
5.	CP22102	Database Practices	PCC	3	0	2	5	4
PRACTICAL COURSES								
6.	CP22103	Advanced Data Structures and Algorithms Laboratory	PCC	0	0	4	4	2
EMPLOYABILITY ENHANCEMENT COURSES								
7.	CP22104	Technical Seminar	EEC	0	0	2	2	1
MANDATORY COURSES								
8.		Audit Course I	AC	2	0	0	2	0
TOTAL				16	1	8	25	**19**

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY COURSES								
1.	CP22204	Advanced Software Engineering	PCC	3	0	0	3	3
2.		Professional Elective II	PEC	3	0	0	3	3
3.		Professional Elective III	PEC	3	0	0	3	3
THEORY COURSES WITH PRACTICAL COMPONENT								
4.	CP22201	Advanced Operating Systems	PCC	3	0	2	5	4
5.	CP22202	Multicore Architecture and Programming	PCC	3	0	2	5	4
6.	CP22203	Machine Learning	PCC	3	0	2	5	4
PRACTICAL COURSES								
7.	CP22205	Software Engineering Laboratory	PCC	0	0	4	4	2
8.	RM22201	Research Tools Laboratory	RMC	0	0	4	4	2
MANDATORY COURSES								
9.		Audit Course II	AC	2	0	0	2	0
TOTAL				20	0	14	34	**25**

*On successful completion of the first year, students will attain knowledge on storing, organizing and managing data in an efficient way and designing and deploying modern software systems. Also, they gain an understanding on the practices of data analysis using advanced statistical inferences, models, and theories to find the meaning in large sets of real data and explore new technology and applications.

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY COURSES								
1.		Professional Elective IV	PEC	3	0	0	3	3
2.		Professional Elective V	PEC	3	0	0	3	3
3.		Open Elective	OEC	3	0	0	3	3
EMPLOYABILITY ENHANCEMENT COURSES								
4.	**CP22301**	Inplant / Industrial / Practical Training (4 weeks during summer vacation)	EEC					2
5.	**CP22302**	Project Work I	EEC	0	0	6	6	3
TOTAL				9	0	6	15	**14**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
EMPLOYABILITY ENHANCEMENT COURSES								
1.	**CP22401**	Project Work II	EEC	-	-	24	24	12
TOTAL								**12**

Total Credit= 70

*On successful completion of the second year, students will have the ability to apply the knowledge and skills they gained into an effective and useful project/product.

SUMMARY

M.E. COMPUTER SCIENCE AND ENGINEERING						
S.No	**Subject Area**	**Credits per Semester**				**Total Credits**
		I	**II**	**III**	**IV**	
1	FC	4	-	-	-	4
2	PCC	9	17	-	-	26
3	PEC	3	6	6	-	15
4	OEC	-	-	3	-	3
5	EEC	1	-	5	12	18
6	RMC	2	2	-	-	4
7	Non-Credit AC	0	0	-	-	0
Total		19	25	14	12	**70**

AUDIT COURSES (AC)

SL. NO	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	AC22101	English for Research Paper Writing	AC	2	0	0	2	0
2	AC22102	Constitution of India	AC	2	0	0	2	0
3	AC22201	Disaster Management	AC	2	0	0	2	0
4	AC22202	நற்றமிழ் இலக்கியம்	AC	2	0	0	2	0

PROFESSIONAL ELECTIVE I – SEMESTER I

SL. NO	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	**CP22111**	Network Technologies	PEC	3	0	0	3	3
2	**CP22112**	Human Computer Interaction	PEC	3	0	0	3	3
3	**CP22113**	Cloud Computing Technologies	PEC	3	0	0	3	3
4	**CP22114**	Wireless Communications	PEC	3	0	0	3	3

PROFESSIONAL ELECTIVES II– SEMESTER II

SL. NO	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	**CP22221**	Principles of Programming Languages	PEC	3	0	0	3	3
2	**CP22222**	Optimization Techniques and Applications	PEC	3	0	0	3	3
3	**CP22223**	Natural Language Processing Techniques	PEC	3	0	0	3	3
4	**CP22224**	GPU Computing	PEC	3	0	0	3	3

PROFESSIONAL ELECTIVES III – SEMESTER II

SL. NO	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	**CP22231**	Performance Analysis of Computer Systems	PEC	3	0	0	3	3
2	**CP22232**	Data Intensive Computing	PEC	3	0	0	3	3
3	**CP22233**	Internet of Things	PEC	3	0	0	3	3
4	**CP22234**	Software Quality Assurance	PEC	3	0	0	3	3

PROFESSIONAL ELECTIVES IV– SEMESTER III

SL. NO	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	**CP22341**	Advanced Digital Image Processing	PEC	3	0	0	3	3
2	**CP22342**	Information Retrieval Techniques	PEC	3	0	0	3	3
3	**CP22343**	Cognitive Computing	PEC	3	0	0	3	3
4	**CP22344**	Data Visualization Techniques	PEC	3	0	0	3	3

PROFESSIONAL ELECTIVES V – SEMESTER III

SL. NO	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	**CP22351**	Agile Methodologies	PEC	3	0	0	3	3
2	**CP22352**	Big Data Mining and Analytics	PEC	3	0	0	3	3
3	**CP22353**	Quantum Computing	PEC	3	0	0	3	3
4	**CP22354**	Mobile and Pervasive Computing	PEC	3	0	0	3	3

SYLLABUS

SEMESTER I

MA22102	APPLIED PROBABILITY AND STATISTICS FOR COMPUTER ENGINEERS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

- To enable students to understand the concepts of Probability and Random Variables
- To understand the basic probability concepts with respect to two dimensional random variables along with the significance of the central limit theorem
- To apply the small / large sample tests through Tests of hypothesis
- To encourage students to develop a working knowledge of Analysis of Variance
- To enable the students to use the concepts of multivariate normal distribution and principal components analysis

UNIT I	PROBABILITY AND RANDOM VARIABLES	12

Probability - Axioms of probability - Conditional probability - Baye's theorem- Discrete random variable – Probability mass function– Continuous random variable – Probability density function – Properties - mean, variance– Binomial, Poisson, Geometric, Uniform and Normal distributions.

UNIT II	TWO DIMENSIONAL RANDOM VARIABLES	12

Two dimensional Random variables-Discrete and continuous Joint distributions –Discrete and continuous Marginal distributions - conditional distributions - Central limit theorem(excluding proof) –Covariance-– Correlation –Karl Pearson correlation coefficient-Regression- Regression lines-Regression coefficient.

UNIT III	TESTING OF HYPOTHESIS	12

Statistical hypothesis - Type I and Type II errors - Large sample tests based on Normal distribution for single mean and difference of means -Tests based on t distribution for single mean and equality of means - Tests based on F distribution for equality of variances - Chi square test for single variance and goodness of fit - Independence of attributes - Contingency table: Analysis of $r \times c$ tables.

UNIT IV	DESIGN OF EXPERIMENTS	12

General principles – Analysis of variance(ANOVA) - One way classification - Completely randomized design (CRD) – Two way classification - Randomized block design (RBD) – Three way classification -Latin square design(LSD) – Two factor experiments: 2^2 factorial design

UNIT V	MULTIVARIATE ANALYSIS	12

Random vectors and matrices – Mean vectors and covariance matrices – Multivariate normal density and its properties – Principal components – Population principal components – Principal components from standardized variables.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

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

CO1	Define the basic concepts of one dimensional, two dimensional random variables, statistical hypothesis and multivariate techniques
CO2	Demonstrate the concepts of probability distributions, correlation and regression in the engineering field
CO3	Explain statistical, multivariate techniques and principal components analysis
CO4	Apply the concept of probability and correlation in engineering discipline

CO5	Apply the concept of testing of hypothesis, analysis of variance and multivariate normality in real life problems

REFERENCES:

1.	Dallas E Johnson, "Applied multivariate methods for data Analysis", Thomson and Duxbury press, Singapore, 1998.
2.	Richard A. Johnson and Dean W. Wichern, "Applied multivariate statistical Analysis", Pearson Education, Fifth Edition, 6th Edition, New Delhi, 2023.
3.	S.P.Gupta, "Statistical Methods", Sultan Chand & Sons, 48th Edition, New Delhi, 2022.
4.	Oliver C. Ibe, "Fundamentals of Applied probability and Random Processes", Academic Press, Boston, 2014.
5.	Johnson R. A., Miller I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson India Education, Asia, 9th Edition, New Delhi, 2017.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	1	-	2	-
CO2	3	-	1	-	2	-
CO3	3	-	1	-	2	-
CO4	3	-	1	-	2	-
CO5	3	-	1	-	2	-
CO	**3**	**-**	**1**	**-**	**2**	**-**

3-High, 2- Medium, 1-Low

CP22101	**ADVANCED DATA STRUCTURES AND ALGORITHMS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSEOBJECTIVES:

- To understand the usage of algorithms in computing
- To learn the usage of graphs and their applications
- To learn and use hierarchical data structures and their operations
- To select and design data structures and algorithms that are appropriate for problems
- To study about NP Completeness of problems

UNITI	**ROLE OF ALGORITHMS IN COMPUTING & COMPLEXITY ANALYSIS**	**9**

Algorithms – Algorithms as a technology- Insertion Sort – Analyzing Algorithms – Designing Algorithms- Asymptotic Notation – Standard Notations and Common Functions- Recurrences: The Substitution Method – The Recursion-Tree Method.

UNIT II	**HIERARCHICAL DATA STRUCTURES**	**9**

Binary Search Trees: Basics – Querying a Binary search tree – Insertion and Deletion- Red Black trees: Properties of Red-Black Trees – Rotations – Insertion – Deletion -B-Trees: Definition of B -trees – Basic operations on B-Trees – Deleting a key from a B-Tree- Heap – Heap Implementation – Disjoint Sets - Fibonacci Heaps: structure – Mergeable-heap operations-Decreasing a key and deleting a node-Bounding the maximum degree.

UNIT III	**GRAPHS**	**9**

Elementary Graph Algorithms: Representations of Graphs – Breadth-First Search – Depth- First Search – Topological Sort – Strongly Connected Components- Minimum Spanning Trees: Growing a Minimum Spanning Tree – Kruskal and Prim- Single-Source Shortest Paths: The

Bellman-Ford algorithm – Single-Source Shortest paths in Directed Acyclic Graphs – Dijkstra's Algorithm; Dynamic Programming - All-Pairs Shortest Paths: Shortest Paths and Matrix Multiplication – The Floyd-Warshall Algorithm.		
UNIT IV	**ALGORITHM DESIGN TECHNIQUES**	**9**
Dynamic Programming: Matrix-Chain Multiplication – Elements of Dynamic Programming – Longest Common Subsequence- Greedy Algorithms: – Elements of the Greedy Strategy- An Activity-Selection Problem - Huffman Coding.		
UNIT V	**NP COMPLETE AND NP HARD**	**9**
NP-Completeness: Polynomial Time – Polynomial-Time Verification – NP-Completeness and Reducibility – NP-Completeness Proofs – NP-Complete Problems.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
At the end of the course, the students will be able to:	
CO1:	Identify appropriate data structures, then build algorithms to address computing issues
CO2:	Design and evaluate algorithms for hierarchical data structures
CO3:	Design algorithms to address real-world issues by utilizing graph structure
CO4:	Create a custom algorithm to solve an ambiguous situation
CO5:	Apply the appropriate design approach while tackling problems

REFERENCES:

1.	T.H. Cormen, C.E.Leiserson, R.L. Rivest and C.Stein, "Introduction to Algorithms", Prentice Hall of India, Fourth Edition, 2022.
2.	E. Horowitz, S. Sahni and S. Rajasekaran, "Fundamentals of Computer Algorithms", University Press, Second Edition, 2008.
3.	Adam Drozdex, "Data Structures and algorithms in C++", Cengage Learning, Fourth Edition, 2013.
4.	Mark Allen Weiss, "Data Structures and Algorithms in C++", Pearson Education, Third Edition, 2009.
5.	Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, "Data Structures and Algorithms", Pearson Education, Reprint 2006.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	-	-	-	-
CO2	3	3	-	-	-	-
CO3	3	3	-	-	-	-
CO4	3	3	-	-	-	-
CO5	3	3	-	-	-	-
CO	**3**	**3**	**-**	**-**	**-**	**-**

3-High, 2- Medium, 1-Low

CP22102	**DATABASE PRACTICES**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**

COURSEOBJECTIVES:

- To describe the fundamental elements of relational database management systems
- To explain the basic concepts of relational data model, entity-relationship model, relational database design, relational algebra and SQL
- To understand the basics of XML and create well-formed and valid XML documents

- To distinguish the different types of NoSQL databases
- To understand the different models involved in database security and their applications in real time world to protect the database and information associated with them

UNITI	RELATIONAL DATA MODEL	15

Entity Relationship Model – Relational Data Model – Mapping Entity Relationship Model to Relational Model – Relational Algebra – Structured Query Language – Database Normalization.

Suggested Activities:

Data Definition Language

- Create, Alter and Drop
- Enforce Primary Key, Foreign Key, Check, Unique and Not Null Constraints
- Creating Views
- Data Manipulation Language
- Insert, Delete, Update
- Cartesian Product, Equi Join, Left Outer Join, Right Outer Join and Full Outer Join
- Aggregate Functions
- Set Operations
- Nested Queries Transaction Control Language
- Commit, Rollback and Save Points

UNIT II	DISTRIBUTED DATABASES, ACTIVE DATABASES AND OPEN DATABASE CONNECTIVITY	15

Distributed Database Architecture – Distributed Data Storage – Distributed Transactions – Distributed Query Processing – Distributed Transaction Management – Event Condition Action Model – Design and Implementation Issues for Active Databases – Open Database Connectivity.

Suggested Activities:

- Distributed Database Design and Implementation
- Row Level and Statement Level Triggers

Accessing a Relational Database using PHP, Python and R

UNIT III	XML DATABASES	15

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.

Suggested Activities:

- Creating XML Documents, Document Type Definition and XML Schema
- Using a Relational Database to store the XML documents as text
- Using a Relational Database to store the XML documents as data elements
- Creating or publishing customized XML documents from pre-existing relational databases
- Extracting XML Documents from Relational Databases
- XML Querying

UNIT IV	NOSQL DATABASES AND BIG DATA STORAGE SYSTEMS	15

NoSQL – Categories of NoSQL Systems – CAP Theorem – Document-Based NoSQL Systems and MongoDB – MongoDB Data Model – MongoDB Distributed Systems Characteristics – NoSQL Key-Value Stores – DynamoDB Overview – Voldemort Key-Value Distributed Data Store – Wide Column NoSQL Systems.

UNIT V	DATABASE SECURITY	15

Database Security Issues – Discretionary Access Control Based on Granting and Revoking Privileges – Mandatory Access Control and Role-Based Access Control for Multilevel Security – SQL Injection – Statistical Database Security – Flow Control – Encryption and Public Key

Infrastructures – Preserving Data Privacy – Challenges to Maintaining Database Security – Database Survivability – Oracle Label-Based Security. Suggested Activity: Implementing Access Control in Relational Databases	
TOTAL: 75 PERIODS	
COURSE OUTCOMES:	
At the end of the course, the students will be able to:	
CO1:	Outline Relational Data Model, Distributed Database, Xml Database, NoSQL Databases and Database Security
CO2:	Make use of Structured Query Language
CO3:	Develop Distributed Database Design
CO4:	Build XML Documents, Document Type Definition and XML Schema
CO5:	Experiment with Access Control in Relational Databases
REFERENCES:	
1.	R. Elmasri, S.B. Navathe, "Fundamentals of Database Systems", Seventh Edition, Pearson Education 2016.
2.	Henry F. Korth, Abraham Silberschatz, S. Sudharshan, "Database System Concepts", Seventh Edition, McGraw Hill, 2019.
3.	C.J.Date, A.Kannan, S.Swamynathan, "An Introduction to Database Systems", Eighth Edition, Pearson Education, 2006.
4.	Harrison, Guy, "Next Generation Databases, NoSQL and Big Data", First Edition, Apress publishers, 2015.
5.	Thomas Cannolly and Carolyn Begg, "Database Systems, A Practical Approach to Design, Implementation and Management", Sixth Edition, Pearson Education, 2015.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	1	1	1
CO2	1	1	1	1	1	1
CO3	3	2	3	3	3	2
CO4	1	2	1	1	1	1
CO5	2	2	3	3	3	2
CO	**2**	**2**	**2**	**2**	**2**	**1**

3-High, 2- Medium, 1-Low

RM22101	**RESEARCH METHODOLOGY**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**2**
COURSEOBJECTIVE:					
● To give an overview of the research methodology and IPR, and explain the techniques of data collection and analysis					
UNITI	**RESEARCH DESIGN**				**6**
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**				**6**
Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.					
UNIT III	**DATA ANALYSIS AND REPORTING**				**6**

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**	**6**
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**	**6**
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: 30 PERIODS		

COURSE OUTCOMES:	
At the end of the course, the students will be able to:	
CO1:	Outline the methodology of research
CO2:	Explain the research design, data collection methods, IPR and patent
CO3:	Prepare a well-structured research paper, scientific presentations and patent applications
CO4:	Develop awareness on IPR, patent law and procedural mechanism in obtaining a patent
CO5:	Compare the methods of measurement scale, questionnaire, sampling and data analysis

REFERENCES:

1.	Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, Eleventh Edition, 2012.
2.	Kothari C R, Gaurav Garg, "Research Methodology- Methods and Techniques", New Age International Publishers, 2019.
3.	Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
4.	David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.
5.	The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", 2013.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	**Programme Outcomes**					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	3	-	-	-
CO2	-	-	3	-	-	-
CO3	-	2	3	-	-	-
CO4	-	-	3	-	-	-
CO5	-	-	3	-	-	2
CO	**-**	**2**	**3**	**-**	**-**	**2**

3-High, 2- Medium, 1-Low

CP22103	ADVANCED DATA STRUCTURES AND ALGORITHMS LABORATORY	L	T	P	C
		0	0	4	2

COURSEOBJECTIVES:

- To acquire the knowledge of using advanced tree structures
- To learn the usage of heap structures
- To understand the usage of graph structures and spanning trees
- To understand the problems such as matrix chain multiplication, activity selectionand Huffman coding
- To understand the necessary mathematical abstraction to solve problems

LIST OF EXPERIMENTS

1. Implementation of recursive function for tree traversal and Fibonacci
2. Implementation of iteration function for tree traversal and Fibonacci
3. Implementation of Merge Sort and Quick Sort
4. Implementation of Binary Search Tree
5. Red-Black Tree Implementation
6. Heap Implementation
7. Fibonacci Heap Implementation
8. Graph Traversals
9. Spanning Tree Implementation
10. Shortest Path Algorithms (Dijkstra's algorithm, Bellman Ford algorithm)
11. Implementation of Matrix Chain Multiplication
12. Activity Selection and Huffman Coding Implementation

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1:	Design and implement basic and advanced data structures extensively
CO2:	Design algorithms using graph structures
CO3:	Design and develop efficient algorithms with minimum complexity using design techniques
CO4:	Develop programs using various algorithms
CO5:	Choose appropriate data structures and algorithms, understand the ADT/libraries, and use it to design algorithms for a specific problem

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	-	-	-
CO2	3	3	1	-	-	-
CO3	3	3	1	-	-	-
CO4	3	3	1	-	-	-
CO5	3	2	1	-	-	-
CO	**3**	**3**	**1**	**-**	**-**	**-**

3-High, 2- Medium, 1-Low

CP22104	TECHNICAL SEMINAR	L	T	P	C
		0	0	2	1

COURSEOBJECTIVE:

- To work on a specific technical topic in Computer Science and Engineering in order to acquire the skills of oral presentation and to acquire technical writing abilities for seminars and conferences

METHOD OF EVALUATION:

In this course, the students will work for two hours per week guided by a staff member. They will be asked to talk on any topic of their choice related to Computer Science and Engineering and to engage in dialogue with the audience. A brief copy of their talk also should be submitted. Similarly, the students will have to present a seminar of not less than fifteen minutes and not more than thirty minutes on the technical topic. They will also answer the queries on the topic. The students as audience also should interact. Evaluation will be based on the technical presentation and the report and also on the interaction during the seminar.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

CO1:	Identify latest developments in the field of Computer Science and Engineering
CO2:	Develop technical writing abilities for seminars, conferences and journal publications
CO3:	Make use of modern tools to present the technical details

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	-	3
CO2	-	3	1	-	-	3
CO3	-	-	1	-	-	3
CO	**3**	**3**	**2**	-	-	**3**

3-High, 2- Medium, 1-Low

SEMESTER II

CP22201	ADVANCED OPERATING SYSTEM	L	T	P	C
		3	0	2	4

COURSEOBJECTIVES:

- To understand the concepts of distributed systems
- To get an insight into the various issues and solutions in distributed operating systems
- To learn about real-time operating systems
- To gain a comprehensive knowledge on the design concepts of mobile operating systems
- To understand cloud, multiprocessor and database operating systems

UNITI	INTRODUCTION	9

Distributed Operating Systems – Issues – Communication Primitives – Limitations of a Distributed System – Lamport's Logical Clocks – Vector Clocks – Causal Ordering of Messages.

UNIT II	DISTRIBUTED OPERATING SYSTEMS	9

Distributed Mutual Exclusion Algorithms – Classification – Preliminaries – Simple Solution - Lamport's Algorithm – Ricart-Agrawala Algorithm – Suzuki-Kasami's Broadcast Algorithm – Raymond's Tree-Based Algorithm – Distributed Deadlock Detection – Preliminaries – Centralized Deadlock Detection Algorithms – Distributed Deadlock Detection Algorithms – Path Pushing Algorithm – Edge Chasing Algorithm – Hierarchical Deadlock Detection Algorithms – Agreement Protocols – Classification – Solutions to the Byzantine Agreement Problem – Lamport-Shostak- Pease Algorithm.

UNIT III	DISTRIBUTED RESOURCE MANAGEMENT	9

Distributed File Systems – Design Issues – Google File System – Hadoop Distributed File System – Distributed Shared Memory – Algorithms for Implementing Distributed Shared Memory – Load Distributing Algorithms – Synchronous and Asynchronous Check Pointing and Recovery – Fault Tolerance – Two-Phase Commit Protocol – Nonblocking Commit Protocol.

UNIT IV	MULTIPROCESSOR AND DATABASE OPERATING SYSTEM	9

Multiprocessor operating systems - Basic multiprocessor system architectures – Interconnection networks for multiprocessor systems – Caching – Hypercube architecture. Multiprocessor Operating System - Structures of multiprocessor operating system, Operating system design issues- Threads- Process synchronization and scheduling. Database Operating systems: Introduction- Requirements of a database operating system, Concurrency control : Theoretical aspects – Introduction, Database systems – A concurrency control model of database systems- The problem of concurrency control – Serializability theory- Distributed database systems, Concurrency control algorithms – Introduction, Basic synchronization primitives, Lock based algorithms - Timestamp based algorithms, Optimistic algorithms – Concurrency control algorithms: Data replication.

UNIT V	REAL TIME MOBILE AND CLOUD OPERATING SYSTEMS	9

Basic Model of Real - Time Systems – Characteristics – Application of Real - Time Systems – Real - Time Task Scheduling – Handling Resource Sharing – Case studies: Android – Overall Architecture – Linux Kernel – Hardware Support – Native User-Space – Dalvik and Android's Java – System Services – iOS - Introduction to Cloud Operating Systems.

TOTAL: 45 PERIODS

PRACTICALS:

1. Install Oracle Virtual Box.
2. Create virtual machine with appropriate configuration.
3. Install Windows OS in Virtual Machine.

4. Install Linux OS in Virtual Machine.	
5. Share and transfer the files between Windows and Linux.	
6. Build a customized Linux kernel.	
7. Install XAMPP server and validate the working of each component.	
TOTAL: 30 PERIODS	
TOTAL: (45+30) 75 PERIODS	
COURSE OUTCOMES:	
At the end of the course, the students will be able to:	
CO1:	Explore the working of theoretical foundations of OS
CO2:	Explain the working principles of resource management
CO3:	Describe the concepts of distributed shared memory and scheduling mechanisms
CO4:	Apply the learning into multiprocessor system architectures
CO5:	Analyze the working of various operating systems
REFERENCES:	
1.	Mukesh Singhal and Niranjan G. Shivaratri, "Advanced Concepts in Operating Systems – Distributed, Database and Multiprocessor Operating Systems", Tata MC Graw-Hill, 2001.
2.	Rajib Mall, "Real-Time Systems: Theory and Practice", Pearson Education India, 2006.
3.	William Stallings, "Operating Systems Internals and Design Principles", Ninth Edition, Pearson, 2018.
4.	Pradeep K.Sinha, "Distributed operating system-Concepts and design", PHI, 2003.
5.	Karim Yaghmour, "Embedded Android", O'Reilly, First Edition, 2013.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	1	1
CO2	2	2	2	2	1	1
CO3	2	2	2	2	1	1
CO4	2	2	2	2	1	1
CO5	2	2	2	2	1	1
CO	**2**	**2**	**2**	**2**	**1**	**1**

3-High, 2- Medium, 1-Low

CP22202	MULTICORE ARCHITECTURE AND PROGRAMMING	L	T	P	C
		3	**0**	**2**	**4**

COURSEOBJECTIVES:	
● To understand the need for multi-core processors, and their architecture	
● To understand the challenges in parallel and multithreaded programming	
● To learn about the various parallel programming paradigms	
● To develop multicore programs and design parallel solutions	
UNITI	**MULTI-CORE PROCESSORS** **9**
Single core to Multi-core architectures – SIMD and MIMD systems – Interconnection networks – Symmetric and Distributed Shared Memory Architectures – Cache coherence – Performance Issues – Parallel program design.	
UNIT II	**PARALLEL PROGRAM CHALLENGES** **9**
Performance – Scalability – Synchronization and data sharing – Data races – Synchronization primitives (mutexes, locks, semaphores, barriers) – deadlocks and livelocks – communication	

between threads (condition variables, signals, message queues and pipes).		
UNIT III	**SHARED MEMORY PROGRAMMING WITH OpenMP**	**9**
OpenMP Execution Model – Memory Model – OpenMP Directives – Work-sharing Constructs – Library functions – Handling Data and Functional Parallelism – Handling Loops – Performance Considerations.		
UNIT IV	**DISTRIBUTED MEMORY PROGRAMMING WITH MPI**	**9**
MPI program execution – MPI constructs – libraries – MPI send and receive – Point-to-point and Collective communication – MPI derived datatypes – Performance evaluation.		
UNIT V	**PARALLEL PROGRAM DEVELOPMENT**	**9**
Case studies – n-Body solvers – Tree Search – OpenMP and MPI implementations and comparison.		
TOTAL: 45 PERIODS		
PRACTICALS:		
1. Write a simple Program to demonstrate an OpenMP Fork-Join Parallelism.		
2. Create a program that computes a simple matrix-vector multiplication b=Ax, either in C/C++. Use OpenMP directives to make it run in parallel.		
3. Create a program that computes the sum of all the elements in an array A (C/C++) or a program that finds the largest number in an array A. Use OpenMP directives to make it run in parallel.		
4. Write a simple Program demonstrating Message-Passing logic using MPI.		
5. Implement the All-Pairs Shortest-Path Problem (Floyd's Algorithm) Using OpenMP.		
6. Implement a program Parallel Random Number Generators using Monte Carlo Methods in OpenMP.		
7. Write a Program to demonstrate MPI-broadcast-and-collective-communication in C.		
8. Write a Program to demonstrate MPI-scatter-gather-and-all gather in C.		
9. Write a Program to demonstrate MPI-send-and-receive in C.		
10. Write a Program to demonstrate by performing-parallel-rank-with-MPI in C.		
TOTAL: 45 PERIODS		
TOTAL: (45+30)75 PERIODS		
COURSE OUTCOMES:		
At the end of the course, the students will be able to:		
CO1:	Describe multicore architectures and identify their characteristics and challenges.	
CO2:	Identify the issues in programming Parallel Processors	
CO3:	Write programs using OpenMP and MPI	
CO4:	Design parallel programming solutions to common problems	
CO5:	Compare and contrast programming for serial processors and programming for parallel processors	
REFERENCES:		
1.	Peter S. Pacheco, "An Introduction to Parallel Programming, Morgan-Kauffman/Elsevier, 2021.	
2.	Darryl Gove, "Multicore Application Programming for Windows, Linux, and Oracle Solaris, Pearson, 2011.	
3.	Michael J Quinn, "Parallel programming in C with MPI and OpenMP, Tata McGraw Hill, 2003.	
4.	Victor Alessandrini, Shared Memory Application Programming, First Edition, Concepts and Strategies in Multicore Application Programming, Morgan Kaufmann, 2015.	
5.	Yan Solihin, Fundamentals of Parallel Multicore Architecture, CRC Press, 2015.	

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2	1	2
CO2	2	1	-	-	2	2
CO3	1	-	2	1	1	2
CO4	2	1	1	1	2	2
CO5	3	1	2	1	2	3
CO	**2**	**1**	**2**	**1**	**2**	**2**

3-High, 2- Medium, 1-Low

CP22203	**MACHINE LEARNING**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**

COURSEOBJECTIVES:

- To understand the concepts and mathematical foundations of machine learning and types of problems tackled by machine learning
- To explore the different supervised learning techniques including ensemble methods
- To outline different aspects of unsupervised learning and reinforcement learning
- To outline the role of probabilistic methods for machine learning
- To understand the basic concepts of neural networks and deep learning

UNITI	**INTRODUCTION AND MATHEMATICAL FOUNDATIONS**	**9**

What is Machine Learning? Need -History - Definitions - Applications - Advantages, Disadvantages & Challenges - Types of Machine Learning Problems - Mathematical Foundations - Linear Algebra & Analytical Geometry - Probability and Statistics - Vector Calculus & Optimization - Information theory

UNIT II	**SUPERVISED LEARNING**	**9**

Introduction- Discriminative and Generative Models - Linear Regression - Least Squares - Under fitting/ Over-fitting - Cross-Validation - Lasso Regression - Classification - Logistic Regression - Gradient Linear Models - Support Vector Machines - Kernel Methods - Instance based Methods - K-Nearest Neighbours - Tree based Methods - Decision Trees - ID3 - CART - Ensemble Methods - Random Forest - Evaluation of Classification Algorithms

UNIT III	**UNSUPERVISED LEARNING AND REINFORCEMENT LEARNING**	**9**

Introduction - Clustering Algorithms – K-Means - Hierarchical Clustering - Cluster Validity - Dimensionality Reduction - Introduction - Principal Component Analysis- Recommendation Systems - EM algorithm. Reinforcement Learning - Elements - Model based Learning - Temporal Difference Learning

UNIT IV	**PROBABILISTIC METHODS FOR LEARNING**	**9**

Introduction -Naive Bayes Algorithm -Maximum Likelihood -Maximum Apriori -Bayesian Belief Networks -Probabilistic Modelling of Problems -Inference in Bayesian Belief Networks - Probability Density Estimation - Sequence Models - Markov Models - Hidden Markov Models

UNIT V	**NEURAL NETWORKS AND DEEP LEARNING**	**9**

Neural Networks - Biological Motivation- Perceptron - Multi-layer Perceptron - Feed Forward Network - Back Propagation-Activation and Loss Functions- Limitations of Machine Learning - Deep Learning - introduction - Convolution Neural Networks - Recurrent Neural Networks - LSTM- Use cases

TOTAL: 45 PERIODS

SUGGESTED ACTIVITIES:

1. Give a new example from our daily life for each type of Machine Learning problem.
2. Study at least 3 open source tools/frameworks available for Machine Learning and discuss the pros and cons of each tool/framework.
3. Take an example of a classification problem. Implement a Random Forest and visualize the individual trees to understand how the model works.
4. Examine the various cross disciplinary use cases of Machine Learning. Eg Machine Learning in Bioinformatics, Climate Science, Economics, etc.
5. Outline 10 machine learning applications in healthcare.
6. Discuss the recent advancements in Reinforcement Learning and why research in Reinforcement Learning is hard.
7. Discuss case studies on the ethical issues that have gained traction in recent years due to bulk collection of data. Eg. Racial profiling, Cambridge Analytica.
8. Give 5 examples where sequential models are suitable.
9. Discuss recent CNN architectures.

PRACTICAL EXERCISES:

1. Implement a Linear Regression with a Real Dataset (https://www.kaggle.com/harrywang/housing). Experiment with different features in building a model. Tune the model's hyperparameters.
2. Implement a binary classification model. That is, answers a binary question such as "Are houses in this neighborhood above a certain price?"(use data from exercise 1). Modify the classification threshold and determine how that modification influences the model. Experiment with different classification metrics to determine your model's effectiveness.
3. Classification with Nearest Neighbours. In this question, you will use the scikit-learn's KNN classifier to classify real vs. fake news headlines. The aim of this question is for you to read the scikit-learn API and get comfortable with training/validation splits. Use California Housing Dataset
4. In this exercise, you'll experiment with validation sets and test sets using the dataset. Split a training set into a smaller training set and a validation set. Analyze deltas between training set and validation set results. Test the trained model with a test set to determine whether your trained model is overfitting. Detect and fix a common training problem.
5. Implement the k-means algorithm using https://archive.ics.uci.edu/ml/ datasets/Codon+usage dataset
6. Implement the Naive Bayes Classifier using https://archive.ics.uci.edu/mI/ datasets/Gait+CIassification dataset
7. Project - (in Pairs) Your project must implement one or more machine learning algorithms and apply them to some data.
    a. Your project may be a comparison of several existing algorithms, or it may propose a new algorithm in which case you still must compare it to at least one other approach.
    b. You can either pick a project of your own design, or you can choose from the set of pre-defined projects.
    c. You are free to use any third-party ideas or code that you wish as long as it is publicly available.
    d. You must properly provide references to any work that is not your own in the write-up.
    e. Project proposal- you must turn in a brief project proposal. Your project proposal should describe the idea behind your project. You should also briefly describe software you will need to write, and papers (2-3) you plan to read.

LIST OF PROJECTS:

1. Sentiment Analysis of Product Reviews
2. Stock Prediction
3. Sales Forecasting
4. Music Recommendation
5. Handwriting Digit Classification
6. Fake News Detection
7. Sports Prediction
8. Object Detection
9. Disease Prediction

TOTAL: 45 PERIODS

TOTAL: (45+30)75 PERIODS

HARDWARE/SOFTWARE REQUIREMENTS:

1. Python 3.x
2. Jupyter Lab
3. Scientific Computing Libraries: Numpy, JAX, MatplotLib
4. Machine Learning Libraries: Scikit-Learning, Turi Create
5. Deep Learning Libraries: Pytorch 1.0, Tensorflow 2.0, TRAX, DyNet
6. Weka, Wekatinator
7. Cloud (for Deep Learning): Google Colab, Paperspace Gradient Intel Core i7 9700K or Ryzen 7 5800X CPU, with minimum 16GB RAM Etc.

COURSE OUTCOMES:

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

CO1:	Understand and outline problems for each type of machine learning
CO2:	Design a Decision tree and Random forest for an application
CO3:	Implement Probabilistic Discriminative and Generative algorithms for an application and analyze the results
CO4:	Use a tool to implement typical Clustering algorithms for different types of applications
CO5:	Design and implement an HMM for a Sequence Model type of application
CO6:	Identify applications suitable for different types of Machine Learning with suitable justification

REFERENCES:

1.	Stephen Marsland, "Machine Learning: An Algorithmic Perspective", Chapman & Hall/CRC, Second Edition, 2014.
2.	Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems" Second Edition, O'reilly, 2017.
3.	Kevin Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.
4.	Tom M Mitchell, "Machine Learning", McGraw Hill Education, 2013.
5.	Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Springer, 2009.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	-	3	1	-
CO2	2	3	-	2	3	1
CO3	2	3	-	2	2	1

CO4	3	3	-	2	3	1
CO5	2	3	-	2	3	1
CO 6	3	3	-	3	2	1
CO	**2**	**3**	**-**	**2**	**2**	**1**

3-High, 2- Medium, 1-Low

CP22204	**ADVANCED SOFTWARE ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSEOBJECTIVES:

- To understand the rationale for software development process models
- To understand why the architectural design of software is important
- To understand the five important dimensions of dependability, namely, availability, reliability, safety, security, and resilience
- To understand the basic notions of a web service, web service standards, and service oriented architecture
- To understand the different stages of testing from testing during development of a software System

UNITI	**SOFTWARE PROCESS &MODELING**	**9**

Prescriptive Process Models – Agility and Process – Scrum – XP – Kanban – DevOps – Prototype Construction – Prototype Evaluation – Prototype Evolution – Modelling – Principles – Requirements Engineering – Scenario-based Modelling – Class-based Modelling – Functional Modelling – Behavioural Modelling.

UNIT II	**SOFTWARE DESIGN**	**9**

Design Concepts – Design Model – Software Architecture – Architectural Styles – Architectural Design – Component-Level Design – User Experience Design – Design for Mobility – Pattern-Based Design.

UNIT III	**SYSTEM DEPENDABILITY AND SECURITY**	**9**

Dependable Systems – Dependability Properties – Sociotechnical Systems – Redundancy and Diversity – Dependable Processes – Formal Methods and Dependability – Reliability Engineering – Availability and Reliability – Reliability Requirements – Fault-tolerant Architectures – Programming for Reliability – Reliability Measurement – Safety Engineering – Safety-critical Systems – Safety Requirements – Safety Engineering Processes – Safety Cases – Security Engineering – Security and Dependability – Safety and Organizations – Security Requirements – Secure System Design – Security Testing and Assurance – Resilience Engineering – Cyber security – Sociotechnical Resilience – Resilient Systems Design.

UNIT IV	**SERVICE-ORIENTED SOFTWARE ENGINEERING, SYSTEMS ENGINEERING AND REAL-TIME SOFTWARE ENGINEERING**	**9**

Service-oriented Architecture – RESTful Services – Service Engineering – Service Composition – Systems Engineering – Sociotechnical Systems – Conceptual Design – System Procurement – System Development – System Operation and Evolution – Real-time Software Engineering – Embedded System Design – Architectural Patterns for Real-time Software – Timing Analysis – Real-time Operating Systems.

UNIT V	**SOFTWARE TESTING AND SOFTWARE CONFIGURATION MANAGEMENT**	**9**

Software Testing Strategy – Unit Testing – Integration Testing – Validation Testing – System Testing – Debugging – White-Box Testing – Basis Path Testing – Control Structure Testing –

Black-Box Testing – Software Configuration Management (SCM) – SCM Repository – SCM Process – Configuration Management for Web and Mobile Apps.	
TOTAL: 45 PERIODS	
COURSE OUTCOMES:	
At the end of the course, the students will be able to:	
CO1:	Identify appropriate process models based on the Project requirements
CO2:	Assess the importance of having a good Software Architecture
CO3:	Explain the five important dimensions of dependability, namely, availability, reliability, safety, security, and resilience
CO4:	Describe the basic notions of a web service, web service standards, and service oriented architecture
CO5:	Describe various levels of Software testing
REFERENCES:	
1.	Software Engineering: A Practitioner's Approach, Ninth Edition. Roger Pressman and Bruce Maxim, McGraw-Hill 2019.
2.	Software Engineering, Tenth Edition, Ian Somerville, Pearson Education Asia 2016.
3.	Software Architecture In Practice, Third Edition, Len Bass, Paul Clements and Rick Kazman, Pearson India 2018.
4.	An integrated approach to Software Engineering, Third Edition, PankajJalote, Narosa Publishing House, 2018.
5.	Fundamentals of Software Engineering, Fifth Edition, Rajib Mall, PHI Learning Private Ltd, 2018.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	-	-	-	-
CO2	3	2	-	-	-	-
CO3	3	2	3	-	-	-
CO4	3	2	3	-	-	-
CO5	3	2	3	-	-	-
CO	**3**	**2**	**3**	**-**	**-**	**-**

3-High, 2- Medium, 1-Low

CP22205	SOFTWARE ENGINEERING LABORATORY	L	T	P	C
		0	**0**	**4**	**2**

COURSEOBJECTIVES:
● To impart state-of-the-art knowledge on Software Engineering and UML in an interactive manner through the Web
● Present case studies to demonstrate practical applications of different concepts
• Provide a scope to students where they can solve small, real-life problems
LIST OF EXPERIMENTS
1. Write a Problem Statement to define a title of the project with bounded scope of project
2. Select relevant process model to define activities and related task set for assigned project Tentative

3. Prepare broad SRS (Software Requirement Specification) for the above selected projects
4. Prepare USE Cases and Draw Use Case Diagram using modelling Tool
5. Develop the activity diagram to represent flow from one activity to another for software development
6. Develop data Designs using DFD Decision Table & ER Diagram.
7. Draw class diagram, sequence diagram, Collaboration Diagram, State Transition Diagram for the assigned project
8. Write Test Cases to validate requirements of assigned project from SRS Document
9. Evaluate Size of the project using function point metric for the assigned project
10. Estimate cost of the project using COCOMO and COCOCMOII for the assigned project
11. Use CPM/PERT for scheduling the assigned project
12. Use timeline Charts or Gantt Charts to track progress of the assigned project
TOTAL: 60 PERIODS
COURSE OUTCOMES:
At the end of the course, the students will be able to:

CO1:	Produce the requirements and use cases the client wants for the software being produced
CO2:	Participate in drawing up the project plan. The plan will include at least extent and work assessments of the project, the schedule, available resources, and risk management can model and specify the requirements of mid-range software and their architecture
CO3:	Create and specify such a software design based on the requirement specification that the software can be implemented based on the design
CO4:	Assess the extent and costs of a project with the help of several different assessment methods

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	-	3	-	-
CO2	3	3	-	3	-	-
CO3	3	3	-	3	-	-
CO4	3	3	-	3	-	-
CO	**3**	**3**	**-**	**3**	**-**	**-**

3-High, 2- Medium, 1-Low

RM22201	**RESEARCH TOOLS LABOTRATORY**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

COURSEOBJECTIVES:
• To familiarize the fundamental concepts/techniques for Project Management
• To familiarize the journal paper formatting using suitable Software
• To familiarize the software for literature review and Bibliography
• To find the plagiarism percentage of article contents
• To prepare a quality research report and the presentation
LIST OF EXPERIMENTS:
1. Use of tools / Techniques for Research - Project management -Microsoft Project / Microsoft OneNote / Asana.

2. Hands on Training related to Software for Paper Formatting like LaTeX / MS Office 3. Design a Layout of a Research Paper - Guidelines for Submitting the Research Paper - Review Process -Addressing Reviewer Comments. 4. Introduction to Data Analysis Software - Origin SPSS, ANOVA etc., 5. Introduction to Software for detection of Plagiarism – Urkund, Turniton 6. Preparing Bibliography / Different Reference Formats. – EndNote, Mently 7. Format of Project Report - Use of Quotations - Method of Transcription- Elements: Title Page - Abstract - Table of Contents - Headings and Sub-Headings - Footnotes - Tables and Figures 8. Introduction to Microsoft Excel –for Research Analysis 9. Presentation using PPTs. 10. Data analysis using Matlab.
TOTAL: 45 PERIODS

COURSE OUTCOMES:	
At the end of the course, the students will be able to:	
CO1:	List the various stages in research and develop systematic planning of project stages
CO2:	Write a journal paper and formulate as per the standard journal format
CO3:	Develop a literature review and relevant references for a research problem using suitable software
CO4:	Determine the plagiarism of the article / report content by using the Software
CO5:	Compile a research report and the presentation

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	**Programme Outcomes**					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	2	2	-	-
CO2	2	-	3	2	-	-
CO3	2	-	-	3	-	-
CO4	2	-	3	3	-	-
CO5	2	-	3	3	-	-
CO	**2**	**-**	**3**	**3**	**-**	**-**

3-High, 2- Medium, 1-Low

SEMESTER III

CP22301	PRACTICAL TRAINING	L	T	P	C
		0	0	0	2

COURSEOBJECTIVES:

- To train the students in the field work so as to have first-hand knowledge of practical problems related to Computer Science Engineering in carrying out engineering tasks

SYLLABUS

The students individually undertake training in reputed companies during the summer vacationfor a specified duration of four weeks. At the end of training, a detailed report on the work done should be submitted within ten days from the commencement of the semester. The students will be evaluated through a viva-voce examination by a team of internal staff.

COURSE OUTCOMES:

Upon completion of the course, the students will.../ will be able to...

CO1:	Describe the Computer Engineering organization
CO2:	Realize the various functions of industrial activities
CO3:	Gain understanding of groups and group dynamics

Mapping of Course Outcomes to Programme Outcomes

CO	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	3	3	3	2	3
2	2	3	3	3	2	3
3	2	3	3	3	2	3
Average	**2**	**3**	**3**	**3**	**2**	**3**

3-High, 2- Medium, 1-Low

CP22302	PROJECT WORK I	L	T	P	C
		0	0	6	3

COURSEOBJECTIVES:

- To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
- To develop the methodology to solve the identified problem
- To train the students in preparing project reports and to face reviews and viva-voce examination

SYLLABUS

The student individually works on a specific topic approved by faculty member who is familiar in this area of interest. The student can select any topic which is relevant to his/her specialization of the programme. The topic may be experimental or analytical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

TOTAL: 90 PERIODS

COURSE OUTCOMES:	
Upon completion of the course, the students will.../ will be able to...	
CO1:	Develop the ability to solve a specific problem right from its identification and literature review till the successful solution and prepare project reports.

Mapping of Course Outcomes to Programme Outcomes

CO	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	3	3	3	-
Average	3	3	3	3	3	-

3-High, 2- Medium, 1-Low

SEMESTER IV

CP22401	PROJECT WORK II	L	T	P	C
		0	0	24	12

COURSEOBJECTIVES:

- To solve the identified problem based on the formulated methodology.
- To develop skills to analyze and discuss the test results, and make conclusions.

SYLLABUS

The student should continue the phase I work on the selected topic as per the formulated methodology / Undergo internship. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated based on the report and the viva-voce examination by a panel of examiners including one external examiner.

TOTAL: 360 PERIODS

COURSE OUTCOMES:	
Upon completion of the course, the students will.../ will be able to...	
CO1:	Discover potential research areas in the field of Computer Science Engineering about the knowledge gained from theoretical and practical courses to be creative, well planned, organized and coordinated, and present the findings of the work conducted by report.

Mapping of Course Outcomes to Programme Outcomes

CO	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	3	3	3	3
Average	3	3	3	3	3	3

3-High, 2- Medium, 1-Low

PROFESSIONAL ELECTIVE I

CP22111	NETWORK TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSEOBJECTIVES:

- To understand the basic concepts of networks
- To explore various technologies in the wireless domain
- To study about 4G and 5G cellular networks
- To learn about Network Function Virtualization
- To understand the paradigm of Software defined networks

UNITI	NETWORKING CONCEPTS	9

Peer to Peer Vs Client-Server Networks. Network Devices. Network Terminology. Network Speeds. Network throughput, delay. OSI Model. Packets, Frames, and Headers. Collision and Broadcast Domains. LAN Vs WAN. Network Adapter. Hub. Switch. Router. Firewall, IP addressing.

UNIT II	WIRELESS NETWORKS	9

Wireless access techniques- IEEE 802.11a, 802.11g, 802.11e, 802.11n/ac/ax/ay/ba/be, QoS – Bluetooth – Protocol Stack – Security – Profiles – Zigbee

UNIT III	MOBILE DATA NETWORKS	9

4G Networks and Composite Radio Environment – Protocol Boosters – Hybrid 4G Wireless Networks Protocols – Green Wireless Networks – Physical Layer and Multiple Access – Channel Modelling for 4G – Concepts of 5G – channel access –air interface - Cognitive Radio spectrum management – C-RAN architecture - Vehicular communications-protocol – Network slicing – MIMO, mmWave, Introduction to 6G

UNIT IV	SOFTWARE DEFINED NETWORKS	9

SDN Architecture. Characteristics of Software-Defined Networking. SDN- and NFV-Related Standards. SDN Data Plane. Data Plane Functions. Data Plane Protocols. OpenFlow Logical Network Device. Flow Table Structure. Flow Table Pipeline. The Use of Multiple Tables. Group Table. OpenFlow Protocol. SDN Control Plane Architecture. Control Plane Functions. Southbound Interface. Northbound Interface. Routing. ITU-T Model. OpenDaylight Architecture. OpenDaylight Helium. SDN Application Plane Architecture. Northbound Interface. Network Services Abstraction Layer. Network Applications. User Interface.

UNIT V	NETWORK FUNCTIONS VIRTUALIZATION	9

Motivation-Virtual Machines –NFV benefits-requirements – architecture- NFV Infrastructure - Virtualized Network Functions - NFV Management and Orchestration- NFV Use Cases- NFV and SDN –Network virtualization – VLAN and VPN.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:	Illustrate the fundamental ideas of networks
CO2:	Discover the ideas behind wireless networks
CO3:	Summarize the 4G and 5G ideas for mobile data networks
CO4:	Enumerate the features of software-defined networks
CO5:	Demonstrate Network Functions Virtualization

REFERENCES:

1. James Bernstein, "Networking made Easy", 2018.
2. William Stallings –"Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud", First Edition, Pearson Education, 2016.

3.	HoudaLabiod, Costantino de Santis, HossamAfifi "Wi-Fi, Bluetooth, Zigbee and WiMax", Springer 2007.
4.	Erik Dahlman, Stefan Parkvall, Johan Skold, 4G: LTE/LTE-Advanced for Mobile Broadband, Academic Press, 2013.
5.	Saad Z. Asif – "5G Mobile Communications Concepts and Technologies" CRC press – 2019.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	1	-	-
CO2	2	2	3	2	-	-
CO3	1	2	2	2	-	-
CO4	2	2	3	1	-	-
CO5	2	2	3	1	-	-
CO	**2**	**2**	**3**	**1**	-	-

3-High, 2- Medium, 1-Low

CP22112	**HUMAN COMPUTER INTERACTION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSEOBJECTIVES:

- To learn the foundations of Human Computer Interaction
- Understanding Interaction Styles and to become familiar with the design technologies for individuals and persons with disabilities
- To understand the process of Evaluation of Interaction Design
- To clarify the significance of task analysis for ubiquitous computing
- To get insight on web and mobile interaction

UNITI	**FOUNDATIONS OF HCI**	**9**

Context of Interaction –Ergonomics - Designing Interactive systems – Understanding Users-cognition and cognitive frameworks, User Centred approaches Usability, Universal Usability, Understanding and conceptualizing interaction, Guidelines, Principles and Theories. Importance of User Interface: Definition-Importance of good design-Benefits of good design-Human-centered development and Evaluation-Human Performance models-A Brief history of screen design

UNIT II	**INTERACTION STYLES**	**9**

GUI: Popularity of graphics - The concept of direct manipulation - Graphical system - Characteristics - Web user - Interface Popularity - Characteristics and Principles of User Interface. Understanding interaction styles, Direct Navigation and Immersive environments, Fluid navigation, Expressive Human and Command Languages, Communication and Collaboration Advancing the user experience, Timely user Experience, Information search, Data Visualization Design process: Human Interaction with computers - Importance of Human Characteristics - Human Consideration - Human Interaction Speeds and Understanding Business Junctions.

UNIT III	**VALUATION OF INTERACTION**	**9**

Evaluation Techniques- assessing user experience- usability testing – Heuristic evaluation and walkthroughs, analytics predictive models. Cognitive models, Socio-organizational issues and stakeholder requirements, Communication and collaboration models.		
UNIT IV	**MODELS AND THEORIES**	**9**
Task analysis, dialog notations and design, Models of the system, Modeling rich interaction, Ubiquitous computing.		
UNIT V	**WEB AND MOBILE INTERACTION**	**9**
Hypertext, Multimedia and WWW, Designing for the web Direct Selection, Contextual Tools, Overlays, Inlays and Virtual Pages, Process Flow. Use Transitions-Lookup patterns-Feedback patterns Mobile apps, Mobile navigation, content and control idioms, Multi-touch gestures, Inter-app integration, Mobile web.		
TOTAL: 45 PERIODS		

COURSE OUTCOMES:	
At the end of the course, the students will be able to:	
CO1:	Explain the basics of human computer interactions via usability engineering and Cognitive modeling
CO2:	Describe the basic design paradigms and complex interaction styles
CO3:	Demonstrate the evaluation of interaction designs and implementations
CO4:	Describe the models and theories for user interaction
CO5:	Illustrate web and mobile applications

REFERENCES:

1. Ben Shneiderman, Catherine Plaisant, Maxine Cohen, Steven Jacobs, Niklas Elmqvist, “Designing the User Interface: Strategies for Effective Human-Computer Interaction”, Sixth Edition, Pearson Education, 2016.
2. Alan Dix, Janet Finlay, G D Abowd and Russel Beale, "Human Computer Interaction", Pearson Education, Third Edition, 2004.
3. Helen Sharp, Jennifer Preece, Yvonne Rogers, “Interaction Design: Beyond Human-Computer Interaction”, Wiley, Fifth Edition, 2019.
4. Alan Cooper, Robert Reimann, David Cronin, Christopher Noessel, “About Face: The Essentials of Interaction Design”, Fourth Edition, Wiley, 2014.
5. Donald A. Norman, “Design of Everyday Things”, MIT Press, 2013.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	-	-	-
CO2	3	2	3	-	-	-
CO3	3	3	2	-	-	-
CO4	3	3	2	-	-	-
CO5	2	3	1	-	-	-
CO	**3**	**3**	**2**	**-**	**-**	**-**

3-High, 2- Medium, 1-Low

CP22113	CLOUD COMPUTING TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSEOBJECTIVES:

- To gain expertise in Virtualization, Virtual Machines and deploy practical virtualization solution
- To understand the architecture, infrastructure and delivery models of cloud computing
- To explore the roster of AWS services and illustrate the way to make applications in AWS
- To gain knowledge in the working of Windows Azure and Storage services offered by Windows Azure
- To develop the cloud application using various programming model of Hadoop and Aneka

UNITI	VIRTUALIZATION AND VIRTUALIZATION INFRASTRUCTURE	6

Basics of Virtual Machines - Process Virtual Machines - System Virtual Machines - Emulation - Interpretation - Binary Translation - Taxonomy of Virtual Machines. Virtualization -Management Virtualization - Hardware Maximization - Architectures - Virtualization Management - Storage Virtualization - Network Virtualization- Implementation levels of virtualization - virtualization structure -virtualization of CPU, Memory and I/O devices - virtual clusters and Resource Management -Virtualization for data center automation

UNIT II	CLOUD PLATFORM ARCHITECTURE	12

Cloud Computing: Definition, Characteristics - Cloud deployment models: public, private, hybrid, community - Categories of cloud computing: Everything as a service: Infrastructure, platform, software- A Generic Cloud Architecture Design - Layered cloud Architectural Development -Architectural Design Challenges

UNIT III	AWS CLOUD PLATFORM – IAAS	9

Amazon Web Services: AWS Infrastructure- AWS API- AWS Management Console - Setting up AWS Storage - Stretching out with Elastic Compute Cloud - Elastic Container Service for Kubernetes- AWS Developer Tools: AWS Code Commit, AWS Code Build, AWS Code Deploy, AWS Code Pipeline, AWS code Star - AWS Management Tools: Cloud Watch, AWS Auto Scaling, AWS control Tower, Cloud Formation, Cloud Trail, AWS License Manage

UNIT IV	PAAS CLOUD PLATFORM	9

Windows Azure: Origin of Windows Azure, Features, The Fabric Controller 3 First Cloud APP in Windows Azure- Service Model and Managing Services: Definition and Configuration, Service runtime API- Windows Azure Developer Portal- Service Management API- Windows Azure Storage Characteristics-Storage Services- REST API- Blops

UNIT V	PROGRAMMING MODEL	9

Introduction to Hadoop Framework - Mapreduce, Input splitting, map and reduce functions, specifying input and output parameters, configuring and running a job 3Developing Map Reduce Applications - Design of Hadoop file system 3Setting up Hadoop Cluster- Aneka: Cloud Application Tentative Platform, Thread Programming, Task Programming and Map-Reduce Programming in Aneka

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:	Describe the concepts of virtualization in the cloud computing
CO2:	Explain the architecture, infrastructure and delivery models of cloud computing
CO3:	Develop the Cloud Application in AWS platform
CO4:	Apply the concepts of Windows Azure to design Cloud Application
CO5:	Develop services using various Cloud computing programming models

REFERENCES:	
1.	Rajkumar Buyya, Christian Vacchiola, S.ThamaraiSelvi, Mastering Cloud Computing, MCGrawHill Education (India) Pvt. Ltd., 2013.
2.	Raoul Alongi, AWS: The Most Complete Guide to Amazon Web Service from Beginner to Advanced Level, Amazon Asia- Pacific Holdings Private Limited, 2019.
3.	Bernard Golden, Amazon Web Service for Dummies, John Wiley & Sons, 2013.
4.	Sriram Krishnan, Programming: Windows Azure, O'Reilly, 2010.
5.	Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2012

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	3	2	1
CO2	-	-	-	2	2	1
CO3	-	-	2	1	3	1
CO4	2	1	1	1	3	1
CO5	2	-	3	2	2	1
CO	**2**	**1**	**2**	**2**	**2**	**1**

3-High, 2- Medium, 1-Low

CP22114	WIRELESS COMMUNICATIONS	L	T	P	C
		3	**0**	**0**	**3**

COURSEOBJECTIVES:
• To understand the basic concepts in cellular communication
• To learn the characteristics of wireless channels
• To understand the impact of digital modulation techniques in fading
• To get exposed to diversity techniques in wireless communication
• To acquire knowledge in multicarrier systems

UNITI	CELLULAR CONCEPTS	9
Frequency Reuse – Channel Assignment Strategies – Handoff Strategies – Interference and system capacity- Co-Channel Interference- Adjacent Channel Interference – Trunking and Grade of service – Improving coverage & capacity in cellular systems-Cell Splitting- Sectoring Repeaters for Range Extension-Microcell Zone Concept.		
UNIT II	**THE WIRELESS CHANNEL**	**9**
Overview of wireless systems – Physical modeling for wireless channels – Time and Frequency coherence – Statistical channel models – Capacity of wireless Channel- Capacity of Flat Fading Channel – Channel Side Information at Receiver – Channel Side Information at Transmitter and Receiver –Capacity comparisons – Capacity of Frequency Selective Fading channels.		
UNIT III	**PERFORMANCE OF DIGITAL MODULATION OVER WIRELESS CHANNELS**	**9**
Performance of flat fading and frequency selective fading – Impact on digital modulation techniques –Outage Probability– Average Probability of Error – Combined Outage and Average Error Probability – Doppler Spread – Inter symbol Interference.		
UNIT IV	**DIVERSITY TECHNIQUES**	**9**
Realization of Independent Fading Paths – Receiver Diversity – Selection Combining – Threshold Combing – Maximal-Ratio Combining – Equal - Gain Combining – Capacity with Receiver		

diversity – Transmitter Diversity – Channel known at Transmitter – Channel unknown at Transmitter – The Alamouti Scheme– Transmit & Receive Diversity-MIMO Systems.		
UNIT V	**MULTICARRIER MODULATION**	**9**
Data Transmission using Multiple Carriers – Multicarrier Modulation with Overlapping Sub channels – Mitigation of Subcarrier Fading – Discrete Implementation of Multicarrier Modulation – Peak to average Power Ratio- Frequency and Timing offset.		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
At the end of the course, the students will be able to:		
CO1:	Explain the basic concepts in cellular communication	
CO2:	Describe the characteristics of wireless channels	
CO3:	Apply multicarrier modulation in wireless communication	
CO4:	Apply various diversity techniques in wireless communication	
CO5:	Analyze the performance of the digital modulation techniques in fading channels	
REFERENCES:		
1.	Theodore. S. Rappaport, "Wireless Communications: Principles and Practice", Second Edition, Pearson Education, India, 2010.	
2.	Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2005.	
3.	David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", Wiley Series in Telecommunications, Cambridge University Press, 2005.	
4.	Saad Z. Asif, "5G Mobile Communications Concepts and Technologies" CRC press – 2019.	
5.	Keith Q. T. Zhang, "Wireless Communications: Principles, Theory and Methodology" First Edition, John Wiley & Sons, 2016.	

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	2	2	2	1
CO2	2	-	2	2	2	1
CO3	2	-	2	2	2	1
CO4	2	-	2	2	2	1
CO5	2	-	2	2	2	1
CO	**2**	**-**	**2**	**2**	**2**	**1**

3-High, 2- Medium, 1-Low

PROFESSIONAL ELECTIVES II

CP22221	PRINCIPLES OF PROGRAMMING LANGUAGES	L	T	P	C
		3	0	0	3

COURSEOBJECTIVES:

- To understand and describe syntax and semantics of programming language
- To understand data, data types, and basic statements
- To understand call-return architecture and ways of implementing them
- To understand object-orientation, concurrency, and event handling in programming languages
- To develop programs in non-procedural programming paradigms

UNITI	SYNTAX AND SEMANTICS	9

Evolution of programming languages – Describing syntax – Context-free grammars – Attribute grammars – Describing semantics – Lexical analysis – Parsing – Recursive-descent – Bottom- up parsing

UNIT II	DATA, DATA TYPES, AND BASIC STATEMENTS	9

Names – Variables – Binding – Type checking – Scope – Scope rules – Lifetime and garbage collection – Primitive data types – Strings – Array types – Associative arrays – Record types – Union types – Pointers and references – Arithmetic expressions – Overloaded operators – Type conversions – Relational and boolean expressions – Assignment statements – Mixed- mode assignments – Control structures – Selection – Iterations – Branching – Guarded statements

UNIT III	SUBPROGRAMS AND IMPLEMENTATIONS	9

Subprograms – Design issues – Local referencing – Parameter passing – Overloaded methods – Generic methods – Design issues for functions – Semantics of call and return – Implementing simple subprograms – Stack and dynamic local variables – Nested subprograms – Blocks – Dynamic scoping

UNIT IV	OBJECT-ORIENTATION, CONCURRENCY, AND EVENT HANDLING	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 Scheme – Programming with ML – Introduction to logic and logic programming – Programming with Prolog – Multi-paradigm languages

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:	Describe statements, syntax and semantics of programming languages
CO2:	Explain the data types, control structures in programming languages
CO3:	Apply object-oriented construct and subprogram concept
CO4:	Implement concurrency and event handling programming constructs
CO5:	Implement programs using different paradigms

REFERENCES:

1.	Robert W. Sebesta, "Concepts of Programming Languages", Eleventh Edition, Addison Wesley, 2012.
2.	W. F. Clocksin and C. S. Mellish, "Programming in Prolog: Using the ISO Standard", Fifth

	Edition, Springer, 2003.
3.	Michael L. Scott, "Programming Language Pragmatics", Fourth Edition, Morgan Kaufmann, 2009.
4.	R.Kent Dybvig, "The Scheme Programming Language", Fourth Edition, MIT Press, 2009.
5.	Hridesh Rajan, "An Experiential Introduction to Principles of Programming Languages", MIT Press, 2022.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	1	1	-	-
CO2	1	-	1	1	-	-
CO3	1	-	1	1	-	-
CO4	1	-	1	2	-	-
CO5	2	-	3	3	2	-
CO	**1**	**-**	**1**	**2**	**2**	**-**

3-High, 2- Medium, 1-Low

CP22222	OPTIMIZATION TECHNIQUES AND APPLICATIONS	L	T	P	C
		3	**0**	**0**	**3**

COURSEOBJECTIVES:

- To impart in-depth knowledge on different advanced optimization techniques to solve engineering problems
- To understand the concept of multi-objective optimization and its applications

UNITI	FUNDAMENTALS OF OPTIMIZATION	9

Definition - Classification of optimization problems - Unconstrained and Constrained optimization – Optimality conditions - Classical Optimization techniques - Linear and non - linear programming - Quadratic programming - Mixed integer programming - Intelligent Search methods – Advantages of intelligent techniques over classical optimization techniques.

UNIT II	EVOLUTIONARY COMPUTATION TECHNIQUES	9

Evolution in nature - Fundamentals of Evolutionary algorithms - Principle of Genetic Algorithm – Evolutionary Strategy and Evolutionary Programming - Genetic Operators - Selection, Crossover and Mutation - Issues in GA implementation - Differential Evolution technique.

UNIT III	PARTICLE SWARM OPTIMIZATION	9

Fundamental principle - Velocity Updation - Parameter selection- hybrid approaches - hybrid of GA and PSO – hybrid of EP and PSO - Binary, discrete and combinatorial PSO - Implementation issues - Convergence issues – Fly Bee Algorithm.

UNIT IV	ADDITIONAL OPTIMIZATION METHODS	9

Simulated annealing algorithm - Tabu search algorithm - Ant colony optimization - Bacteria Foraging optimization - Artificial immune system.

UNIT V	MULTI OBJECTIVE OPTIMIZATION	9

Concept of pareto optimality - Conventional approaches for MOO - Weighted Sum and Constrained methods - Multiobjective GA - Fitness assignment - Multi-objective PSO -Dynamic neighbourhood PSO - Vector evaluated PSO – Necessity for multi-criteria decision making.

	TOTAL: 45 PERIODS
COURSE OUTCOMES:	
At the end of the course, the students will be able to:	
CO1:	Familiarize with the basic concept of optimization techniques
CO2:	Explain the concept of different advanced optimization techniques and their applications
CO3:	Explain the concept of Multi-objective optimization and apply it for solving real world problems
CO4:	Apply Genetic Algorithm for solving engineering problems
CO5:	Apply Swarm Optimization techniques for solving engineering problems
REFERENCES:	
1.	Kalyanmoy Deb, "Multi objective optimization using Evolutionary Algorithms", John Wiley and Sons, 2020.
2.	Kalyanmoy Deb, "Optimization for Engineering Design - Algorithms and Examples", Prentice Hall of India, 1995.
3.	David Goldberg, "Genetic Algorithms in Search, Optimization, and Machine Learning", Addison-Wesley, Reading, 1989.
4.	Kwang Y.Lee, Mohammed A.El Sharkawi, "Modern heuristic optimization techniques", John Wiley and Sons, 2008.
5.	Carlos A.Coello Coello, Gary B.Lamont, David A.Van Veldhuizen, "Evolutionary Algorithms for solving Multi Objective Problems", Second Edition, Springer, 2007.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	1	1	-
CO2	3	2	2	1	1	-
CO3	3	2	2	1	1	-
CO4	3	2	2	1	1	-
CO5	3	2	2	1	1	-
CO	**3**	**2**	**2**	**1**	**1**	**-**

3-High, 2- Medium, 1-Low

CP22223	**NATURAL LANGUAGE PROCESSING TECHNIQUES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
COURSEOBJECTIVES:					
• To understand basics of linguistics, probability and statistics					
• To study statistical approaches to NLP and understand sequence labeling					
• To outline different parsing techniques associated with NLP					
• To explore semantics of words and semantic role labeling of sentences					
• To understand discourse analysis, question answering and chatbots					
UNITI	**INTRODUCTION**				**9**
Natural Language Processing – Components - Basics of Linguistics and Probability and Statistics -Words-Tokenization-Morphology-Finite State Automata					
UNIT II	**STATISTICAL NLP AND SEQUENCE LABELING**				**9**
N-grams and Language models –Smoothing -Text classification- Naïve Bayes classifier –					

Evaluation - Vector Semantics – TF-IDF - Word2Vec- Evaluating Vector Models –Sequence Labeling – Part of Speech – Part of Speech Tagging -Named Entities –Named Entity Tagging		
UNIT III	**CONTEXTUAL EMBEDDING**	**9**
Constituency –Context Free Grammar –Lexicalized Grammars- CKY Parsing – Earley's algorithm Evaluating Parsers -Partial Parsing – Dependency Relations- Dependency Parsing - Transition Based - Graph Based		
UNIT IV	**COMPUTATIONAL SEMANTICS**	**9**
Word Senses and WordNet – Word Sense Disambiguation – Semantic Role Labeling – Proposition Bank- FrameNet- Selectional Restrictions - Information Extraction - Template Filling		
UNIT V	**DISCOURSE ANALYSIS AND SPEECH PROCESSING**	**9**
Discourse Coherence – Discourse Structure Parsing – Centering and Entity Based Coherence – Question Answering –Factoid Question Answering – Classical QA Models – Chatbots and Dialogue systems – Frame-based Dialogue Systems – Dialogue–State Architecture		
TOTAL: 45 PERIODS		

COURSE OUTCOMES:	
At the end of the course, the students will be able to:	
CO1:	Recall the basics of linguistics, probability and statistics associated with NLP
CO2:	Demonstrate a sequence labeling problem for a given domain
CO3:	Illustrate the parsing techniques associated with NLP
CO4:	Build semantic processing tasks and simple document indexing and searching system using the concepts of NLP
CO5:	Develop a simple chatbot using dialogue system concepts

REFERENCES:

1.	Daniel Jurafsky and James H.Martin, "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition" (Prentice Hall Series in Artificial Intelligence), 2020.
2.	Christopher Manning, "Foundations of Statistical Natural Language Processing", MIT Press, 2009.
3.	Nitin Indurkhya, Fred J. Damerau, "Handbook of Natural Language Processing", Second edition, Chapman & Hall/CRC: Machine Learning & Pattern Recognition, Hardcover, 2010.
4.	Deepti Chopra, Nisheeth Joshi, "Mastering Natural Language Processing with Python", Packt Publishing Limited, 2016.
5.	Samuel Burns "Natural Language Processing: A Quick Introduction to NLP with Python and NLTK, 2019.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	**Programme Outcomes**					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	1	1	-
CO2	3	2	2	1	1	-
CO3	3	2	2	1	1	-
CO4	3	2	2	1	1	-
CO5	3	2	2	1	1	-
CO	**3**	**2**	**2**	**1**	**1**	**-**

3-High, 2- Medium, 1-Low

CP22224	GPU COMPUTING	L	T	P	C
		3	0	0	3

COURSEOBJECTIVES:

- To understand the basics of GPU architectures
- To understand GPU Program Partitioning
- To write programs for massively parallel processors
- To understand the issues in mapping algorithms for GPUs
- To introduce different GPU programming models

UNITI	GPU ARCHITECTURE	9

Evolution of GPU architectures - Understanding Parallelism with GPU –Typical GPU Architecture - CUDA Hardware Overview –Setting up CUDA- Threads, Blocks, Grids, Warps, Scheduling - Memory Handling with CUDA: Shared Memory, Global Memory, Constant Memory and Texture Memory.

UNIT II	CUDA PROGRAMMING	9

Using CUDA - Multi GPU - Multi GPU Solutions - Optimizing CUDA Applications: Problem Decomposition, Memory Considerations, Transfers, Thread Usage, Resource Contentions.

UNIT III	PROGRAMMING ISSUES	9

Common Problems: CUDA Error Handling, Parallel Programming Issues, Synchronization, Algorithmic Issues, Finding and Avoiding Errors.

UNIT IV	OPENCL BASICS	9

OpenCL Standard – Kernels – Host Device Interaction – Execution Environment – Memory Model – Basic OpenCL Examples.

UNIT V	ALGORITHMS ON GPU	9

Parallel Patterns: Convolution, Prefix Sum, Sparse Matrix - Matrix Multiplication – Programming- Heterogeneous Cluster.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:	Explain the basics of GPU Architecture
CO2:	Illustrate the process of optimizing CUDA applications
CO3:	Describe the issues in GPU programming
CO4:	Implement programs using OpenCL
CO5:	Implement efficient algorithms in GPUs for common application kernels

REFERENCES:

1.	Shane Cook, CUDA Programming: A Developer's Guide to Parallel Computing with GPUs (Applications of GPU Computing), First Edition, Morgan Kaufmann, 2012.
2.	David R. Kaeli, Perhaad Mistry, Dana Schaa, Dong Ping Zhang, Heterogeneous computing with OpenCL, Third Edition, Morgan Kauffman, 2015.
3.	Nicholas Wilt, CUDA Handbook: A Comprehensive Guide to GPU Programming, Addison - Wesley, 2013.
4.	Jason Sanders, Edward Kandrot, CUDA by Example: An Introduction to General Purpose GPU Programming, Addison - Wesley, 2010.
5.	David B. Kirk, Wenmei W. Hwu, Programming Massively Parallel Processors - A Hands-on Approach, Third Edition, Morgan Kaufmann, 2016.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	1	3	1
CO2	2	1	3	2	3	1
CO3	2	1	3	2	3	1
CO4	2	1	3	2	3	1
CO5	2	1	3	2	3	1
CO	**2**	**1**	**3**	**2**	**3**	**1**

3-High, 2- Medium, 1-Low

PROFESSIONAL ELECTIVES III

CP22231	PERFORMANCE ANALYSIS OF COMPUTER SYSTEMS	L	T	P	C
		3	0	0	3

COURSEOBJECTIVES:

- To understand the mathematical foundations needed for performance evaluation of computer systems
- To understand the metrics used for performance evaluation
- To understand the analytical modeling of computer systems
- To enable the students to develop new queuing analysis for both simple and complex systems
- To appreciate the use of smart scheduling and introduce the students to analytical techniques for evaluating scheduling policies

UNITI	OVERVIEW OF PERFORMANCE EVALUATION	9

Need for Performance Evaluation in Computer Systems – Overview of Performance Evaluation Methods – Introduction to Queuing – Probability Review – Generating Random Variables for Simulation – Sample Paths, Convergence and Averages – Little‘s Law and other Operational Laws – Modification for Closed Systems.

UNIT II	MARKOV CHAINS AND SIMPLE QUEUES	9

Discrete-Time Markov Chains – Ergodicity Theory – Real World Examples – Google, Aloha – Transition to Continuous-Time Markov Chain – M/M/1.

UNIT III	MULTI-SERVER AND MULTI-QUEUE SYSTEMS	9

Server Farms: M/M/k and M/M/k/k – Capacity Provisioning for Server Farms – Time Reversibility and Burke‘s Theorem – Networks of Queues and Jackson Product Form – Classed and Closed Networks of Queues.

UNIT IV	REAL-WORLD WORKLOADS	9

Case Study of Real-world Workloads – Phase-Type Distributions and Matrix-Alalytic Methods – Networks with Time-Sharing Servers – M/G/1 Queue and the Inspection Paradox – Task Assignment Policies for Server Farms.

UNIT V	SMART SCHEDULING IN THE M/G/1	9

Performance Metrics – Scheduling Non-Preemptive and Preemptive Non-Size-Based Policies - Scheduling Non-Preemptive and Preemptive Size-Based Policies – Scheduling - SRPT and Fairness.

TOTAL: 45 PERIODS

COURSE OUTCOMES:	
At the end of the course, the students will be able to:	
CO1:	Describe the mathematical foundations needed for performance evaluation of computer systems
CO2:	Identify appropriate tools for various performance measurements
CO3:	Explain the queuing analysis for both simple and complex systems
CO4:	Predict and forecast workload and performance parameters of a given computer system
CO5:	Use smart scheduling and analytical techniques for evaluating scheduling policies

REFERENCES:

1. K. S. Trivedi, "Probability and Statistics with Reliability, Queueing and Computer Science Applications", John Wiley and Sons, Second Edition, 2016.
2. Krishna Kant, "Introduction to Computer System Performance Evaluation‖, McGraw-Hill, 1992.
3. Lieven Eeckhout, Computer Architecture Performance Evaluation Methods, Morgan and Claypool Publishers, 2010.
4. Paul J. Fortier and Howard E. Michel, "Computer Systems Performance Evaluation and Prediction", Elsevier, 2003.
5. Raj Jain, "The Art of Computer Systems Performance Analysis: Techniques for Experimental Design, Measurement, Simulation and Modeling, Wiley-Interscience, 1991.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	2	2	-	1	2
CO2	-	2	2	1	1	2
CO3	-	2	2	1	1	2
CO4	-	2	2	1	1	2
CO5	-	2	2	1	1	2
CO	-	**2**	**2**	**1**	**1**	**2**

3-High, 2- Medium, 1-Low

CP22232	DATA INTENSIVE COMPUTING	L	T	P	C
		3	**0**	**0**	**3**

COURSEOBJECTIVES:

- To understand the basics of the various database systems including databases for big data
- To learn about the architecture of data intensive computing
- To learn about parallel processing for data intensive computing
- To learn about Security in Data Intensive Computing Systems
- To learn about the applications that involves Data intensive computing

UNITI	INTRODUCTION	9

Introduction to Distributed systems – Databases Vs. File Systems - Distributed file systems(HDFS) – Distributed Machine-Learning System - Data Parallelism – Characteristics - Hadoop –Execution Engines -Map Reduce- Distributed Storage System for Structured Data – NoSQL databases -Casandra, Mongo DB-Developing a Distributed Application

UNIT II	ARCHITECTURES AND SYSTEMS	9
High performance Network Architectures for Data intensive Computing – Architecting Data Intensive Software systems – ECL/HPCC: A Unified approach to Big Data – Scalable storage for Data Intensive Computing - Computation and Storage of scientific data sets in cloud- Stream Data Model - Architecture for Data Stream Management-Stream Queries –Sampling Data in a Stream Filtering Streams		
UNIT III	**TECHNOLOGIES AND TECHNIQUES**	**9**
Load balancing techniques for Data Intensive computing – Resource Management for data Intensive Clouds – SALT - Parallel Processing, Multiprocessors and Virtualization in Data intensive Computing - Challenges in Data Intensive Analysis and Visualization - Large-Scale Data Analytics Using Ensemble Clustering - Ensemble Feature Ranking Methods for Data Intensive Computing Application - Record Linkage Methodology and Applications- Semantic Wrapper		
UNIT IV	**SECURITY**	**9**
Security in Data Intensive Computing Systems - Data Security and Privacy in Data-Intensive Supercomputing Clusters - Information Security in Large Scale Distributed Systems -Privacy and Security Requirements of Data Intensive Applications in Clouds		
UNIT V	**APPLICATIONS AND FUTURE TRENDS**	**9**
Cloud and Grid Computing for Data Intensive Applications -Scientific Applications - Bioinformatics Large Science Discoveries - Climate Change - Environment - Energy - Commercial Applications - Future trends in Data Intensive Computing		
TOTAL: 45 PERIODS		

COURSE OUTCOMES:	
At the end of the course, the students will be able to:	
CO1:	Describe the basics of the various database systems including databases for big data
CO2:	Suggest appropriate architecture for data intensive computing systems
CO3:	Identify parallel processing techniques for data intensive computing
CO4:	Decide on the various security techniques that are necessary for data intensive applications
CO5:	Design applications that involve data intensive computing

REFERENCES:

1.	Tom White, “Hadoop: The Definitive Guide”, O'Reilly Media. October 2010.
2.	Hector Garcia-Molina, Jeffrey D. Ullman, and Jennifer Widom, “Database Systems: The Complete Book”, Pearson, 2013.
3.	Furht, Borko, Escalante, Armando, “Handbook of Data Intensive Computing”, Springer 2011.
4.	Ian Gorton, Deborah k. Gracio, “Data-Intensive Computing Architectures, Algorithms, and Applications”, Cambridge University Press 2013.
5.	Mamta Mittal, Valentina E. Balas, D. Jude Hemanth, Raghvendra Kumar, & Data Intensive Computing Applications for Big Data”, IOS Press, 2018.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	2	3	1
CO2	1	-	-	2	2	1
CO3	1	-	-	2	2	2
CO4	1	-	–	2	1	1

CO5	1	-	-	3	2	1
CO	**1**	**-**	**-**	**2**	**2**	**1**

3-High, 2- Medium, 1-Low

CP22233	**INTERNET OF THINGS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSEOBJECTIVES:

- To understand the fundamentals of IoT
- To gain knowledge on how IoT is related with other enabling technologies
- To understand the IoT Reference architecture
- To learn the basics of different IoT protocols
- To gain experience in Raspberry PI and experiment simple IoT application on it

UNITI	**INTRODUCTION TO IoT**	**9**

Internet of Things- Physical Design- Logical Design- IoT Enabling Technologies - IoT Levels & Deployment Templates - Domain Specific IoTs - IoT and M2M - IoT System Management with NETCONF-YANG- IoT Platforms Design Methodology

UNIT II	**ARCHITECTURE**	**9**

ETSI high-level architecture-Reference model and architecture - IoT reference model- Information model – Functional model – Communication model- IoT reference architecture – Smart grid

UNIT III	**PROTOCOLS**	**9**

IEEE 802.15.4 -BACNet Protocol - Z-Wave – ModBus – ZigBee - 6LoWPAN – CoAP – MQTT

UNIT IV	**IOT PROJECTS ON RASPBERRY PI**	**9**

Building IOT with RASPBERRY PI- IoT Device -Building blocks – Programming Raspberry PI with Python -Creating the sensor project - Preparing Raspberry Pi - Clayster libraries – Hardware Interacting with the hardware - Interfacing the hardware- Internal representation of sensor values - Persisting data - External representation of sensor values - Exporting sensor data – Arduino

UNIT V	**ENABLING TECHNOLOGIES**	**9**

IaaS- PaaS – SaaS - Sensor-Cloud for IoT - Fog-Computing applications –Towards a Greener-IoT –Security in IoT

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:	Describe the basics and levels of IoT
CO2:	Outline the functions of different components used in building IoT
CO3:	Interpret the working of various enabling technologies
CO4:	Develop simple real time projects in IoT
CO5:	Analyze the performances of protocols used by IoT

REFERENCES:

1.	Arshdeep Bahga, Vijay Madisetti, “Internet of Things – A hands-on approach”, Universities Press, 2015.
2.	Peter Waher, “Learning Internet of Things”, Packt Publishing, 2015.
3.	Jan Ho¨ ller, Vlasios Tsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.
4.	Olivier Hersent, David Boswarthick, Omar Elloumi, “The Internet of Things – Key applications and Protocols”, Wiley, 2012.

5.	Sudip Misra, Subhadeep Sarkar, Subarna Chatterjee, "Sensors, Cloud and Fog: The enabling Technologies for the Internet of Things", CRC Press, 2019.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2	1	1
CO2	3	1	3	2	1	1
CO3	3	1	3	2	1	1
CO4	3	3	3	3	3	3
CO5	3	1	3	2	1	2
CO	**3**	**1**	**3**	**2**	**1**	**2**

3-High, 2- Medium, 1-Low

CP22234	**SOFTWARE QUALITY ASSURANCE**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSEOBJECTIVES:

- Be exposed to the software quality factors, Quality Assurance (SQA) architecture and SQA components
- Understand the integration of SQA components into the project life cycle
- Be familiar with the software quality infrastructure
- Be exposed to the management components of software quality
- Be familiar with the Quality standards, certifications and assessments

UNITI	**INTRODUCTION TO SOFTWARE QUALITY & ARCHITECTURE**	**9**

Need for Software quality – Software quality assurance (SQA) – Software quality factors- McCall's quality model – SQA system components – Pre project quality components – Development and quality plans.

UNIT II	**SQA COMPONENTS AND PROJECT LIFE CYCLE**	**9**

Integrating quality activities in the project life cycle – Reviews – Software Testing – Quality of software maintenance components – Quality assurance for external participants contribution – CASE tools for software quality Management.

UNIT III	**SOFTWARE QUALITY INFRASTRUCTURE**	**9**

Procedures and work instructions – Supporting quality devices - Staff training and certification - Corrective and preventive actions – Configuration management – Software change control – Configuration management audit -Documentation control.

UNIT IV	**SOFTWARE QUALITY MANAGEMENT & METRICS**	**9**

Project process control – Software quality metrics – Cost of software quality – Classical quality cost model – Extended model – Application and Problems in application of Cost model

UNIT V	**STANDARDS, CERTIFICATIONS & ASSESSMENTS**	**9**

Quality management standards – ISO 9001 and ISO 9000-3 –Capability Maturity Models – CMM and CMMI assessment methodologies - Bootstrap methodology – SPICE Project – SQA project process standards – Organization of Quality Assurance – Role of management in SQA – SQA units and other actors in SQA systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:	
At the end of the course, the students will be able to:	
CO1:	Utilize the concepts of SQA in software development life cycle
CO2:	Demonstrate their capability to adopt quality standards
CO3:	Describe the software quality infrastructure
CO4:	Apply the concepts in preparing the quality plan & documents
CO5:	Analyze whether the product meets company's quality standards and client's expectations and demands
REFERENCES:	
1.	Daniel Galin, "Software Quality Assurance", Pearson Publication, 2009.
2.	Kshirasagar Naim and Priyadarshi Tripathy," Software Testing and Quality Assurance Theory and Practice", John Wiley & Sons Inc., 2008.
3.	Alan C. Gillies, "Software Quality: Theory and Management", International Thomson Computer Press, 2011.
4.	Mordechai Ben-Menachem, "Software Quality: Producing Practical Consistent Software", International Thompson Computer Press, 2014.
5.	Jeff Tian, John Wiley & Sons, "Software Quality Engineering: Testing, Quality Assurance, and Quantifiable Improvement", Inc., Hoboken, New Jersey. 2005.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	-	-	-
CO2	2	2	2	2	-	-
CO3	2	2	2	2	-	-
CO4	2	2	2	2	-	-
CO5	1	2	2	1	-	-
CO	**2**	**2**	**2**	**3**	-	-

3-High, 2- Medium, 1-Low

PROFESSIONAL ELECTIVES IV

CP22341	ADVANCED DIGITAL IMAGE PROCESSING	L	T	P	C
		3	0	0	3

COURSEOBJECTIVES:

- To understand the essentials of digital image processing.
- To know about various segmentation techniques for image analysis.
- To get an understanding of various feature extraction techniques for image analysis.
- To understand the concepts of image registration and fusion.
- To get an understanding of 3D image visualization.

UNITI	REVIEW OF DIGITAL IMAGE PROCESSING	9

Steps in digital image processing-Elements of visual perception- brightness adaptation, Mach band effect. Image enhancement in spatial and frequency domain, Histogram equalization

UNIT II	SEGMENTATION	9

Edge detection, Thresholding, Region growing, Fuzzy clustering, Watershed algorithm, Active contour models, Texture feature based segmentation, Graph based segmentation, Wavelet based Segmentation - Applications of image segmentation.

UNIT III	FEATURE EXTRACTION	9

First and second order edge detection operators, Phase congruency, Localized feature extraction - detecting image curvature, shape features, Hough transform, shape skeletonization, Boundary descriptors, Moments, Texture descriptors- Autocorrelation, Co-occurrence features, Runlength features, Fractal model based features, Gabor filter, wavelet features.

UNIT IV	REGISTRATION AND IMAGE FUSION	9

Registration - Preprocessing, Feature selection - points, lines, regions and templates Feature correspondence - Point pattern matching, Line matching, Region matching, Template matching. Transformation functions - Similarity transformation and Affine Transformation. Resampling – Nearest Neighbour and Cubic Splines. Image Fusion - Overview of image fusion, pixel fusion, wavelet based fusion -region based fusion.

UNIT V	3D IMAGE VISUALIZATION	9

Sources of 3D Data sets, Slicing the Data set, Arbitrary section planes, The use of color, Volumetric display, Stereo Viewing, Ray tracing, Reflection, Surfaces, Multiple connected surfaces, Image processing in 3D, Measurements on 3D images

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:	Explain the essentials of digital image processing.
CO2:	Describe various segmentation techniques for image analysis.
CO3:	Outline the various feature extraction techniques for image analysis.
CO4:	Discuss the concepts of image registration and fusion.
CO5:	Illustrate 3D image visualization.

REFERENCES:

1. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing', Pearson Education, Inc., Second Edition, 2004.

2.	Mark Nixon, Alberto Aguado, "Feature Extraction and Image Processing", Academic Press, 2008.
3.	Ardeshir Goshtasby, "2D and 3D Image registration for Medical, Remote Sensing and Industrial Applications", John Wiley and Sons, 2005.
4.	John C.Russ, "The Image Processing Handbook", CRC Press, 2007.
5.	Rick S.Blum, Zheng Liu, "Multisensor image fusion and its Applications", Taylor & Francis, 2006.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	-	-	-
CO2	2	2	2	-	2	1
CO3	2	2	2	-	2	1
CO4	2	1	2	-	3	3
CO5	2	1	2	-	3	3
CO	**2**	**2**	**2**	**-**	**2**	**1**

3-High, 2- Medium, 1-Low

CP22342	**INFORMATION RETRIEVAL TECHNIQUES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSEOBJECTIVES:

- To understand the basics of information retrieval with pertinence to modeling, query operations and indexing
- To get an understanding of machine learning techniques for text classification and clustering.
- To understand the various applications of information retrieval giving emphasis to multimedia IR, web search
- To get an understanding of machine learning techniques for text classification and clustering.
- To understand the concepts of digital libraries

UNITI INTRODUCTION: MOTIVATION **9**

Basic Concepts – Practical Issues - Retrieval Process – Architecture - Boolean Retrieval – Retrieval Evaluation – Open-Source IR Systems–History of Web Search – Web Characteristics– The impact of the web on IR —IR Versus Web Search–Components of a Search engine.

UNIT II MODELING **9**

and Characterization of IR Models – Boolean Model – Vector Model - Term Weighting – Scoring and Ranking –Language Models – Set Theoretic Models - Probabilistic Models – Algebraic Models – Structured Text Retrieval Models – Models for Browsing

UNIT III INDEXING **9**

Static and Dynamic Inverted Indices – Index Construction and Index Compression. Searching - Tentative Sequential Searching and Pattern Matching. Query Operations -Query Languages – Query Processing - Relevance Feedback and Query Expansion - Automatic Local and Global Analysis – Measuring Effectiveness and Efficiency

UNIT IV	EVALUATION AND PARALLEL INFORMATION RETRIEVAL	9
Effectiveness Measures – Statistics in Evaluation – Minimizing Adjudication Effect – Nontraditional Effectiveness Measures – Measuring Efficiency – Efficiency Criteria –Queueing Theory – Query Scheduling – Parallel Information Retrieval – Parallel Query Processing – MapReduce.		
UNIT V	**SEARCHING THE WEB**	**9**
The Web –Structure of the Web –IR and web search – Static and Dynamic Ranking – Web Crawling and Indexing – Link Analysis - XML Retrieval Multimedia IR: Models and Languages – Indexing and Searching Parallel and Distributed IR – Digital Libraries.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES:		
At the end of the course, the students will be able to:		
CO1:	Explain the basic and advanced concepts of IR	
CO2:	Describe the various information Retrieval models.	
CO3:	Explain different indexing and query processing for IR.	
CO4:	Demonstrate evaluation methods and parallel information retrieval.	
CO5:	Apply indexing and searching on parallel and distributed IR.	
REFERENCES:		
1.	Christopher D. Manning, Prabhakar Raghavan, Hinrich Schutze, "Introduction to Information Retrieval, Cambridge University Press, First South Asian Edition, 2008.	
2.	Ricardo Baeza – Yates, Berthier Ribeiro – Neto, "Modern Information Retrieval: The concepts and Technology behind Search (ACM Press Books), Second Edition, 2011.	
3.	Stefan Buttcher, Charles L. A. Clarke, Gordon V. Cormack, "Information Retrieval Implementing and Evaluating Search Engines", The MIT Press Cambridge, Massachusetts London, England, 2016.	
4.	W. Bruce Croft, Donald Metzler, Trevor Strohman, "Search Engines: Information Retrieval in Practice", Pearson Education, Inc - 2015.	
5.	Mark Levene, "An Introduction To Search Engines And Web Navigation", A John Wiley & Sons, Inc., Publication - 2010	

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	-	-	-
CO2	2	2	2	-	1	1
CO3	2	2	2	-	1	1
CO4	2	1	2	-	3	3
CO5	2	1	2	-	3	3
CO	**2**	**2**	**2**	**-**	**2**	**1**

3-High, 2- Medium, 1-Low

CP22343	COGNITIVE COMPUTING	L	T	P	C
		3	0	0	3

COURSEOBJECTIVES:

- To familiarize Use the Innovation Canvas to justify potentially successful products.
- To learn various ways in which to develop a product idea.
- To understand about how Big Data can play vital role in Cognitive Computing
- To know about the business applications of Cognitive Computing
- To get into all applications of Cognitive Computing

UNITI	FOUNDATION OF COGNITIVE COMPUTING	9

Foundation of Cognitive Computing: cognitive computing as a new generation, the uses of cognitive systems, system cognitive, gaining insights from data, Artificial Intelligence as the foundation of cognitive computing, understanding cognition. Design Principles for Cognitive Systems: Components of a cognitive system, building the corpus, bringing data into cognitive system, machine learning, hypotheses generation and scoring, presentation, and visualization services

UNIT II	NATURAL LANGUAGE PROCESSING IN COGNITIVE SYSTEMS	9

Natural Language Processing in support of a Cognitive System: Role of NLP in a cognitive system, Semantic web, Applying Natural language technologies to Business problems, Representing knowledge in Taxonomies and Ontologies: Representing knowledge, Defining Taxonomies and Ontologies, knowledge representation, models for knowledge representation, implementation considerations

UNIT III	BIG DATA AND COGNITIVE COMPUTING	9

Relationship between Big Data and Cognitive Computing: Dealing with human-generated data, defining big data, architectural foundation, analytical data warehouses, Hadoop, data in motion and streaming data, integration of big data with traditional data, Applying Advanced Analytics to cognitive computing: Advanced analytics is on a path to cognitive computing, Key capabilities in advanced analytics, using advanced analytics to create value, Impact of open source tools on advanced analytics

UNIT IV	BUSINESS IMPLICATIONS OF COGNITIVE COMPUTING	9

Preparing for change, advantages of new disruptive models, knowledge meaning to business, difference with a cognitive systems approach, meshing data together differently, using business knowledge to plan for the future, answering business questions in new ways, building business specific solutions, making cognitive computing a reality, cognitive application changing the market. The process of building a cognitive application: Emerging cognitive platform, defining the objective, defining the domain, understanding the intended users and their attributes, questions and exploring insights, training and testing

UNIT V	APPLICATION OF COGNITIVE COMPUTING	9

Building a cognitive health care application: Foundations of cognitive computing for healthcare, constituents in healthcare ecosystem, learning from patterns in healthcare Data, Building on a foundation of big data analytics, cognitive applications across the health care eco system, starting with a cognitive application for healthcare, using cognitive applications to

improve health and wellness, using a cognitive application to enhance the electronic medical record, Using cognitive application to improve clinical teaching	
TOTAL: 45 PERIODS	
COURSE OUTCOMES:	
At the end of the course, the students will be able to:	
CO1:	Explain foundation of cognitive computing
CO2:	Illustrate natural language processing in cognitive systems
CO3:	Explain about big data and cognitive computing
CO4:	Discover the business implications of cognitive computing
CO5:	Examine applications of cognitive computing
REFERENCES:	
1.	Judith H Hurwitz, Marcia Kaufman, Adrian Bowles, "Cognitive computing and Big Data Analytics", Wiley, 2015
2.	Robert A. Wilson, Frank C. Keil, "The MIT Encyclopaedia of the Cognitive Science", The MIT Press, 1999.
3.	Noah D. Goodman, Joshua B. Tenenbaum, The ProbMods Contributors, "Probabilistic Models of Cognition", Second Edition, 2016, https://probmods.org/.
4.	Bernadette Sharp, Florence Sedes, Wieslaw Lubaszewski, "Cognitive Approach to Natural Language Processing", Elsevier, 31-May-2017.
5.	Vishal Jain, Akash Tayal, Jaspreet Singh, Arun Solanki, "Cognitive Computing Systems Applications and Technological Advancements" First Edition, 2021.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	-	2	2	-
CO2	-	-	-	2	2	2
CO3	2	-	-	1	1	3
CO4	1	-	-	1	3	1
CO5	2	-	-	2	2	2
CO	**2**	**-**	**-**	**2**	**2**	**2**

3-High, 2- Medium, 1-Low

CP22344	**DATA VISUALIZATION TECHNIQUES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
COURSEOBJECTIVES:					
• To develop skills to both design and critique visualizations.					
• To introduce visual perception and core skills for visual analysis.					
• To understand technological advancements of data visualization					
• To understand various data visualization techniques					
• To understand the methodologies used to visualize large data sets					
UNITI	**INTRODUCTION AND DATA FOUNDATION**				**9**
Basics - Relationship between Visualization and Other Fields - The Visualization Process - Pseudo code Conventions - The Scatter plot. Data Foundation - Types of Data - Structure within and between Records - Data Preprocessing - Data Sets					

UNIT II	FOUNDATIONS FOR VISUALIZATION	9
Visualization stages - Semiology of Graphical Symbols - The Eight Visual Variables – Historical Perspective - Taxonomies - Experimental Semiotics based on Perception Gibson's Affordance theory – A Model of Perceptual Processing.		
UNIT III	**VISUALIZATION TECHNIQUES**	**9**
Spatial Data: One-Dimensional Data - Two-Dimensional Data – Three Dimensional Data - Dynamic Data - Combining Techniques. Geospatial Data: Visualizing Spatial Data - Visualization of Point Data -Visualization of Line Data - Visualization of Area Data – Other Issues in Geospatial Data Visualization Multivariate Data: Point-Based Techniques – Line-Based Techniques - Region-Based Techniques - Combinations of Techniques – Trees Displaying Hierarchical Structures – Graphics and Networks- Displaying Arbitrary Graphs/Networks.		
UNIT IV	**INTERACTION CONCEPTS AND TECHNIQUES**	**9**
Text and Document Visualization: Introduction - Levels of Text Representations - The Vector Space Model - Single Document Visualizations -Document Collection Visualizations – Extended Text Visualizations Interaction Concepts: Interaction Operators - Interaction Operands and Spaces - A Unified Framework. Interaction Techniques: Screen Space - Object-Space –Data Space - Attribute Space- Data Structure Space - Visualization Structure – Animating Transformations - Interaction Control.		
UNIT V	**RESEARCH DIRECTIONS IN VISUALIZATIONS**	**9**
Steps in designing Visualizations – Problems in designing effective Visualizations- Issues of Data. Issues of Cognition, Perception, and Reasoning. Issues of System Design Evaluation, Hardware and Applications		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
At the end of the course, the students will be able to:	
CO1:	Visualize the objects in different dimensions.
CO2:	Identify appropriate data visualization techniques given particular requirements imposed by the data.
CO3:	Apply the visualization techniques in physical sciences, computer science, applied mathematics and medical sciences.
CO4:	Apply the virtualization techniques for research projects.
CO5:	Design and process the data for Visualization.

REFERENCES:

1. Matthew Ward, Georges Grinstein and Daniel Keim, "Interactive Data Visualization Foundations, Techniques, Applications", 2010.
2. Colin Ware, "Information Visualization Perception for Design", Fourth Edition, Morgan Kaufmann Publishers, 2021.
3. Robert Spence "Information visualization – Design for interaction", Pearson Education, Second Edition, 2007.
4. Alexandru C. Telea, "Data Visualization: Principles and Practice," A. K. Peters Ltd, 2008.
5. Jack Dougherty and Ilya Ilyankou "Hands-on data visualization", Shroff publication 2022.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	-	-	2

CO2	3	3	2	-	-	2
CO3	3	3	2	-	-	2
CO4	3	3	2	-	-	2
CO5	3	3	2	-	-	2
CO	**3**	**3**	**2**	**-**	**-**	**2**

3-High, 2- Medium, 1-Low

PROFESSIONAL ELECTIVES V

CP22351	**AGILE METHODOLOGIES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSEOBJECTIVES:

- To learn the fundamental principles and practices associated with each of the agile development methods
- To apply the principles and practices of agile software development on a project of interest and relevance to the student.
- To provide a good understanding of software design and a set of software technologies and APIs.
- To do a detailed examination and demonstration of Agile development and testing techniques.
- To understand Agile development and testing.

UNITI	**AGILE SOFTWARE DEVELOPMENT**	**9**

Basics and Fundamentals of Agile Process Methods, Values of Agile, Principles of Agile, stakeholders, Challenges. Lean Approach: Waste Management, Kaizen and Kanban, add process and products add value. Roles related to the lifecycle, differences between Agile and traditional plans, differences between Agile plans at different lifecycle phases. Testing plan links between testing, roles and key techniques, principles, understand as a means of assessing the initial status of a project/ How Agile helps to build quality

UNIT II	**AGILE AND SCRUM PRINCIPLES**	**9**

Agile Manifesto, Twelve Practices of XP, Scrum Practices, Applying Scrum. Need of scrum, working of scrum, advanced Scrum Applications, Scrum and the Organization, scrum values

UNIT III	**AGILE PRODUCT MANAGEMENT**	**9**

Communication, Planning, Estimation Managing the Agile approach Monitoring progress, Targeting and motivating the team, Managing business involvement, Escalating issue. Quality, Risk, Metrics and Measurements, Managing the Agile approach Monitoring progress, Targeting and motivating the team, Managing business involvement and Escalating issue Tentative

UNIT IV	**AGILE REQUIREMENTS AND AGILE TESTING**	**9**

User Stories, Backlog Management. Agile Architecture: Feature Driven Development. Agile Risk Management: Risk and Quality Assurance, Agile Tools. Agile Testing Techniques, Test-Driven Development, User Acceptance Test

UNIT V	**AGILE REVIEW AND SCALING AGILE FOR LARGE PROJECTS**	**9**

Agile Metrics and Measurements, The Agile approach to estimating and project variables, Agile Measurement, Agile Control: the 7 control parameters. Agile approach to Risk, The Agile approach Configuration Management, The Atern Principles, Atern Philosophy, The rationale for using Atern, Refactoring, Continuous integration, Automated Build Tools. Scrum of Scrums, Team collaborations, Scrum, Estimate a Scrum Project, Track Scrum Projects, Communication in Scrum Projects, Best Practices to Manage Scrum
TOTAL: 45 PERIODS

COURSE OUTCOMES:	
At the end of the course, the students will be able to:	
CO1:	Describe Agile software development and recall the existing problems
CO2:	Explain the Agile principles and SCRUM practices
CO3:	Explain the most appropriate way to improve results for a specific circumstance or need.
CO4:	Determine the most appropriate modifications to current procedures or methods based on an examination of common issues
CO5:	Develop a model of expected successes and plans to address any risks or issues.

REFERENCES:	
1.	Robert C. Martin, Agile Software Development, Principles, Patterns, and Practices Alan Apt Series (2011)
2.	Succeeding with Agile : Software Development Using Scrum, Pearson (2010)
3.	David J. Anderson and Eli Schragenheim, "Agile Management for Software Engineering: Applying the Theory of Constraints for Business Results, Prentice Hall, 2003.
4.	Hazza and Dubinsky, "Agile Software Engineering, Series: Undergraduate Topics in Computer Science, Springer, 2009.
5.	Craig Larman, "Agile and Iterative Development: A Managers Guide, Addison-Wesley, 2004

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	**Programme Outcomes**					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	-	-	1
CO2	3	2	2	-	-	1
CO3	3	2	2	-	-	1
CO4	3	2	2	-	-	1
CO5	3	2	2	-	-	1
CO	**3**	**2**	**2**	**-**	**-**	**1**

3-High, 2- Medium, 1-Low

CP22352	**BIG DATA MINING AND ANALYTICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSEOBJECTIVES:
• To understand the computational approaches to Modeling, Feature Extraction
• To understand the need and application of Map Reduce
• To understand the various search algorithms applicable to Big Data
• To understand and interpret streaming data
• To learn how to handle large data sets in main memory and learn the various clustering techniques applicable to Big Data

UNITI	DATA MINING AND LARGE SCALE FILES	9
Introduction to Statistical modeling – Machine Learning – Computational approaches to modeling – Summarization – Feature Extraction – Statistical Limits on Data Mining - Distributed File Systems – Map-reduce – Algorithms using Map Reduce – Efficiency of Cluster Computing Techniques.		
UNIT II	**SIMILAR ITEMS**	**9**
Nearest Neighbor Search – Shingling of Documents – Similarity preserving summaries – Locality sensitive hashing for documents – Distance Measures – Theory of Locality Sensitive Functions – LSH Families – Methods for High Degree of Similarities.		
UNIT III	**MINING DATA STREAMS**	**9**
Stream Data Model – Sampling Data in the Stream – Filtering Streams – Counting Distance Elements in a Stream – Estimating Moments – Counting Ones in Window – Decaying Windows.		
UNIT IV	**LINK ANALYSIS AND FREQUENT ITEMSETS**	**9**
Page Rank –Efficient Computation - Topic Sensitive Page Rank – Link Spam – Market Basket Model – A-priori algorithm – Handling Larger Datasets in Main Memory – Limited Pass Algorithm – Counting Frequent Item sets.		
UNIT V	**CLUSTERING**	**9**
Introduction to Clustering Techniques – Hierarchical Clustering –Algorithms – K-Means – CURE – Clustering in Non -– Euclidean Spaces – Streams and Parallelism – Case Study: Advertising on the Web – Recommendation Systems.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
At the end of the course, the students will be able to:	
CO1:	Describe the need and application of Map Reduce and explain computational approaches to Modeling, Feature Extraction
CO2:	Explain various search algorithms applicable to Big Data
CO3:	Describe the streaming data applicable to Big Data
CO4:	Apply algorithms and propose solutions for Big Data by optimizing main memory consumption.
CO5:	Apply appropriate clustering techniques for problems in Big Data.

REFERENCES:

1. Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, Third Edition, 2020.
2. Jiawei Han, Micheline Kamber, Jian Pei, "Data Mining Concepts and Techniques", Morgan Kaufman Publications, Third Edition, 2012.
3. Ian H.Witten, Eibe Frank "Data Mining – Practical Machine Learning Tools and Techniques", Morgan Kaufman Publications, Third Edition, 2011.
4. David Hand, Heikki Mannila and Padhraic Smyth, "Principles of Data Mining", MIT PRESS, 2001
5. Tan, Steinbach & Kumar, "Introduction to Data Mining", Second Edition, Pearson, 2021.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	-	1	1
CO2	2	1	2	-	1	1

CO3	2	1	2	-	2	1
CO4	2	-	2	-	2	3
CO5	2	-	2	-	2	3
CO	**2**	**1**	**2**	**-**	**2**	**2**

3-High, 2- Medium, 1-Low

CP22353	**QUANTUM COMPUTING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSEOBJECTIVES:

- To introduce the building blocks of Quantum computers and highlight the
- To understand the Quantum state transformations and the algorithms
- To understand entangled quantum subsystems and properties of entangled
- To explore the applications of quantum computing

UNITI	**QUANTUM BUILDING BLOCKS**	**9**

The Quantum Mechanics of Photon Polarization, Single-Qubit Quantum Systems, Quantum State Spaces, Entangled States, Multiple-Qubit Systems, Measurement of Multiple-Qubit States, EPR Paradox and Bell's Theorem, Bloch sphere Tentative

UNIT II	**QUANTUM STATE TRANSFORMATIONS**	**9**

Unitary Transformations, Quantum Gates, Unitary Transformations as Quantum Circuits, Reversible Classical Computations to Quantum Computations, Language for Quantum Implementations.

UNIT III	**QUANTUM ALGORITHMS**	**9**

Computing with Superpositions, Quantum Subroutines, Quantum Fourier Transformations, Shor's Algorithm and Generalizations, Grover's Algorithm and Generalizations

UNIT IV	**ENTANGLED SUBSYSTEMS AND ROBUST QUANTUM COMPUTATION**	**9**

Quantum Subsystems, Properties of Entangled States, Quantum Error Correction, Graph states and codes, CSS Codes, Stabilizer Codes, Fault Tolerance and Robust Quantum Computing

UNIT V	**QUANTUM INFORMATION PROCESSING**	**9**

Limitations of Quantum Computing, Alternatives to the Circuit Model of Quantum Computation, Quantum Protocols, Building Quantum, Computers, Simulating Quantum Systems, Bell states. Quantum teleportation. Quantum Cryptography, no cloning theorem

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:	Explain the basic principles of quantum computing.
CO2:	Describe several basic quantum computing algorithms.
CO3:	Apply entangled quantum subsystems and properties of entangled states.
CO4:	Develop the classes of problems that can be expected to be solved well by quantum computers.
CO5:	Analyze the fundamental differences between conventional computing and quantum computing.

REFERENCES:

1. John Gribbin, "Computing with Quantum Cats: From Colossus to Qubits", 2021.

2.	William (Chuck) Easttom, "Quantum Computing Fundamentals", 2021.
3.	Parag Lala, "Quantum Computing", 2019.
4.	Eleanor Rieffel and Wolfgang Polak, "QUANTUM COMPUTING A Gentle Introduction", 2011
5.	Nielsen M. A., "Quantum Computation and Quantum Information", Cambridge University Press.2002.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	2	2	-	1
CO2	2	-	2	2	-	1
CO3	2	-	2	2	-	1
CO4	2	-	2	2	-	1
CO5	2	-	2	2	-	1
CO	**2**		**2**	**2**	**-**	**1**

3-High, 2- Medium, 1-Low

CP22354	MOBILE AND PERVASIVE COMPUTING	L	T	P	C
		3	0	0	3

COURSEOBJECTIVES:

- To understand the basics of Mobile Computing and Personal Computing
- To learn the role of cellular networks in Mobile and Pervasive Computing
- To expose to the concept of sensor and mesh networks
- To expose to the context aware and wearable computing
- To learn to develop applications in mobile and pervasive computing environment

UNITI	INTRODUCTION	9

Differences between Mobile Communication and Mobile Computing – Contexts and Names – Functions – Applications and Services – New Applications – Making Legacy Applications Mobile Enabled – Design Considerations – Integration of Wireless and Wired Networks – Standards Bodies – Pervasive Computing – Basics and Vision – Principles of Pervasive Computing – Categories of Pervasive Devices

UNIT II	3G AND 4G CELLULAR NETWORKS	9

Migration to 3G Networks – IMT 2000 and UMTS – UMTS Architecture – User Equipment – Radio Network Subsystem – UTRAN – Node B – RNC functions – USIM – Protocol Stack – CS and PS Domains – IMS Architecture – Handover – 3.5G and 3.9G a brief discussion – 4G LAN and Cellular Networks – LTE – Control Plane – NAS and RRC – User Plane – PDCP, RLC and MAC – WiMax IEEE 802.16d/e – WiMax Internetworking with 3GPP

UNIT III	SENSOR AND MESH NETWORKS	9

Sensor Networks – Role in Pervasive Computing – In Network Processing and Data Dissemination – Sensor Databases – Data Management in Wireless Mobile Environments – Wireless Mesh Networks – Architecture – Mesh Routers – Mesh Clients – Routing – Cross Layer Approach – Security Aspects of Various Layers in WMN – Applications of Sensor and Mesh networks

UNIT IV	CONTEXT AWARE COMPUTING & WEARABLE COMPUTING	9

Adaptability – Mechanisms for Adaptation - Functionality and Data – Transcoding – Location Aware Computing – Location Representation – Localization Techniques – Triangulation and Scene Analysis – Delaunay Triangulation and Voronoi graphs – Types of Context – Role of Mobile Middleware – Adaptation and Agents – Service Discovery Middleware Health BAN-Medical and Technological Requirements-Wearable Sensors-Intra-BAN communications		
UNIT V	**APPLICATION DEVELOPMENT**	**9**
Three tier architecture - Model View Controller Architecture - Memory Management – Information Access Devices – PDAs and Smart Phones – Smart Cards and Embedded Controls – J2ME – Programming for CLDC – GUI in MIDP – Application Development ON Android and iPhone		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
At the end of the course, the students will be able to:	
CO1:	Outline the principles of mobile and pervasive computing and routing in a mesh network.
CO2:	Explain the basic architecture for a pervasive computing environment and allocate the resources on the 3G and 4G wireless networks.
CO3:	Discuss the role of sensors in Wireless networks.
CO4:	Deploy the location and context information for application development.
CO5:	Illustrate mobile computing applications based on the paradigm of context aware computing and wearable computing.

REFERENCES:

1. Asoke K Talukder, Hasan Ahmed, Roopa R Yavagal, "Mobile Computing: Technology, Applications and Service Creation", Second Edition, Tata McGraw Hill, 2017.
2. Reto Meier, "Professional Android 2 Application Development", Wrox Wiley, 2010.
3. Jochen Burthardt et al, 'Pervasive Computing: Technology and Architecture of Mobile Internet Applications', Pearson Education, 2003.
4. Mobile Networks Architecture by Andre Perez, Wiley, March 2012.
5. John Horton, Android Programming for Beginners, Second Edition, 2018.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	-	-	-
CO2	3	3	3	-	-	-
CO3	3	3	3	-	-	-
CO4	3	3	3	-	-	-
CO5	3	3	3	-	3	-
CO	**3**	**3**	**3**	**-**	**3**	**-**

3-High, 2- Medium, 1-Low

AUDIT COURSES

AC22101	ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	C
		2	0	0	0

COURSEOBJECTIVES:

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNITI	**INTRODUCTION TO RESEARCH PAPER WRITING**	**6**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II	**PRESENTATION SKILLS**	**6**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III	**TITLE WRITING SKILLS**	**6**

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV	**RESULT WRITING SKILLS**	**6**

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, Skills are needed when writing the Conclusions

UNIT V	**VERIFICATION SKILLS**	**6**

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

CO1:	Understand that how to improve writing skills and level of readability
CO2:	Learn about what to write in each section
CO3:	Understand the skills needed when writing a Title
CO4:	Understand the skills needed when writing the Conclusion
CO5:	Ensure the good quality of paper at very first-time submission

REFERENCES:

1.	Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.
2.	Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006.
3.	Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006.
4.	Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

AC22102	CONSTITUTION OF INDIA	L	T	P	C
		2	0	0	0

COURSEOBJECTIVES:

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism
- To address the role of socialism in India after the commencement of the Bolshevik Revolution 1917 and its impact on the initial drafting of the Indian Constitution

UNITI	HISTORY OF MAKING OF THE INDIAN CONSTITUTION	2

History, Drafting Committee, (Composition & Working)

UNIT II	PHILOSOPHY OF THE INDIAN CONSTITUTION	2

Preamble, Salient Features

UNIT III	CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES	6

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV	ORGANS OF GOVERNANCE	6

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V	LOCAL ADMINISTRATION	8

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayat raj: Introduction, PRI: Zila Panchayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy

UNIT VI	ELECTION COMMISSION	6

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

CO1:	Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics
CO2:	Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India
CO3:	Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution
CO4:	Discuss the passage of the Hindu Code Bill of 1956

REFERENCES:

1.	The Constitution of India, 1950(Bare Act), Government Publication.
2.	Dr. S.N. Busi, Dr. B. R. Ambedkar Framing of Indian Constitution, First Edition, 2015.

3.	M.P. Jain, Indian Constitution Law, Seventh Edition, LexisNexis, 2014.
4.	D.D. Basu, Introduction to the Constitution of India, LexisNexis, 2015.

AC22201	DISASTER MANAGEMENT	L	T	P	C
		2	0	0	0

COURSEOBJECTIVES:

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations
- Develop the strengths and weaknesses of disaster management approaches

UNITI	**INTRODUCTION**	**6**

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II	**REPERCUSSIONS OF DISASTERS AND HAZARDS**	**6**

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III	**DISASTER PRONE AREAS IN INDIA**	**6**

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV	**DISASTER PREPAREDNESS AND MANAGEMENT**	**6**

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V	**RISK ASSESSMENT**	**6**

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

CO1:	Ability to summarize basics of disaster
CO2:	Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response
CO3:	Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives
CO4:	Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations
CO5:	Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCES:

1.	Goel S. L., Disaster Administration and Management Text and Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi, 2009.
2.	NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies", New Royal book Company, 2007.
3.	Sahni, Pradeep Et.Al.," Disaster Mitigation Experiences and Reflections", PrenticeHall of India, New Delhi, 2001.

AC22202	நற்றமிழ் இலக்கியம்	L	T	P	C
		2	0	0	0

UNIT I	சங்க இலக்கியம்	6

1. தமிழின் துவக்க நூல் தொல்காப்பியம் – எழுத்து, சொல், பொருள்
2. அகநானூறு (82) - இயற்கை இன்னிசை அரங்கம்
3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி
4. புறநானூறு (95,195) - போரை நிறுத்திய ஔவையார்

UNIT II	அறநெறித் தமிழ்	6

1. அறநெறி வகுத்த திருவள்ளுவர்
   - அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புரவறிதல், ஈகை, புகழ்
2. பிற அறநூல்கள் - இலக்கிய மருந்து
   – ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை
   (தூய்மையை வலியுறுத்தும் நூல்)

UNIT III	இரட்டைக் காப்பியங்கள்	6

1. கண்ணகியின் புரட்சி - சிலப்பதிகார வழக்குரை காதை
2. சமூகசேவை இலக்கியம் மணிமேகலை
   - சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை

UNIT IV	அருள்நெறித் தமிழ்	6

1. சிறுபாணாற்றுப்படை
   - பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குப் போர்வை கொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்
2. நற்றிணை - அன்னைக்குரிய புன்னை சிறப்பு
3. திருமந்திரம் (617, 618) - இயமம் நியமம் விதிகள்
4. தர்மச்சாலையை நிறுவிய வள்ளலார்
5. புறநானூறு - சிறுவனே வள்ளலானான்
6. அகநானூறு (4) - வண்டு
   நற்றிணை (11) - நண்டு
   கலித்தொகை (11) - யானை, புறா
   ஐந்திணை 50 (27) - மான் ஆகியவை பற்றிய செய்திகள்

UNIT V	நவீன தமிழ் இலக்கியம்	6

1.உரைநடைத் தமிழ்,

- தமிழின் முதல் புதினம், - தமிழின் முதல் சிறுகதை, - கட்டுரை இலக்கியம், - பயண இலக்கியம், - நாடகம், 2.நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும், 3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும், 4.பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும், 5.அறிவியல் தமிழ், 6.இணையத்தில் தமிழ், 7.சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.	
TOTAL: 30 PERIODS	
REFERENCES:	
1	தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University)
2	தமிழ் விக்கிப்பீடியா (Tamil Wikipedia)
3	தர்மபுர ஆதீன வெளியீடு
4	வாழ்வியல் களஞ்சியம்
5	தமிழ்கலைக் களஞ்சியம் - தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)
6	அறிவியல் களஞ்சியம் - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்