KIT - Kalaignarkarunanidhi Institute of Technology

An Autonomous Institution

Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai
Accredited by NAAC with 'A' GRADE & NBA (AERO, CSE, ECE, EEE, MECH & MBA)

An ISO 9001 : 2015 Certified Institution, Coimbatore - 641 402.

Regulations, Curriculum & Syllabus - 2023

(For Students admitted from the Academic Year 2023-24 and onwards)

MASTER OF ENGINEERING DEGREE

IN

COMPUTER SCIENCE AND ENGINEERING

Department of Computer Science and Engineering

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Department of Computer Science and Engineering

Conceptual Frame work

(For Students admitted from the Academic Year 2023-24 and onwards)

Semester	Level of Course	Hours / Week	No of Courses	Range of Credits / Courses	Total Credits
PART - I					
A - Foundation Courses					
I	Basic Sciences (BS)	4	1	4	4
B - Professional Core Courses					
I to III	Professional Core (PC)	3 – 4	12	3 - 4	37
C - Elective Courses					
I to III	Professional Elective (PE)	3 - 5	4	3	12
D - Project Work					
III & IV	Project Work (PW)	12 -24	2	6 - 12	18
Total Credit					**71**
PART - II					
F- Career Enhancement Courses (CEC)					
II	Term Paper Writing and Seminar	2	1	1	1
Total Credit					**1**
Total Credit to be Earned					**72**

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Curriculum and Scheme of Assessment

(For Students admitted from the Academic Year 2023-24 and onwards)

Semester - I										
Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
Theory / Theory with Practical										
M23MAT102	Applied Probability and Statistics for Computer Science Engineers	BS	4	3	1	0	4	40	60	100
M23CST101	Research Methodology and IPR	PC	3	3	0	0	3	40	60	100
M23CST102	Advanced Data Structures and Algorithms	PC	3	3	0	0	3	40	60	100
M23CST103	Network Technologies	PC	3	3	0	0	3	40	60	100
M23CST104	Principles of Programming Languages	PC	3	3	0	0	3	40	60	100
M23CST105	Database Practices	PC	5	3	1	0	4	50	50	100
Practical										
M23CSP101	Advanced Data Structures and Algorithms Laboratory	PC	4	0	0	4	2	40	60	100
Total credits to be earned							22			

Semester - II										
Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
Theory / Theory with Practical										
M23CST201	Advanced Software Engineering	PC	3	3	0	0	3	40	60	100
M23CST204	Internet of Things	PC	5	3	1	0	4	50	50	100
M23CST202	Multi-core Architecture and Programming	PC	5	3	1	0	4	50	50	100
M23CST203	Machine Learning	PC	5	3	1	0	4	50	50	100
	Professional Elective I	PE	3	3	0	0	3	40	60	100
	Professional Elective II	PE	3	3	0	0	3	40	60	100
Practical										
M23CSP201	Software Engineering Laboratory	PC	0	0	0	2	2	60	40	100
M23CSP202	Term Paper Writing and Seminar	CEC	2	0	2	0	1	60	40	100
Total credits to be earned							24			

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Semester - III										
Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
Theory / Theory with Practical										
M23CST301	Security Practices	**PC**	3	3	0	0	3	40	60	100
	Professional Elective III	**PE**	3	3	0	0	3	40	60	100
	Professional Elective IV	**PE**	3	3	1	0	4	40	60	100
	Professional Elective V	**PE**	3	3	0	0	3	40	60	100
Practical										
M23CSP301	Project Phase I	**PW**	12	0	12	12	6	40	60	100
Total credits to be earned							**19**			

Semester - IV										
Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
Practical										
M23CSP301	Project Phase II	**PW**	24	0	0	24	12	40	60	100
Total credits to be earned							**12**			

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BASIC SCIENCES (BS)										
Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
M23MAT102	Applied Probability and Statistics for Computer Science Engineers	BS	4	3	1	0	4	40	60	100

PROFESSIONAL CORE (PC)										
Course Code	Course Name	CT	Instructional Hours				Assessment			
			CP	L	T	P	C	CIA	ESE	Total
M23CST101	Research Methodology and IPR	PC	3	3	0	0	3	40	60	100
M23CST102	Advanced Data Structures and Algorithms	PC	3	3	0	0	3	40	60	100
M23CST105	Database Practices	PC	5	3	1	0	4	40	60	100
M23CST103	Network Technologies	PC	3	3	0	0	3	40	60	100
M23CST104	Principles of Programming Languages	PC	3	3	0	0	3	40	60	100
M23CST204	Internet of Things	PC	5	3	1	0	4	40	60	100
M23CST202	Multi-core Architecture and Programming	PC	5	3	1	0	4	40	60	100
M23CST203	Machine Learning	PC	5	3	1	0	4	40	60	100
M23CST201	Advanced Software Engineering	PC	3	3	0	0	3	40	60	100
M23CST301	Security Practices	PC	3	3	0	0	3	40	60	100

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PROFESSIONAL ELECTIVE (PE)										
SEMESTER II – ELECTIVE I										
Course Code	Course Name	CT	Instructional Hours				Assessment			
			CP	L	T	P	C	CIA	ESE	Total
M23CSE201	Human Computer Interaction	PE	3	3	0	0	3	40	60	100
M23CSE202	Cloud Computing Technologies	PE	3	3	0	0	3	40	60	100
M23CSE203	Foundations of Data Sciences	PE	3	3	0	0	3	40	60	100
M23CSE204	Wireless Communications	PE	3	3	0	0	3	40	60	100
M23CSE205	Agile Methodologies	PE	3	3	0	0	3	40	60	100
M23CSE206	Performance Analysis of Computer Systems	PE	3	3	0	0	3	40	60	100
M23CSE207	Advanced Operating System	PE	3	3	0	0	3	40	60	100
M23CSE208	Digital Image Processing	PE	3	3	0	0	3	40	60	100

PROFESSIONAL ELECTIVE (PE)										
SEMESTER II – ELECTIVE II										
Course Code	Course Name	CT	Instructional Hours				Assessment			
			CP	L	T	P	C	CIA	ESE	Total
M23CSE209	High Performance Computing for Big Data	PE	3	3	0	0	3	40	60	100
M23CSE210	Informational Retrieval Techniques	PE	3	3	0	0	3	40	60	100
M23CSE211	Software Quality Assurance	PE	3	3	0	0	3	40	60	100
M23CSE212	Autonomous Systems	PE	3	3	0	0	3	40	60	100
M23CSE213	Web Analytics	PE	3	3	0	0	3	40	60	100
M23CSE214	Cognitive Computing	PE	3	3	0	0	3	40	60	100
M23CSE215	Quantum Computing	PE	3	3	0	0	3	40	60	100
M23CSE216	Big Data Mining and Analytics	PE	3	3	0	0	3	40	60	100

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PROFESSIONAL ELECTIVE (PE)										
SEMESTER III – ELECTIVE III										
Course Code	Course Name	CT	Instructional Hours				Assessment			
			CP	L	T	P	C	CIA	ESE	Total
M23CSE301	Mobile and Pervasive Computing	PE	3	3	0	0	3	40	60	100
M23CSE302	Web Services and API Design	PE	3	3	0	0	3	40	60	100
M23CSE303	Data Visualization Techniques	PE	3	3	0	0	3	40	60	100
M23CSE304	Formal Models of Software Systems	PE	3	3	0	0	3	40	60	100
M23CSE305	Natural Language Processing	PE	3	3	0	0	3	40	60	100
M23CSE306	GPU Computing	PE	3	3	0	0	3	40	60	100

PROFESSIONAL ELECTIVE (PE)										
SEMESTER III – ELECTIVE IV										
Course Code	Course Name	CT	Instructional Hours				Assessment			
			CP	L	T	P	C	CIA	ESE	Total
M23CSE307	Devops and Microservices	PE	3	3	1	0	4	40	60	100
M23CSE308	Mobile Application Development	PE	3	3	1	0	4	40	60	100
M23CSE309	Deep Learning	PE	3	3	1	0	4	40	60	100
M23CSE310	Blockchain Technologies	PE	3	3	1	0	4	40	60	100
M23CSE311	Cyber Physical Systems	PE	3	3	1	0	4	40	60	100
M23CSE312	Mixed Reality	PE	3	3	1	0	4	40	60	100

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PROFESSIONAL ELECTIVE (PE)										
SEMESTER III – ELECTIVE V										
Course Code	Course Name	CT	Instructional Hours				Assessment			
			CP	L	T	P	C	CIA	ESE	Total
M23CSE313	Embedded Software Development	PE	3	3	0	0	3	40	60	100
M23CSE314	Ethical Management	PE	3	3	0	0	3	40	60	100
M23CSE315	Compiler Optimization Techniques	PE	3	3	0	0	3	40	60	100
M23CSE316	Full Stack Web Application Development	PE	3	3	0	0	3	40	60	100
M23CSE317	Intellectual Property Rights	PE	3	3	0	0	3	40	60	100
M23CSE318	Soft Computing	PE	3	3	0	0	3	40	60	100

PROJECT WORK (PW)										
Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
M23CSP301	Project Work Phase – I	PW	12	0	0	12	6	40	60	100
M23CSP401	Project Work Phase - II	PW	24	0	0	24	12	40	60	100

CAREER ENHANCEMENT COURSE (CEC)										
Course Code	Course Name	CT	Instructional Hours					Assessment		
			CP	L	T	P	C	CIA	ESE	Total
M23CSP202	Term Paper Writing and Seminar	CEC	2	0	2	0	1	100	-	100

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Semester - I

M.E / M.Tech	M23CST101- RESEARCH METHODOLOGY AND IPR	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the basics of research formulation and design
2.	Construct and interpret the basic Engineering drawings.
3.	Improve their visualization skills so that they can apply these skills in new product development.
4.	Enhance their technical communication skill in the form of communicative drawings.
5.	Comprehend the theory of projection.

UNIT - I	RESEARCH DESIGN	9

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

UNIT - II	DATA COLLECTION AND SOURCES	9

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

UNIT - III	DATA ANALYSIS AND REPORTING	9

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

UNIT - IV	INTELLECTUAL PROPERTY RIGHTS	9

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

UNIT - V	PATENTS	9

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

Registration of patent agents.

Total Instructional hours : 45

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Course Outcomes : Students will be able to	
CO1	Outline the concept of research formulation and design.
CO2	Demonstrate the process of data collection and sources.
CO3	Make use of the data analysis methods and report writing.
CO4	Apply the basics of IPR and its functions.
CO5	Make use of the benefits and registration of patent.

Reference Books	
1.	The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013
2.	Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2012).
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.

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M.E / M.Tech	M23CST102- ADVANCE DATASTRUCTURES AND ALGORITHMS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the usage of algorithms in computing.
2.	To learn and use hierarchical data structures and its operations.
3.	To learn the usage of graphs and its applications.
4.	To select and design data structures and algorithms that is appropriate for problems.
5.	To study about NP Completeness of problems.

UNIT - I	ROLE OF ALGORITHMS IN COMPUTING & COMPLEXITY ANALYSIS	9

Review of Basic Concept - Asymptotic Analysis of Recurrences Asymptotic notation - Importance of efficient algorithms- Program performance measurement - Randomized Algorithm - Randomized Quick sort - Analysis of Hashing algorithms- The Recursion-Implementing Recursion using Stacks, Queues – ADT.

UNIT - II	HIERARCHICAL DATA STRUCTURES	9

Binary Search Trees: Basics – Querying a Binary search tree – Insertion and Deletion- Application to Splay Trees. External Memory ADT - B-Trees. Applications to Shortest Path Algorithms .Basic operations on B-Trees. Red Black trees: Properties of Red-Black Trees – Rotations – Insertion – Deletion-Priority Queues and Their Extensions: Heap- Binomial heaps, Fibonacci heaps. String Matching algorithms.

UNIT - III	GRAPHS	9

Elementary Graph Algorithms: Breadth-First Search – Depth-First Search – Topological Sort – Strongly Connected Components- Minimum Spanning Trees: Growing a Minimum Spanning Tree – Kruskal's and Prims– 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's Algorithm-Connectivity.

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. Backtracking, branch and bound, Brute force search.

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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 Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Apply the computational complexity of different algorithms.
CO2	Identify computational solution to well-known problems using hierarchical data structure.
CO3	Solve minimum cost problems using graphs.
CO4	Apply algorithms using appropriate design techniques
CO5	Infer all the possible solutions for a given problem using Backtracking, Branch and Bound.

Text Books	
1.	Jean-Paul Tremblay and Paul G Sorenson, An Introduction to Data structures with Applications, Second Edition, McGraw Hill, 1994 (chapters 0,2-5).
2.	"Introduction to Algorithms" by Thomas H. Cormen, Charles E Leiserson, Ronald L. Rivest, and Clifford Stein.

Reference Books	
1.	S.Sridhar," Design and Analysis of Algorithms", Oxford University Press, 1st Edition, 2014.
2.	Adam Drozdex, "Data Structures and algorithms in C++", Cengage Learning, 4th Edition, 2013.
3.	T.H. Cormen, C.E.Leiserson, R.L. Rivest and C.Stein, "Introduction to Algorithms", Prentice Hall of India, 3rd Edition, 2012.
4.	Mark Allen Weiss, "Data Structures and Algorithms in C++", Pearson Education, 3rd Edition,
5.	E. Horowitz, S. Sahni and S. Rajasekaran, "Fundamentals of Computer Algorithms", University Press, 2nd Edition, 2008.
6.	Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, "Data Structures and Algorithms", Pearson Education, Reprint 2006.

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M.E / M.Tech	M23CST103- NETWORK TECHNOLOGIES	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the basic concepts of networks.
2.	To explore various technologies in the wireless domain.
3.	To study about 4G and 5G cellular networks..
4.	To learn about Network Function Virtualization.
5.	To understand the paradigm of Software defined networks.

UNIT - I	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 AndBroadcast 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, mm Wave, 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. Open Flow Logical Network Device. Flow Table Structure. Flow Table Pipeline. The Use of Multiple Tables. Group Table. Open Flow Protocol. SDN Control Plane Architecture. Control Plane Functions. Southbound Interface. Northbound Interface. Routing. ITU-T Model. Open Daylight. Open Day light Architecture. Open Daylight 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

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Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Explain basic networking concepts.
CO2	Compare different wireless networking protocols.
CO3	Identify the developments in each generation of mobile data networks.
CO4	Plan and develop SDN based applications.
CO5	Interpret the concepts of network function virtualization.

Reference Books	
1.	James Bernstein, “Networking made Easy”, 2018. (UNIT I)
2.	HoudaLabiod, Costantino de Santis, HossamAfifi “Wi-Fi, Bluetooth, Zigbee and WiMax”, Springer 2007
3.	ErikDahlman, Stefan Parkvall, Johan Skold, 4G: LTE/LTE-Advanced for Mobile Broadband, Academic Press, 2013 (UNIT 3)
4.	Saad Z. Asif “5G Mobile Communications Concepts and Technologies” CRC press – 2019 (UNIT 3)
5.	William Stallings “Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud” 1st Edition,

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M.E/M.Tech	M23CST104– PRINICIPLES OF PROGRAMMING LANGUAGES	L	T	P	C
		3	0	0	3

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

UNIT - I	SYNTAX AND SEMANTICS	9

Evolution of programming languages – principles of language 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- type Equivalence – 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-Short Circuit Evaluation.

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- Introductions to Data Abstraction- Design Issues- Language Examples- Encapsulation Constructs- Naming Encapsulations.

UNIT - IV	OBJECT-ORIENTATION, CONCURRENCY, AND EVENT HANDLING	9

Object-orientation – design issues for OOP languages – implementation of object-oriented constructs – concurrency in function languages – semaphores – monitors – message passing – threads – statement level concurrency – exception handling in Ada,c++,JAVA – event handling.

UNIT - V	FUNCTIONAL AND LOGIC PROGRAMMING LANGUAGES	9

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Introduction to lambda calculus – fundamentals of functional programming languages – Programming with Scheme – Programming with ML – Introduction to logic and logic programming–Application of logic programming – Programming with Prolog – multi-paradigm

Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Analyze syntax and semantics of programming languages.
CO2	Explain data, data types, and basic statements of programming languages.
CO3	Develop and implement subprogram constructs.
CO4	Apply object-oriented, concurrency, and event handling programming constructs.
CO5	Develop programs in Scheme, ML, and Prolog and Understand and adopt new programming language.

Text Books	
1.	Concepts of Programming Languages Robert. W. Sebesta 10/E, Pearson Education.
2.	Programming Language Design Concepts, D. A. Watt, Wiley Dreamtech, 2007.

Reference Books	
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.KentDybvig,“TheSchemeprogramminglanguage”,FourthEdition,MITPress, 2009.
5.	Richard A. O'Keefe, “The craft of Prolog”, MIT Press, 2009 6. W. F.ClocksinandC.S.Mellish,“ProgramminginProlog:UsingtheISOStandard”,Fifth Edition, Springer,2003

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M.E / M.Tech	M23CST105 - DATABASE PRACTICES	L	T	P	C
		3	1	0	4

Course Objectives	
1.	Describe the fundamental elements of relational database management systems
2.	Explain the basic concepts of relational data model, entity-relationship model, relational database design, relational algebra and SQL
3.	Understand query processing in a distributed database system.
4.	Understand the basics of XML and create well-formed and valid XML documents.
5.	Distinguish the different types of No SQL databases

UNIT - I	RELATIONAL DATA MODEL	12

Entity Relationship Model – Relational Data Model – Mapping Entity Relationship Model to Relational Model – Relational Algebra – Structured Query Language – Database Normalization. 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 DATABASESOPEN DATABASE CONNECTIVITY	12

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	12

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	12

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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 – Hbase Data Model – Hbase Crud Operations – Hbase Storage and Distributed System Concepts – NoSQL Graph Databases and Neo4j – Cypher Query Language of Neo4j – Big Data – MapReduce – Hadoop – YARN.Suggested Activities: Creating Databases using MongoDB, DynamoDB, Voldemort Key-Value Distributed Data Store Hbase and Neo4j- Writing simple queries to access databases created using MongoDB, DynamoDB, Voldemort Key-Value Distributed Data Store Hbase and Neo4j.

UNIT - V	DATABASE SECURITY	12

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 Activities: Implementing Access Control in Relational Databases.

Total Instructional hours : 60

Course Outcomes : Students will be able to	
CO1	Translate the ER-model to relational tables, populate relational databases and formulate SQL queries on data.
CO2	Explain and write well-formed XML documents.
CO3	Apply methods and techniques for distributed query processing.
CO4	Experiment with secure database systems.
CO5	Make use of the data control, definition, and manipulation languages of the NoSQL databases.

Reference Books	
1.	Henry F. Korth, Abraham Silberschatz, S. Sudharshan, “Database System Concepts”, Seventh Edition, McGraw Hill, 2019
2.	R. Elmasri, S.B. Navathe, “Fundamentals of Database Systems”, Seventh Edition, Pearson Education 2016
3.	Raghu Ramakrishnan , Johannes Gehrke “Database Management Systems”, Fourth Edition, McGraw Hill Education, 2015.
4.	Harrison, Guy, “Next Generation Databases, NoSQL and Big Data” , First Edition, Apress publishers, 2015.
5.	C.J.Date, A.Kannan, S.Swamynathan, “An Introduction to Database Systems, Eighth Edition, Pearson Education, 2006

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M.E / M.Tech	M23CSP101- ADVANCED DATA STRUCTURES AND ALGORITHMS LABORATORY	L	T	P	C
		0	0	4	2

Course Objectives	
1.	To acquire the knowledge of using advanced tree structures.
2.	To learn the usage of heap structures.
3.	To understand the usage of graph structures and spanning trees.
4.	To understand the problems such as matrix chain multiplication, activity selection and Huffman coding.
5.	To understand the necessary mathematical abstraction to solve problems.

Expt. No.	Description of the Experiments
1.	Implementation of randomized quick sort algorithm.
2.	Implementation of hash functions and associated algorithms.
3.	Implementation of operations on splay trees.
4.	Implementation of operations on Fibonacci heaps.
5.	Implementation of operations on binary heaps.
6.	Implementation on operations on B-Trees.
7.	Implementation of operations on partition ADT and union-find data structures.
8.	Graph Traversals.
9.	Shortest Path Algorithms (Dijkstra's algorithm, Bellman Ford Algorithm).
10.	Implementation of Matrix Chain Multiplication.
	Total Instructional hours=45

Course Outcomes : Students will be able to	
CO1	Develop basic Python programs.
CO2	Construct Python programs using control statements.
CO3	Experiment with user-defined functions and different types of function arguments.
CO4	Build python programs with modules.
CO5	Develop Python application using file operations.

Reference Books

Approved by BoS Chairman

1.	James Bernstein, “Networking made Easy”, 2018. (UNIT I)
2.	HoudaLabiod, Costantino de Santis, HossamAfifi “Wi-Fi, Bluetooth, Zigbee and WiMax”, Springer 2007 (UNIT 2)
3.	ErikDahlman, Stefan Parkvall, Johan Skold, 4G: LTE/LTE-Advanced for Mobile Broadband, Academic Press, 2013 (UNIT 3)
4.	Saad Z. Asif “5G Mobile Communications Concepts and Technologies” CRC press – 2019 (UNIT 3)
5.	William Stallings “Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud” 1st Edition, Pearson Education, 2016.(Unit 4 and 5)

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Semester - II

M.E / M.Tech	M23CST201-ADVANCED SOFTWARE ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the rationale for software development process models
2.	To understand why the architectural design of software is important;
3.	To understand the five important dimensions of dependability, namely, availability, reliability, safety, security, and resilience.
4.	To understand the basic notions of a web service, web service standards, and service-oriented architecture.
5.	To understand the different stages of testing from testing during development of a software system.

UNIT - I	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 –

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

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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 Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Identify appropriate process models based on the Project requirements
CO2	Outline the importance of having a good Software Architecture.
CO3	Demonstrate the five important dimensions of dependability, Namely, availability, reliability, safety, security, and resilience.
CO4	Infer the basic notions of a web service, web service Standards, and service- oriented architecture;
CO5	Experiment with various levels of Software testing

Reference Books	
1.	Software Engineering: A Practitioner's Approach, 9 th Edition. Roger Pressman and Bruce Maxim, McGraw-Hill 2019.
2.	Software Engineering, 10 th Edition, Ian Somerville, Pearson Education Asia 2016.
3.	Software Architecture In Practice, 3 rd Edition, Len Bass, Paul Clements and Rick Kazman, Pearson India 2018.
4.	An integrated approach to Software Engineering, 3 rd Edition, Pankaj Jalote, Narosa Publishing House, 2018.

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M.E / M.Tech	M23CST204- INTERNET OF THINGS	L	T	P	C
		3	1	0	4

Course Objectives	
1.	To Understand the Architectural Overview of IoT.
2.	To Understand the IoT Reference Architecture and Real World Design Constraints
3.	To Understand the various IoT levels.
4.	To understand the basics of cloud architecture.
5.	To gain experience in Raspberry PI and experiment simple IoT application on it.

UNIT - I	INTRODUCTION	12
Internet of Things- Domain Specific IoTs - IoT and M2M-Sensors for IoT Applications–Structure of IoT–IoT Map Device		

UNIT - II	IoT ARCHITECTURE, GENERATIONS	12
IETF architecture for IoT - IoT reference architecture -First Generation – Description &Characteristics–Advanced Generation – Description & Characteristics–Integrated IoT Sensors		

UNIT - III	IoT PROTOCOLS AND TECHNOLOGY	12
SCADA and RFID Protocols - BACnet Protocol - Zigbee Architecture - 6LowPAN - CoAP– Wireless Sensor Structure – Energy Storage Module – Power Management Module – RF Module – Sensing Module		

UNIT -IV	CLOUD ARCHITECTURE BASICS	12
The Cloud types; IaaS, PaaS, SaaS.- Development environments for service development; Amazon, Azure, Google Appcloud platform in industry		

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UNIT - V	IOT WITH RASPBERRY PI	12
Building IOT with RASPBERRY PI - Creating the sensor project - Preparing Raspberry Pi – Clayster libraries – Hardware Interacting with the hardware - Interfacing the hardware- Internal representation of sensor values - External representation of sensor values.		

Total Instructional hours : 60

Course Outcomes : Students will be able to	
CO1	Demonstrate the various concept of the IoT and their technologies.
CO2	Develop the IoT application using different hardware platforms
CO3	Choose various IoT Protocols
CO4	Outline the basic principles of cloud computing
CO5	Develop and deploy the IoT application into cloud environment

Reference Books	
1.	Arshdeep Bahga, Vijay Madisetti, Internet of Things: A hands-on approach, Universities Press, 2015.
2.	Dieter Uckelmann, Mark Harrison, Florian Michahelles (Eds), Architecting the Internet of Things, Springer, 2011.
3.	Peter Waher, & 39;Learning Internet of Things', Packet Publishing, 2015.
4.	Ovidiu Vermesan Peter Friess, 'Internet of Things – From Research and Innovation to Market
5.	N. Ida, Sensors, Actuators and Their Interfaces: A Multidisciplinary Introduction, 2nd EditionScitech
6.	Reese, G. (2009). Cloud Application Architectures: Building Applications and Infrastructure in the Cloud.Sebastopol, CA: O'Reilly Media, Inc. (2009)

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M.E / M.Tech	M19CST202- MULTICORE ARCHITECTURE AND PROGRAMMING	L	T	P	C
		3	1	0	4

Course Objectives	
1.	To understand the need for multi-core processors, and their architecture.
2.	To understand the challenges in parallel and multithreaded programming.
3.	To learn about the various parallel programming paradigms,
4.	To learn distributed memory and MPI concepts
5.	To develop multicore programs and design parallel solutions.

UNIT - I	MULTI-CORE PROCESSORS	12

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	12

Performance – Scalability – Synchronization and data sharing – Data races – Synchronization primitives (mutexes, locks, semaphores, barriers) – deadlocks and livelocks – communication between threads.

UNIT - III	SHARED MEMORY PROGRAMMING WITH OpenMP	12

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	12

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	12

Case studies – n-Body solvers – Tree Search – OpenMP and MPI implementations and comparison.

Total Instructional hours : 60

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Course Outcomes : Students will be able to	
CO1	Outline multicore architectures and identify their characteristics and challenges.
CO2	Identify the issues in programming Parallel Processors.
CO3	Develop programs using Open MP and MPI
CO4	Experiment with parallel programming solutions to common problems.
CO5	Compare and contrast programming for serial and for parallel processors.

Reference Books	
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 (unit 2)
3.	Michael J Quinn, “Parallel programming in C with MPI and OpenMP, Tata McGraw Hill,2003.
4.	Victor Alessandrini, Shared Memory Application Programming, 1st Edition, Concepts and Strategies in Multicore Application Programming, Morgan Kaufmann, 2015.
5.	Yan Solihin, Fundamentals of Parallel Multicore Architecture, CRC Press, 2015.

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M.E / M.Tech	M23CST203 - MACHINE LEARNING	L	T	P	C
		3	1	0	4

Course Objectives	
1.	To understand the concepts and mathematical foundations of machine learning and types of problems tackled by machine learning
2.	To explore the different supervised learning techniques including ensemble methods
3.	To learn different aspects of unsupervised learning and reinforcement learning
4.	To learn the role of probabilistic methods for machine learning
5.	To understand the basic concepts of neural networks and deep learning

UNIT - I	INTRODUCTION AND MATHEMATICAL FOUNDATIONS	12

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- Bayesian Conditional Probability -Vector Calculus Optimization - Decision Theory - Information theory

UNIT - II	SUPERVISED LEARNING	12

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 Neighbors - Tree based Methods –Decision Trees –ID3 – CART - Ensemble Methods – Random Forest - Evaluation of Classification Algorithms

UNIT - III	UNSUPERVISED LEARNING AND REINFORCEMENT LEARNING	12

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

UNIT - IV	PROBABILISTIC METHODS FOR LEARNING	12

Introduction - Naïve 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	12

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Neural Networks – Biological Motivation- Perceptron – Multi-layer Perceptron – Feed Forward Network – Back Propagation-Activation and Loss Functions- Limitations of Machine Learning –Deep Learning– Convolution Neural Networks – Recurrent Neural Networks – Use cases
Total Instructional hours : 60

Course Outcomes: Students will be able to	
CO1	Outline problems for each type of machine learning
CO2	Illustrate Decision tree and Random Forest for an application
CO3	Experiment Probabilistic Discriminative and Generative algorithms
CO4	Make Use of a tool to implement typical Clustering algorithms
CO5	Organize a HMM for a Sequence Model type of applications and suitable for different types of Machine Learning

Reference Books	
1.	Stephen Marsland, “Machine Learning: An Algorithmic Perspective”, Chapman /CRC, 2nd Edition, 2014.
2.	Kevin Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012
3.	Ethem Alpaydin, “Introduction to Machine Learning”, Third Edition, Adaptive Computation and Machine Learning Series, MIT Press, 2014
4.	Tom M Mitchell, “Machine Learning”, McGraw Hill Education, 2013.
5.	Peter Flach, “Machine Learning: The Art and Science of Algorithms that Make Sense of Data”, First Edition, Cambridge University Press, 2012.

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M.E / M.Tech	M23CSP201 – SOFTWARE ENGINEERING LABORATORY	L	T	P	C
		0	0	4	2

Course Objectives	
1.	To identify and execute the basic programs in Python.
2.	To create the Python programs by using built-in data types and their methods.
3.	To create the user-defined functions and modules in Python.
4.	To implement the file handling operations.
5.	To learn the list and dictionary concepts in Python.

Expt. No.	Description of the Experiments
1.	FORWARD ENGINEERING Students have to form a team with a batch size of two or three and take up a case study based project to analyze, plan, design UML models and create a prototypical model (identifying deliverables) by coding the developed designs and finally documenting considering any one example of the following domains:- 1. Academics (Course Registration System, Student marks analyzing system) 2. Health Care (Expert system to prescribe medicines for given symptoms, Remote Diagnostics, Patient/Hospital Management System) 3. Finance (Banking: ATM/Net Banking, UPI: PayTM/ PhonePay, Stocks:Zerodha) 4. E-Commerce (various online shopping portals like FlipKart/Amazon/Myntra) 5. Logistics (Postal/Courier:IndiaPost/DTDC/UPS/FedEx,Freight:Maersk) 6. Hospitality (Tourism Management :Telangana Tourism/Incredible India, Event Management :MeraEvents/BookMyShow/Explara/EventBrite) 7. Social Networking (LinkedIn, FaceBook, Shaadi.com, BharatMatrimony,Tinder) 8. Customer Support (Banking Ombudsman,Indian Consumer ComplaintsForum) 9. Booking/Ticketing(Food:Zomato/Swiggy/BigBasket/Grofers/JioMart, Hotel:OYO/Trivago or Travel:{Cars:Uber/OLA/Zoom, Railways:IRCTC, Buses:OnlineTSRTC/RedBus/AbhiBus, Flights:MakeMyTrip/Goibibo, Ships:Lakport})
2.	REVERSE ENGINEERING: Students have to refer any project repository: GitLab /GitHub,execute the code in order to observe its functionalities/features/requirements and by the help of any tool derive the designs from the code for understanding the relationships among various subsystems/classes/components and if the tool partially generates models then identify by associating elements to judge/mark the appropriate relationships
3.	TESTING: Prepare Test Plan and develop Test Case Hierarchy to monitor or uncover/report errors using manual/automated testing tools
	Total Instructional hours = 45

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M.E / M.Tech	M23CSP202 – TERM PAPER WRITING AND SEMINAR	L	T	P	C
		0	2	0	1

Course Objectives	
1.	To work on a specific technical topic of research interest for oral presentation
2.	To acquire technical writing abilities for seminars and conferences.
3.	To publish quality papers and reputed journals.
4.	In this course, students will develop their scientific and technical reading and writing skills that they need to understand and construct research articles.
5.	A term paper requires a student to obtain information from a variety of sources (i.e., Journals,

The work involves the following steps:

1. Selecting a subject, narrowing the subject into a topic
2. Stating an objective.
3. Collecting the relevant bibliography (at least 15 journal papers)
4. Preparing a working outline.
5. Studying the papers and understanding the author's contributions and critically analyzing each paper.
6. Preparing a working outline
7. Linking the papers and preparing a draft of the paper.
8. Preparing conclusions based on the reading of all the papers.
9. Writing the Final Paper and giving final Presentation

Please keep a file where the work carried out by you is maintained.

Activity	Instructions	Submission week	Evaluation
Selection of area of interest and Topic	You are requested to select an area of interest, topic and state an objective.	2nd week	3 % Based on clarity of thought, current relevance and clarity in writing
Collecting Information about your	1. List 1 Special Interest Groups or professional society 2. List 2 journals	3rd week	3% (the selected information must

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area & topic	3. List 2 conferences, symposia or workshops 4. List 1 thesis title 5. List 3 web presences (mailing lists, forums, news sites) 6. List 3 authors who publish regularly in your area 7. Attach a call for papers (CFP) from your area.		be area specific and of international and national standard)
Collection of Journal papers in the topic in the context of the objective – collect 20 & then filter	• You have to provide a complete list of references you will be using- Based on your objective -Search various digital libraries and Google Scholar • When picking papers to read - try to: • Pick papers that are related to each other in some ways and/or that are in the same field so that you can write a meaningful survey out of them, • Favour papers from well-known journals and conferences, • Favour “first” or “foundational” papers in the field (as indicated in other people’s survey paper), • Favour more recent papers, • Pick a recent survey of the field so you can quickly gain an overview, • Find relationships with respect to each other and to your topic area (classification scheme/categorization) • Mark in the hard copy of papers whether complete work or section/sections of the paper are being considered	4th week	6% (the list of standard papers and reason for selection)
Reading and	Reading Paper Process	5th week	8%

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notes for first 5 papers	• For each paper form a Table answering the following questions: • What is the main topic of the article? • What was/were the main issue(s) the author said they want to discuss? • Why did the author claim it was important? • How does the work build on other's work, in the author's opinion? • What simplifying assumptions does the author claim to be making? • What did the author do? • How did the author claim they were going to evaluate their work and compare it to others? • What did the author say were the limitations of their research? • What did the author say were the important directions for future research? Conclude with limitations/issues not addressed by the paper (from the perspective of your survey)		(the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Reading and notes for next 5 papers	Repeat Reading Paper Process	6th week	8% (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Reading and	Repeat Reading Paper Process	7th week	8%

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notes for final 5 papers			(the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Draft outline 1 and Linking papers	Prepare a draft Outline, your survey goals, along with a classification / categorization diagram	8th week	8% (this component will be evaluated based on the linking and classification among the papers)
Abstract	Prepare a draft abstract and give a presentation	9th week	6% (Clarity, purpose and conclusion) 6% Presentation & Viva Voce
Introduction Background	Write an introduction and background sections	10th week	5% (clarity)
Sections of the paper	Write the sections of your paper based on the classification / categorization diagram in keeping with the goals of your survey	11th week	10% (this component will be evaluated based on the linking and classification among

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			the papers)
Your conclusions	Write your conclusions and future work	12th week	5% (conclusions – clarity and your ideas)
Final Draft	Complete the final draft of your paper	13th week	10% (formatting, English, Clarity and linking) 4% Plagiarism Check Report
Seminar	A brief 15 slides on your paper	14th and 15th week	10% (based on presentation and Viva-voce)
			Total Instructional hours: 30

Requirements for a Batch of 30 Students		
Sl. No.	**Description of the Equipment**	**Quantity required (Nos.)**
1.	Dell Optiplex 380 PCs Operating systems: Windows* 7 or later, macOS, and Linux. Software Required: StarUML/Umbrello, NetBeans/Eclipse IDE, XAMPP/MEANstack, JUnit, JMeter, Selenium, Bugzilla	25

Course Outcomes : Students will be able to	
CO1	Interpret variety of approaches and perspectives of system development.
CO2	Identify the requirements which are relevant to the design of the system.
CO3	Model software design with a set of objects and their relationships using structural modelling.
CO4	Take part in using the advanced and behavioural modelling to develop case study
CO5	Build activities with the help of architectural modeling

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M.E / M.Tech	M23CSE201- HUMAN COMPUTER INTERACTION	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To learn the foundations of Human Computer Interaction
2.	Understanding Interaction Styles and to become familiar with the design technologies for all.
3.	To understand the process of Evaluation of Interaction Design.
4.	To clarify the significance of task analysis for ubiquitous computing
5.	To get insight on web and mobile interaction.

UNIT - I	FOUNDATIONS OF HCI	9

Context of Interaction –Human memory - Designing Interactive systems – Understanding Users-cognition and cognitive frameworks, User Centered approaches Usability, Universal Usability, 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-Device for virtual reality and 3D interaction.

UNIT - II	INTERACTION STYLES	9

GUI: Popularity of graphics - The concept of direct manipulation - Graphical system - Characteristics - Interface Popularity - Characteristics and Principles of User Interface. Understanding interaction styles, Elements of WIMP interface, 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	EVALUATION OF INTERACTION	9

Evaluation Techniques- assessing user experience- usability testing –HCI in the software process, 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, and Textual dialog notations.

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UNIT - V	WEB AND MOBILE INTERACTION	9
Hypertext, Multimedia and WWW, Designing for the web Direct Selection, control flow, Contextual Tools, Overlays, Inlays and Virtual Pages, Process Flow. Use, shared application and artifacts, Mobile navigation, content and control idioms, Multi-touch gestures, Inter- app integration, Mobile web.		
Total Instructional hours: 45		

Course Outcomes : Students will be able to	
CO1	Show the basics of human computer interactions via usability engineering and cognitive modeling.
CO2	Identify the basic design paradigms, complex interaction styles.
CO3	Compare the models and theories for user interaction
CO4	Examine the evaluation of interaction designs and implementations.
CO5	Classify the above issues for web and mobile applications.

Reference Books	
1.	Ben Shneiderman, Catherine Plaisant, Maxine Cohen, Steven Jacobs, Niklas Elmqvist, Designing the User Interface: Strategies for Effective Human-Computer Interaction, 6th Ed, Pearson Education, 2016.
2.	Alan Dix, Janet Finlay, G D Abowd and Russel Beale, Human Computer Interaction,
3.	Helen Sharp, Jennifer Preece, Yvonne Rogers, Interaction Design: Beyond Human-Computer Interaction", Wiley, 5th Edition, 2019.
4.	Alan Cooper,RobertReimann, David Cronin, Christopher Noessel,"About Face: The Essentials of Interaction Design", 4th Edition, Wiley, 2014.
5.	Donald A. Norman, Design of Everyday Things, MIT Press, 2013.

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M.E / M.Tech	M23CSE202 CLOUD COMPUTING TECHNOLOGIES	L	T	P	C
		3	0	0	3

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

UNIT - I	VIRTUALIZATION AND INFRASTRUCTURE	9

Basics of Virtual Machines - Process Virtual Machines – System Virtual Machines –Emulation – Interpretation – Services and applications. 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 –Resource Management – Virtualization for data center automation

UNIT - II	CLOUD PLATFORM ARCHITECTURE	9

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, Understanding Hypervisors.

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 Manager

UNIT - IV	PAAS CLOUD PLATFORM	9

Windows Azure: Origin of Windows Azure, Features, The Fabric Controller – 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

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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 –Developing Map Reduce Applications - Design of Hadoop file system –Setting up Hadoop Cluster- Aneka: Cloud Application Platform, Thread Programming, Task Programming and Map-Reduce Programming in Aneka		
Total Instructional hours: 45		

Course Outcomes : Students will be able to	
CO1	Explain the concepts of virtualization in the cloud computing
CO2	Identify 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.

Reference Books	
1.	Bernard Golden, Amazon Web Service for Dummies, John Wiley & Sons, 2013.
2.	Raoul Alongi, AWS: The Most Complete Guide to Amazon Web Service from Beginner to
3.	Sriram Krishnan, Programming: Windows Azure, O'Reilly,2010
4.	Rajkumar Buyya, Christian Vacchiola, S.Thamarai Selvi, Mastering Cloud Computing , MCGraw Hill Education (India) Pvt. Ltd., 2013.
5.	John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010
6.	Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2012.

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M.E / M.Tech	M23CSE203- FOUNDATIONS OF DATA SCIENCES	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To apply fundamental algorithms to process data.
2.	Learn to apply hypotheses and data into actionable predictions.
3.	Document and transfer the results and display findings using visualization techniques.
4.	To learn statistical methods and machine learning algorithms required for Data Science.
5.	To develop the fundamental knowledge and understand concepts to become a data science

UNIT - I	INTRODUCTION TO DATA SCIENCE	9

Data Science: Benefits and uses – facets of data – Data Science Process: Overview – Defining research goals – Retrieving data – Data preparation – Exploratory Data analysis – build the model– presenting findings and building applications – cleaning and sampling for modeling and validation – introduction to No SQL.

UNIT - II	MODELING METHODS	9

Choosing and evaluating models – mapping problems to machine learning, evaluating clustering models, validating models – cluster analysis – K-means algorithm, Naïve Bayes – Memorization Methods – Linear and logistic regression – unsupervised methods.

UNIT - III	INTRODUCTION TO R	9

Reading and getting data into R – ordered and unordered factors – arrays and matrices – lists and data frames – reading data from files – probability distributions – statistical models in R - manipulating objects – data distribution, Loops and functions in R.

UNIT - IV	MAP REDUCE	9

Introduction – distributed file system – algorithms using map reduce, Matrix-Vector Multiplication by Map Reduce – Hadoop - Understanding the Map Reduce architecture - Writing Hadoop Map Reduce Programs - Loading data into HDFS - Executing the Map phase - Shuffling and sorting - Reducing phase execution.

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UNIT - V	DATA VISUALIZATION	9
Documentation and deployment – producing effective presentations – Introduction to graphical analysis – plot() function – displaying multivariate data – matrix plots – multiple plots in one Window - exporting graph using graphics parameters - Importing Matplotlib – Line plots – Scatter plots – visualizing errors – density and contour plots.		
Total Instructional hours: 45		

Course Outcomes : Students will be able to	
CO1	Illustrate the process of collect, clean/process and transform data.
CO2	Interpret data using an ethically responsible approach after analysis.
CO3	Make use of appropriate models to analyze, assess input before deriving insight from results, and investigate potential issues.
CO4	Apply computing theory, languages and algorithms, as well as mathematical and Statistical models, and optimization for data analysis.
CO5	Construct and use appropriate models of data analysis to solve business-related challenges.

Reference Books	
1.	Nina Zumel, John Mount, “Practical Data Science with R”, Manning Publications, 2014.
2.	Mark Gardener, “Beginning R - The Statistical Programming Language”, John Wiley & Sons, Inc., 2012.
3.	W. N. Venables, D. M. Smith and the R Core Team, “An Introduction to R”, 2013.
4.	Tony Ojeda, Sean Patrick Murphy, Benjamin Bengfort, Abhijit Dasgupta, “Practical Data Science Cookbook”, Packt Publishing Ltd., 2014.
5.	Nathan Yau, “Visualize This: The FlowingData Guide to Design, Visualization, and Statistics”, Wiley, 2011.

Approved by BoS Chairman

M.E / M.Tech	M23CSE204- WIRELESS COMMUNICATIONS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the basic concepts in cellular communication.
2.	To learn the characteristics of wireless channels.
3.	To understand the impact of digital modulation techniques in fading.
4.	To get exposed to diversity techniques in wireless communication.
5.	To acquire knowledge in multicarrier systems

UNIT - I	CELLULAR CONCEPTS	9

Multiple Access techniques — FDMA, TDMA, CDMA — Capacity calculations–Cellular concept- Co-Channel Interference- Adjacent Channel Interference – Trucking and Grade of service – Improving coverage & capacity in cellular systems-Cell Splitting- Sectoring- truncking & grade of service — Coverage and capacity improvement.

UNIT - II	THE WIRELESS CHANNEL	9

Overview of wireless systems – Physical modeling for wireless channels Large scale path loss - Path loss models: Free Space and Two-Ray models -Link Budget design -Small scale fading- Parameters of mobile multipath channels - Time dispersion parameters-Coherence bandwidth - Doppler spread & Coherence time, fading due to Multipath time delay spread -flat fading - frequency selective fading - Fading due to Doppler spread - fast fading -slow fading.

UNIT - III	DIGITAL MODULATION OVER WIRELESS CHANNELS	9

Performance of flat fading and frequency selective fading – Structure of a wireless communication link, Principles of Offset-QPSK, p/4-DQPSK,–- Outage Probability– Average Probability of Error – Combined Outage and Average Error Probability – Doppler Spread – Inter symbol Interference.

UNIT - IV	DIVERSITY TECHNIQUES	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.

Approved by BoS Chairman

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 Instructional hours: 45		

Course Outcomes : Students will be able to	
CO1	Build solutions for cellular communication
CO2	Demonstrate the capacity of wireless channels
CO3	Experiment the performance of the digital modulation techniques in fading channels
CO4	Apply various diversity techniques in wireless communication
CO5	Make use of multicarrier systems in wireless communication

Reference Books	
1.	Theodore.S. Rappaport, “Wireless Communications: Principles and Practice", 2nd Edition, Pearson Education, India, 2010.
2.	Saad Z. Asif, “5G Mobile Communications Concepts and Technologies” CRC press – 2019.
3.	Keith Q. T. Zhang, “Wireless Communications: Principles, Theory and Methodology” 1st edition, John Wiley & Sons, 2016.
4.	Ramjee Prasad, "OFDM for Wireless Communication Systems", Artech House, 2004.

Approved by BoS Chairman

M.E / M.Tech	M23CSE205- AGILE METHODOLOGIES	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To learn the fundamental principles and practices associated with agile development methods
2.	To apply the principles and practices of agile software development on a relevant project.
3.	To provide a good understanding of software design and a set of software technologies and APIs.
4.	To do a detailed examination and demonstration of agile development and testing techniques.
5.	To understand agile development and testing

UNIT - I	AGILE SOFTWARE DEVELOPMENT	9

Basics and Fundamentals of Agile Process Methods, Values of Agile, Principles of Agile, stake holders, Challenges Theories for Agile Management – Agile Software Development – Traditional Model vs. Agile Model - Classification of Agile Methods – Agile Manifesto and Principles – Agile Project Management – Agile Team Interactions – Ethics in Agile Teams - Agility in Design, Testing – Agile Documentations – Agile Drivers, Capabilities and Values, differences between Agile plans at different lifecycle phases

UNIT - II	AGILE AND SCRUM PRINCIPLES	9

Agile Manifesto, Crystal, Feature Driven Development- Adaptive Software Development - Extreme Programming: Method Overview – Lifecycle – Work Products, Roles and Practices. 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 issueof XP, Scrum Practices, Applying Scrum. Need of scrum, working of scrum, advanced Scrum Applications, Scrum and the Organization, scrum values

UNIT - IV	AGILE REQUIREMENTS AND AGILE TESTING	9

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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

Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions and miscellaneous problems. Perspective projection of simple solids-prisms, pyramids and cylinders by visual ray method.

Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Model existing problems with the team, development process and wider organization
CO2	Apply a thorough understanding of Agile principles and specific practices
CO3	Select the most appropriate way to improve results for a specific circumstance or need
CO4	Construct appropriate adaptations to existing practices or processes depending upon analysis of typical problems
CO5	Identify likely successes and formulate plans to manage likely risks or problems

Reference Books

1.	K. Venugopal and V.Prabhu Raja, “Engineering Graphics”, New Age International Publishers, 2017.
2.	K.R.Gopalakrishna., “Engineering Drawing” (Vol. I & II combined) Subhas Publications, Bangalore, 2018.
3.	N.S Parthasarathy and Vela Murali, “Engineering Drawing”, Oxford University Press, 2015.
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.

Approved by BoS Chairman

M.E / M.Tech	M23CSE206- PERFORMANCE ANALYSIS OF COMPUTER SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the mathematical foundations of performance evaluation of computer systems
2.	understand the metrics used for performance evaluation
3.	To understand the analytical modeling of computer systems
4.	To enable the students to develop new queuing analysis for both simple and complex systems
5.	To use smart scheduling to analytical techniques for evaluating scheduling policies.

UNIT - I	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.

Approved by BoS Chairman

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 Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Identify the need for performance evaluation and the metrics used for it
CO2	Distinguish between open and closed queuing networks
CO3	Apply Little'e law and other operational laws to open and closed systems
CO4	Make use of discrete-time and continuous-time Markov chains to model real world
CO5	Develop analytical techniques for evaluating scheduling policies

Reference Books

1. K. S. Trivedi, "Probability and Statistics with Reliability, Queueing and Computer Science Applications‖, John Wiley and Sons, 2001.
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. Mor Harchol - Balter, "Performance Modeling and Design of Computer Systems – Queueing Theory in Action, Cambridge University Press, 2013.
5. Paul J. Fortier and Howard E. Michel, "Computer Systems Performance Evaluation and Prediction, Elsevier, 2003.
6. Raj Jain, "The Art of Computer Systems Performance Analysis: Techniques for Experimental Design, Measurement, Simulation and Modeling‖, Wiley-Interscience, 1991.
7. Raj Jain, Art of Computer Systems Performance Analysis: Techniques For Experimental Design Measurements Simulation and Modeling,2nd edition, wiley, 2015

Approved by BoS Chairman

M.E / M.Tech	M23CSE207- ADVANCED OPERATING SYSTEM	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To get a comprehensive knowledge of the architecture of distributed systems.
2.	To understand the deadlock and shared memory issues and their solutions in distributed environments.
3.	To know the security issues and protection mechanisms for distributed environments.
4.	To get a knowledge of multiprocessor operating systems and database operating systems.

UNIT - I	INTRODUCTION	9

Architectures of Distributed Systems - System Architecture types - issues in distributed operating systems - communication networks – communication primitives. Theoretical Foundations - inherent limitations of a distributed system – lamport's logical clocks – vector clocks – causal ordering of messages – global state – cuts of a distributed computation – termination detection. Distributed Mutual Exclusion – introduction – the classification of mutual exclusion and associated algorithms – a comparative performance analysis

UNIT - II	DISTRIBUTED DEADLOCK DETECTION AND RESOURCE MANAGEMENT	9

Distributed Deadlock Detection -Introduction - deadlock handling strategies in distributed systems Issues in deadlock detection and resolution – control organizations for distributed deadlock detection Centralized and distributed deadlock detection algorithms –hierarchical deadlock detection algorithms. Agreement protocols – introduction-the system model, a classification of agreement problems, Solutions to the Byzantine agreement problem, applications of agreement algorithms. Distributed resource management: introduction-architecture – mechanism for building distributed File systems – design issues – log structured file systems.

UNIT - III	DISTRIBUTED SHARED MEMORY AND SCHEDULING	9

Distributed shared memory-Architecture– algorithms for implementing DSM – memory coherence and protocols – design issues. Distributed Scheduling – introduction – issues in load distributing – components of a load distributing algorithm – stability – load distributing algorithms – performance comparison – selecting a suitable load sharing algorithm – requirements for load distributing -task migration and associated issues. Failure Recovery and Fault tolerance: introduction– basic concepts – classification of failures – backward and forward error recovery, backward error recovery- recovery in concurrent systems – consistent set of checkpoints – synchronous and asynchronous check pointing and recovery – check pointing for distributed database systems- recovery in replicated distributed databases.

Approved by BoS Chairman

UNIT - IV	DATA SECURITY	9
Protection and security -preliminaries, the access matrix model and its implementations.-safety in matrix model- advanced models of protection. Data security – cryptography: Model of cryptography, conventional cryptography- modern cryptography, private key cryptography, data encryption standard- public key cryptography – multiple encryption – authentication in distributed systems.		

UNIT - V	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.		
Total Instructional hours : 45		

Course Outcomes : Students will be able to	
CO1	Explain the working of Theoretical Foundations of OS.
CO2	Illustrate the working principles of Distributed Deadlock Detection and resource
CO3	Outline the concepts of distributed shared memory and scheduling mechanisms
CO4	Construct and analyze the working of Data security
CO5	Apply the learning into multiprocessor system architectures.

Reference Books	
1.	Mukesh Singhal, Niranjan G.Shivaratri, "Advanced concepts in operating systems: Distributed, Database and multiprocessor operating systems", TMH, 2001
2	Andrew S.Tanenbaum, "Modern operating system", PHI, 2003
3	Pradeep K.Sinha, "Distributed operating system-Concepts and design", PHI, 2003.

Approved by BoS Chairman

M.E / M.Tech	M23CSE208- DIGITAL IMAGE PROCESSING	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To study fundamental concepts of digital image processing.
2.	To understand and learn image processing operations and restoration.
3.	To use the concepts of Feature Extraction
4.	To study the concepts of Image Compression
5.	To expose students to current trends in the field of image segmentation.

UNIT - I	INTRODUCTION	9

Examples of fields that use digital image processing, fundamental steps in digital image processing, components of image processing system. Image transformation: A simple image formation model, image sampling and quantization, basic relationships between pixels. Image enhancement in the spatial domain: Basic gray-level transformation, histogram processing, object boundary and shape representations, basic spatial filtering, smoothing, and sharpening spatial filters, combining the spatial enhancement methods.

Suggested Activities: Discussion of Mathematical Transforms. Numerical problem solving using Fourier Transform. Numerical problem solving in Image Enhancement. External learning – Image Noise and its typesat different lifecycle phases

UNIT - II	AGILE AND SCRUM PRINCIPLES	9

A model of the image degradation/restoration process, noise models, restoration in the presence of noise–only spatial filtering, Weiner filtering, constrained least squares filtering; Introduction to the Fourier transform and the frequency domain, estimating the degradation function. Color Image Processing: Color fundamentals, pseudo color image processing, basics of full–color image processing, color transforms, smoothing and sharpening, color segmentation

Suggested Activities: Discussion on Image Artifacts and Blur, Discussion of Role of Wavelet Transforms in Filter and Analysis, Numerical problem solving in Wavelet Transforms, External learning – Image restoration algorithms.

Suggested Evaluation Methods: Tutorial – Wavelet transforms, Assignment problems on order statistics and multi-resolution expansions, Quizzes on wavelet transforms.

UNIT - III	FEATURE EXTRACTION	9

Approved by BoS Chairman

Detection of discontinuities – Edge linking and Boundary detection- Thresholding- -Edge based segmentation-Region based Segmentation- matching-Advanced optimal border and surface detection- Use of motion in segmentation. Image Morphology – Boundary descriptors- Regional descriptors, Detecting DoG features and extracting SIFT descriptors.

Suggested Activities: External learning – Feature selection and reduction, External learning – Image salient features, Assignment on numerical problems in texture computation,

Suggested Evaluation Methods: Assignment problems on feature extraction and reduction. Quizzes on feature selection and extraction

UNIT - IV	IMAGE COMPRESSION	9

Fundamentals, image compression models, error-free compression, lossy predictive coding, image compression standards Morphological Image Processing: Preliminaries, dilation, erosion, open and closing, hit or miss transformation, basic morphological algorithms, Texture - Patterns and Pattern classes - Recognition based on matching.

Suggested Activities: Flipped classroom on different image coding techniques, Practical – Demonstration of EXIF format for given camera. Practical – Implementing effects quantization, color change.

Case study of Google's WebP image format.

Suggested Evaluation Methods: Evaluation of the practical implementations, Assignment on image file formats

UNIT - V	IMAGE SEGMENTATION	9

Detection of discontinuous, edge linking and boundary detection, thresholding, region–based segmentation. Object Recognition: Patterns and patterns classes, recognition based on decision–theoretic methods, matching, optimum statistical classifiers, Morphological processing- erosion and dilation.

Suggested Activities: Flipped classroom on importance of segmentation.

Suggested Evaluation Methods: Tutorial – Image segmentation and edge detection.

Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Apply knowledge of Mathematics for image processing operations
CO2	Make use of techniques for image restoration.
CO3	Choose and extract salient features of images.
CO4	Identify appropriate tools (Contemporary) for image compression and analysis.
CO5	Outline segmentation techniques and do object recognition

Approved by BoS Chairman

Reference Books	
1.	Digital Image Processing, Rafeal C.Gonzalez, Richard E.Woods, Second Edition, Pearson Education/PHI., 2002
2.	Digital Image Processing, Sridhar S, Second Edition, Oxford University Press, 2016
3.	Introduction to Digital Image Processing with Matlab, Alasdair McAndrew, Thomson Course Technology, . Brooks/Cole 2004
4.	Milan Sonka, Vaclav Hlavac, Roger Boyle, “Image Processing, Analysis and Machine Vision”, Second Edition, Thompson Learning, 2007.
5.	Digital Image Processing using Matlab, Rafeal C.Gonzalez, Richard E.Woods, Steven L. Eddins, Pearson Education.Second Edition, 2017

Approved by BoS Chairman

M.E / M.Tech	M23CSE209-HIGH PERFORMANCE COMPUTING FOR BIG DATA	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To learn the fundamental concepts of High Performance Computing.
2.	To learn the network & software infrastructure for high performance computing.
3.	To understand real time analytics using high performance computing.
4.	To learn the different ways of security perspectives and technologies used in HPC.
5.	To understand the emerging big data applications.

UNIT - I	INTRODUCTION	9

The Emerging IT Trends- IOT/IOE-Apache Hadoop for big data analytics-Big data into big insights and actions – Emergence of BDA discipline – strategic implications of big data – BDA Challenges – HPC paradigms – Cluster computing – Grid Computing – Cloud computing – Heterogeneous computing – Mainframes for HPC - Supercomputing for BDA – Appliances for BDA.

UNIT - II	NETWORK & SOFTWARE INFRASTRUCTURE FOR HIGH PERFORMANCE BDA	9

Design of Network Infrastructure for high performance BDA – Network Virtualization – Software Defined Networking – Network Functions Virtualization – WAN optimization for transfer of big data-started with SANs- storage infrastructure requirements for storing big data – FC SAN – IP SAN – NAS – GFS – Panasas – Luster file system – Introduction to cloud storage.

UNIT - III	REAL TIME ANALYTICS USING HIGH PERFORMANCE COMPUTING	9

Technologies that support Real time analytics – MOA: Massive online analysis – GPFS: General parallel file system – Client case studies – Key distinctions – Machine data analytics – operational analytics – HPC Architecture models – In Database analytics – In memory analytics

UNIT - IV	SECURITY AND TECHNOLOGIES	9

Sectioning of solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones.

Approved by BoS Chairman

UNIT - V	EMERGING BIG DATA APPLICATIONS	9
Deep learning Accelerators – Accelerators for clustering applications in machine learning - Accelerators for classification algorithms in machine learning – Accelerators for Big data Genome Sequencing		

Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Illustrate the basics concepts of High Performance computing systems.
CO2	Apply the concepts of network and software infrastructure for high performance computing.
CO3	Show real time analytics using high performance computing.
CO4	Apply the security models and big data applications in high performance computing
CO5	Construct simple solids and its sections in isometric view and projections and to draw its perspective views.

Reference Books	
1.	High performance computing: Modern systems and practices", Thomas Sterling, Matthew Anderson, Morgan Kaufmann publishers,1st Edition,2017
2.	High Performance Computing for Big Data: Methodologies and Applications", Chao wang ,CRC Press,1st Edition,2018
3.	Pethuru Raj, Anupama Raman, Dhivya Nagaraj and Siddhartha Duggirala, High-Performance Big- Data Analytics: Computing Systems and Approaches, Springer, 1st Edition, 2015.
4.	Big Data Management and Processing", Kuan-Ching Li , Hai Jiang, Albert Y. Zomaya, CRC Press,1st Edition,2017.

Approved by BoS Chairman

M.E / M.Tech	M23CSE210- INFORMATION RETRIEVAL TECHNIQUES	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the basics of information retrieval with pertinence to modeling, query operations and indexing
2.	To get an understanding of machine learning techniques for text
3.	To understand the various applications of information retrieval giving emphasis to multimedia
4.	To get an understanding of machine learning techniques for text classification and clustering
5.	To understand the concepts of digital libraries.

UNIT - I	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

Design of Network Infrastructure for high performance BDA – Network Virtualization – Software Defined Networking – Network Functions Virtualization – WAN optimization for transfer of big data-started with SANs- storage infrastructure requirements for storing big data – FC SAN – IP SAN – NAS – GFS – Panasas – Luster file system – Introduction to cloud storage.

UNIT - III	INDEXING	9

Static and Dynamic Inverted Indices – Index Construction and Index Compression. Searching –

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

Sectioning of solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones.

Approved by BoS Chairman

UNIT - V	SEARCHING THE WEB	9
Deep learning Accelerators – Accelerators for clustering applications in machine learning - Accelerators for classification algorithms in machine learning – Accelerators for Big data Genome Sequencing		

Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Build an Information Retrieval system using the available tools.
CO2	Identify and design the various components of an Information Retrieval system.
CO3	Compare the different types of IR Models
CO4	Apply machine learning techniques to text classification and clustering which is used for efficient Information Retrieval.
CO5	Select an efficient search engine and analyze the Web content structure.

Reference Books	
1.	Christopher D. Manning, Prabhakar Raghavan, Hinrich Schutze, Introduction to Information Retrieval, Cambridge University Press, First South Asian Edition, 2008
2.	Stefan Buttcher, Implementing and Evaluating Search Engines, The MIT Press, Cambridge, Massachusetts London, England, 2016
3.	Ricardo Baeza – Yates, Berthier Ribeiro – Neto, “Modern Information Retrieval: The concepts and Technology behind Search (ACM Press Books), Second Edition, 2011

Approved by BoS Chairman

M.E / M.Tech	M23CSE211- SOFTWARE QUALITY ASSURANCE	L	T	P	C
		3	0	0	3

Course Objectives	
1.	Be exposed to the software quality factors, quality assurance architecture and SQA components.
2.	Understand the integration of SQA components into the project life cycle.
3.	Be familiar with the software quality infrastructure.
4.	Be exposed to the management components of software quality.
5.	Be familiar with the Quality standards, certifications and assessments

UNIT - I	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

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

Approved by BoS Chairman

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 Instructional hours : 45

Course Outcomes : 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	Identify the quality of software products
CO4	Apply the concepts in preparing the quality plan & documents.
CO5	Experiment with the product meets company's quality standards and client's expectations and demands.

Reference Books	
1.	Kshirasagar Naim and Priyadarshini Tripathy, Software Testing and Quality Assurance Theory and Practice, John Wiley & Sons Inc., 2008
2.	Mordechai Ben-Menachem “Software Quality: Producing Practical Consistent Software, International Thompson Computer Press, 2014
3.	Daniel Galin, Software Quality Assurance, Pearson Publication, 2009.
4.	Alan C. Gillies, “Software Quality: Theory and Management”, International Thomson Computer Press, 2011.

Approved by BoS Chairman

M.E / M.Tech	M23CSE212- AUTONOMOUS SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To impart knowledge on the functional architecture of autonomous vehicles
2.	To impart knowledge on Localization and mapping fundamentals
3.	To impart knowledge on process end effectors and robotic controls
4.	To learn Robot cell design, Robot Transformation and Sensors
5.	To learn Micro/Nano Robotic Systems

UNIT - I	INTRODUCTION AND FUNCTIONAL ARCHITECTURE	9

Functional architecture - Major functions in an autonomous vehicle system, Motion Modeling - Coordinate frames and transforms, point mass model, Vehicle modeling (kinematic and dynamic bicycle model - two-track models), Sensor Modeling - encoders, inertial sensors, GPS.

UNIT - II	PERCEPTION FOR AUTONOMOUS SYSTEM	9

SLAM - Localization and mapping fundamentals, LIDAR and visual SLAM, Navigation – Global path planning, Local path planning, Vehicle control - Control structures, PID control, Linear quadratic regulator, Sample controllers

UNIT - III	ROBOTICS INTRODUCTION, END EFFECTORS AND CONTROL	9

Robot anatomy-Definition, law of robotics, Simple problems Specifications of Robot- Speed of Robot-Robot joints and links-Robot classifications-Architecture of robotic systems, Mechanical grippers-Slider crank mechanism, Screw type, Rotary actuators, cam type-Magnetic grippers- Vacuum grippers-Air operated grippers-Gripper force analysis - Gripper design-Simple problems- Robot controls-Point to point control, Continuous path control, Intelligent robotControl system for robot joint-Control actions-Feedback devices- Encoder, Resolver, LVDTMotion Interpolations- Adaptive control.

UNIT - IV	ROBOT TRANSFORMATIONS, SENSORS AND ROBOT CELL DESIGN	9

Robot kinematics-Types- 2D, 3D Transformation-Scaling, Rotation, Translation- Homogeneous coordinates, multiple transformation-Simple problems. Sensors in robot – Touch sensors-Tactile, Robot work cell design and control-Sequence control, Operator interface, Safety monitoring devices in Robot-Mobile robot working principle, actuation using MATLAB, NXT Software.

Approved by BoS Chairman

UNIT - V	MICRO/NANO ROBOTICS SYSTEM	9
Micro/Nano robotics system overview-Scaling effect-Top down and bottom up approach Actuators of Micro/Nano robotics system-Nano robot communication techniques-Fabrication of micro/nano grippers-Wall climbing micro robot working principles-Biomimetic robot-Swarm robot-Nano robot in targeted drug delivery system.		

Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Choose architecture and modeling of autonomous systems
CO2	Make use of localization mapping techniques for autonomous systems
CO3	Develop solutions for autonomous systems control.
CO4	Analyze Robot Transformations, Sensors and Cell Design
CO5	Explain the working principles of Micro/Nano Robotic system

Reference Books	
1.	Markus Maurer, Autonomous driving: technical, legal and social aspects. Springer, 2016
2.	Jha, Theory, Design and Applications of Unmanned Aerial Vehicles, CRC Press, 2016
3.	S.R. Deb, Robotics Technology and flexible automation, Tata McGraw-Hill Education.,2009
4.	Mikell P Groover & Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, Industrial Robotics, Technology programming and Applications, McGraw Hill, 2012.
5.	Karsten Berns, Ewald Puttkamer, Springer, Autonomous Land Vehicles: Steps towards Service Robots, 2009
6.	Daniel Watzenig and Martin Horn (Eds.), Automated Driving: Safer and More Efficient Future Driving, Springer, 2017

Approved by BoS Chairman

M.E / M.Tech	M23CSE213 – WEB ANALYTICS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the Web analytics platform, and their evolution.
2.	To learn about the various Data Streams Data.
3.	To learn about the benefits of surveys and capturing of data.
4.	To understand Common metrics of web as well as KPI related concepts.
5.	To learn about the various Web analytics versions.

UNIT- I	INTRODUCTION	9

Definition, Process, Key terms: Site references, Keywords and Key phrases; building block terms: Visit characterization terms, Content characterization terms, Conversion metrics; Categories: Offsite web, on site web; Web analytics platform, Web analytics evolution, Need for web analytics, Advantages, Limitations.

UNIT-II	DATA COLLECTION	9

Click stream Data: Web logs, Web Beacons, JavaScript tags, Packet Sniffing; Outcomes Data: E-commerce, Lead generation, Brand/Advocacy and Support; Research data: Mindset, Organizational structure, Timing; Competitive Data: Panel-Based measurement, ISP-based measurement, Search Engine data.

UNIT-III	QUALITATIVE ANALYSIS	9

Heuristic evaluations: Conducting a heuristic evaluation, Benefits of heuristic evaluations; Site Visits: Conducting a site visit, Benefits of site visits; Surveys: Website surveys, Post-visit surveys, creating and running a survey, Benefits of surveys. Capturing data: Web logs or JavaScript's tags, Separate data serving and data capture, Type and size of data, Innovation, Integration, Selecting optimal web analytic tool, Understanding click stream data quality, Identifying unique page definition, Using cookies, Link coding issues.

UNIT-IV	WEB METRICS	9

Approved by BoS Chairman

Common metrics: Hits, Page views, Visits, Unique visitors, Unique page views, Bounce, Bounce rate, Page/visit, Average time on site, New visits; Optimization (e-commerce, non e-commerce sites): Improving bounce rates, Optimizing adwords campaigns; Real time report, Audience report, Traffic source report, Custom campaigns, Content report, Google analytics, Introduction to KPI, characteristics, Need for KPI, Perspective of KPI, Uses of KPI. Relevant Technologies: Internet & TCP/IP, Client / Server Computing, HTTP (Hypertext Transfer Protocol), Server Log Files & Cookies, Web Bugs.

UNIT-V	WEB ANALYTICS 2.0	9

Web analytics 1.0, Limitations of web analytics 1.0, Introduction to analytic 2.0, Competitive intelligence analysis : CI data sources, Toolbar data, Panel data ,ISP data, Search engine data, Hybrid data, Website traffic analysis: Comparing long term traffic trends, Analyzing competitive site overlap and opportunities. Google Analytics: Brief introduction and working, Adwords, Benchmarking, Categories of traffic: Organic traffic, Paid traffic; Google website optimizer, Implementation technology, Limitations, Performance concerns, Privacy issues.

Total Instructional hours:45

Course Outcomes : Students will be able to	
CO1	Demonstrate the Web analytics platform, and their evolution.
CO2	Make use of the various Data Streams Data.
CO3	Explain the survey of capturing of data will benefit.
CO4	Illustrate Common metrics of web as well as KPI related concepts.
CO5	Apply various Web analytics versions in existence.

ReferenceBooks	
1.	Clifton B., Advanced Web Metrics with Google Analytics, Wiley Publishing, Inc.2nd ed, 2012.
2.	Kaushik A., Web Analytics 2.0, The Art of Online Accountability and Science of Customer Centricity, Wiley Publishing, Inc. 1st ed, 2010.
3.	Sterne J., Web Metrics: Proven methods for measuring web site success, John Wiley and Sons, 2002

Approved by BoS Chairman

M.E/M.Tech	M23CSE214- COGNITIVE COMPUTING	L	T	P	C
		3	0	0	3

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

UNIT- I	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.

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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 Instructional hours:45	

Course Outcomes : Students will be able to	
CO1	Explain applications in Cognitive Computing.
CO2	Demonstrate Natural language processor role in Cognitive computing.
CO3	Explain future directions of Cognitive Computing
CO4	Identify the process of taking a product to market
CO5	Select the applications involved in this domain.

ReferenceBooks	
1.	Judith H Hurwitz, Marcia Kaufman, Adrian Bowles, “Cognitive computing and Big Data Analytics”, Wiley, 2015.
2.	Noah D. Goodman, Joshua B. Tenenbaum, The ProbMods Contributors, “ProbabilisticModels of Cognition”, Second Edition, 2016, https://probmods.org/.
3.	Robert A. Wilson, Frank C. Keil, “The MIT Encyclopedia of the Cognitive Sciences”, The MIT Press, 1999.

Approved by BoS Chairman

M.E/M.Tech	M23CSE215- QUANTUM COMPUTING	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To introduce the building blocks of Quantum computers and highlight the paradigm change between conventional computing and quantum computing
2.	To understand the Quantum state transformations and the algorithms
3.	To understand entangled quantum subsystems and properties of entangled states
4.	To explore the applications of quantum computing
5.	To introduce the building blocks of Quantum computers and highlight the paradigm change between conventional computing and quantum computing

UNIT- I	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		

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

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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 Instructional hours:45

Course Outcomes:Students will be able to	
CO1	Outline the basics principles of quantum computing
CO2	Identify the difference between conventional and quantum computing
CO3	Interpret the steps of quantum computing algorithms
CO4	Summarize the quantum computation techniques
CO5	Compare the classes of problems to be solved by quantum computers

Reference Books	
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
6	Benenti G., Casati G. and Strini G., Principles of Quantum Computation and Information, Vol. I: Basic Concepts, Vol II: Basic Tools and Special Topics, World Scientific. 2004
7	Pittenger A. O., An Introduction to Quantum Computing Algorithms 2000

Approved by BoS Chairman

M.E/M.Tech	M23CSE216- BIG DATA MINING AND ANALYTICS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the computational approaches to Modeling, Feature Extraction.
2.	To understand the need and application of Map Reduce.
3.	To understand the various search algorithms applicable to Big Data.
4.	To analyze and interpret streaming data and handle large data sets in main memory.
5.	To learn the various clustering techniques applicable to Big Data.

UNIT- I	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 FREQUEN 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.

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Total Instructional hours:45

Course Outcomes :Students will be able to	
CO1	Identify algorithms by employing Map Reduce technique for solving Big Dataproblems.
CO2	Demonstrate algorithms for Big Data by deciding on the apt Features set
CO3	Develop algorithms for handling petabytes of datasets
CO4	Classify algorithms and propose optimized memory based solutions for Big Data
CO5	Infer solutions for problems in Big Data using appropriate clustering techniques.

Reference Books	
1.	Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 3rd 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, HeikkiMannila and Padhraic Smyth, “Principles of Data Mining”, MIT PRESS, 2001

Approved by BoS Chairman

Semester - III

M.E	M23CST301 SECURITY PRACTICES	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To learn the core fundamentals of system and web security concepts
2.	To have through understanding in the security concepts related to networks
3.	To deploy the security essentials in IT Sector
4.	To be exposed to the concepts of cyber security and cloud security
5.	To perform a detailed study of privacy and storage security and related Issues

UNIT - I	SYSTEM SECURITY	9

Model of network security – Security attacks, services and mechanisms – OSI security architecture - A Cryptography primer- Intrusion detection system- Intrusion Prevention system - Security web applications- Case study: OWASP - Top 10 Web Application Security Risks.

UNIT - II	NETWORK SECURITY	9

Internet Security - Intranet security- Local Area Network Security - Wireless Network Security - Wireless Sensor Network Security- Cellular Network Security - Mobile security - IOT security - Case Study - Kali Linux.

UNIT - III	SECURITY MANAGEMENT	9

Information security essentials for IT Managers- Security Management System - Policy Driven System Management- IT Security - Online Identity and User Management System. Case study: Metasploit

UNIT - IV	CYBER SECURITY AND CLOUD SECURITY	9

Cyber Forensics- Disk Forensics – Network Forensics – Wireless Forensics – Database Forensics – Malware Forensics – Mobile Forensics – Email Forensics- Best security practices for automate Cloud infrastructure management – Establishing trust in IaaS, PaaS, and SaaS Cloud types.

Approved by BoS Chairman

UNIT - V	PRIVACY AND STORAGE SECURITY	9
Privacy on the Internet - Privacy Enhancing Technologies - Personal privacy Policies - Detection of Conflicts in security policies- privacy and security in environment monitoring systems. Storage Area Network Security - Storage Area Network Security Devices - Risk management - Physical Security Essentials.		

Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Summarize the core fundamentals of system security.
CO2	Apply the security concepts to wired and wireless networks
CO3	Build the security essentials in IT Sector
CO4	Outline the concepts of Cyber Security and Cyber forensics
CO5	Inspect Privacy and Storage security Issues.

Reference Books	
1	Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, Seventh Edition,
2	Richard E. Smith, Elementary Information Security, Third Edition, Jones and Bartlett Learning, 2019
3	John R. Vacca, Computer and Information Security Handbook, Third Edition, Elsevier 2017
4	Siani Pearson, George Yee "Privacy and Security for Cloud Computing" Computer Communications and Networks, Springer, 2013.
5	John Sammons, “The Basics of Digital Forensics- The Primer for Getting Started in Digital Forensics”, Syngress, 2012
6	Cory Altheide and Harlan Carvey, “Digital Forensics with Open Source Tools”,2011 Syngress, ISBN: 9781597495875.

Approved by BoS Chairman

CO-PO mapping:

COs	K level	PO1 (K3)	PO2 (K4)	PO3 (K5)	PO4 (K5)	PO5 (K6)	PO6 (K3) (A3)	PO7 (K2) (A3)	PO8 (K3) (A3)	PO9 (A3)	PO10 (A3)	PO11 (K3) (A3)	PO12 (A3)	PSO1 (K4) (A3)	PSO2 (K3) (A3)
CO1	K2	2	2	1	-	-	-	-	-	1	1	-	1	2	2
CO2	K3	3	2	1	-	-	-	-	-	1	1	-	1	2	2
CO3	K3	3	2	2	-	-	-	-	-	1	1	-	1	2	2
CO4	K2	2	2	1	-	-	-	-	-	1	1	-	1	2	2
CO5	K3	3	2	2	-	-	-	-	-	1	1	-	1	2	3
Weighted average		3	2	2	-	-	-	-	-	1	1	-	1	2	2

3-Substainability 2-moderate 1-low '-'- no correlation

Approved by BoS Chairman

PROFESSIONAL ELECTIVE - III

M.E	M23CSE301- MOBILE AND PERVASIVE COMPUTING	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the basics of Mobile Computing and Personal Computing.
2.	To learn the role of cellular networks in Mobile and Pervasive Computing.
3.	To expose to the concept of sensor and mesh networks.
4.	To expose to the context aware and wearable computing.
5.	To learn to develop applications in mobile and pervasive computing environment.

UNIT - I	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	4G AND 5G CELLULAR NETWORKS	9

Migration to 4G Networks - IMT advanced and LTE- LTE Architecture - User Equipment - Radio Network Subsystem – UTRAN - eNode B - NAS and RRC - User Plane - PDCP, RLC and MAC - WiMAX IEEE 802.16d/e – WiMAX Internetworking with 3GPP. 5G vs. LTE-A Comparison, 5G frequency bands in fr1 and fr2, 5G simplified architecture, 5G Use cases (Autonomous Vehicles). Three high level 5G usage scenarios (eMBB, URLLC, mMTC).

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.

Approved by BoS Chairman

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.		

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 Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Organize a basic architecture for a pervasive computing environment.
CO2	Plan the resources on the 3G-4G wireless networks.
CO3	Analyze the role of sensors in Wireless networks, mesh networks.
CO4	Examine context aware computing and wearable computing.
CO5	Develop pervasive mobile applications on Android and iphone.

Approved by BoS Chairman

Reference Books	
1	Asoke K Talukder, Hasan Ahmed, Roopa R Yavagal, “Mobile Computing: Technology, Applications and Service Creation”, 2nd ed, Tata McGraw Hill, 2017.
2	Mohammad s. Obaidat et al, “Pervasive Computing and Networking” ,John wiley, 2011
3	Reto Meier, “Professional Android 2 Application Development”, Wrox Wiley,2010.
4	Stefan Poslad, “Ubiquitous Computing: Smart Devices, Environments and Interactions”, Wiley, 2009.
5	Pei Zheng and Lionel M Li, ‘Smart Phone & Next Generation Mobile Computing’, Morgan Kaufmann Publishers, 2006.
6	Uwe Hansmaan et al, ‘Principles of Mobile Computing’, Springer, 2nd edition,2006.
7	Frank Adelstein, ‘Fundamentals of Mobile and Pervasive Computing’, TMH, 2005

CO-PO mapping:

COs	K level	PO1 (K3)	PO2 (K4)	PO3 (K5)	PO4 (K5)	PO5 (K6)	PO6 (K3) (A3)	PO7 (K2) (A3)	PO8 (K3) (A3)	PO9 (A3)	PO10 (A3)	PO11 (K3) (A3)	PO12 (A3)	PSO1 (K4) (A3)	PSO2 (K3) (A3)
CO1	K3	3	2	2	-	-	-	-	-	1	1	-	1	2	2
CO2	K3	3	2	2	2	-	-	-	-	1	1	-	1	2	2
CO3	K4	3	2	2	1	-	-	-	-	1	1	-	1	2	2
CO4	K4	3	2	2	2	-	-	-	-	1	1	-	1	2	2
CO5	K3	3	2	2	-	-	-	-	-	1	1	-	1	2	3
Weighted average		3	2	2	2	-	-	-	-	1	1	-	1	2	2

3-Substainability 2-moderate 1-low ‘-‘- no correlation

Approved by BoS Chairman

M.E	M23CSE302-WEB SERVICES AND API DESIGN	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To learn the basics of Web service.
2.	To become familiar with the Web Services building blocks
3.	To learn to work with RESTful web services.
4.	To implement the RESTful web services.
5.	To understand resource-oriented Architecture.

UNIT - I	INTRODUCTION TO WEB SERVICE	9

Overview - Web service-Architecture - Service-Oriented Architecture (SOA), Architecting Web Services: Web Services Technology Stack, Logical Architectural View, Deployment Architectural View, and Process Architectural View.

UNIT - II	WEB SERVICE BUILDING BLOCKS	9

Introduction to SOAP: SOAP Syntax- Sending SOAP Messages - SOAP Implementations - Introduction to WSDL: WSDL Syntax - SOAP Binding - WSDL Implementations - Introduction to UDDI: The UDDI API - Implementations - The Future of UDDI

UNIT - III	RESTFUL WEB SERVICES	9

Programmable Web - HTTP: Documents in Envelopes - Method Information - Scoping Information - The Competing Architectures - Technologies on the Programmable Web -Leftover Terminology - Writing Web Service Clients: The Sample Application - Making the Request: HTTP Libraries - Processing the Response: XML Parsers - JSON Parsers: Handling Serialized Data - Clients Made Easy with WADL.

Approved by BoS Chairman

UNIT - IV	IMPLEMENTATION OF RESTFUL WEB SERVICES	9
Introducing the Simple Storage Service - Object-Oriented Design of S3 - Resources – HTTP Response Codes Resource- URIs - Addressability - Statelessness - Representations - Links and Connectedness - The Uniform Interface – Spring Web Services – Spring MVC Components - Spring Web Flow - A Service Implementation using Spring Data REST.		

UNIT - V	RESOURCE ORIENTED ARCHITECTURE	9
Resource- URIs - Addressability - Statelessness - Representations - Links and Connectedness – The Uniform Interface- Designing Read-Only Resource-Oriented Services: Resource Design – Turning Requirements into Read-Only Resources - Figure Out the Data Set- Split the Data Set into Resources- Name the Resources - Design Representation- Link the Resources to Each Other- The HTTP Response.		

Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Illustrate how to write XML documents.
CO2	Apply the web service building blocks such as SOAP, WSDL and UDDI.
CO3	Examine the RESTful web services.
CO4	Solve the RESTful web service with Spring Boot MVC.
CO5	Inference Resource-oriented Architecture.

Approved by BoS Chairman

Reference Books	
1.	Raja CSP Raman, Ludovic Dewailly, “Building A RESTful Web Service with Spring 5”, Packt Publishing, 2018.
2.	Mario-Leander Reimer, “Building RESTful Web Services with Java EE 8: Create modern RESTful web services with the Java EE 8 API”, Packt publishing, 2018.
3.	Craig Walls, “Spring in Action, Fifth Edition”, Manning Publications, 2018.
4.	Bogunuva Mohanram Balachandar, “Restful Java Web Services, Third Edition: A pragmatic guide to designing and building RESTful APIs using Java”, Ingram short title, 3rd Edition, 2017.
5.	Lindsay Bassett, Introduction to JavaScript Object Notation, O’Reilly Media, 2015.
6.	Leonard Richardson and Sam Ruby, RESTful Web Services, O’Reilly Media, 2007.
7.	McGovern, et al., "Java Web Services Architecture", Morgan Kaufmann Publishers,2005.

CO-PO mapping:

Cos	K level	PO1 (K3)	PO2 (K4)	PO3 (K5)	PO4 (K5)	PO5 (K6)	PO6 (K3) (A3)	PO7 (K2) (A3)	PO8 (K3) (A3)	PO9 (A3)	PO10 (A3)	PO11 (K3) (A3)	PO12 (A3)	PSO1 (K4) (A3)	PSO2 (K3) (A3)
CO1	K2	2	1	1	-	-	-	-	-	-	1	-	1	2	2
CO2	K3	3	2	1	1	-	-	-	-	-	1	-	1	2	2
CO3	K4	3	2	2	1	-	-	-	-	-	1	-	1	2	2
CO4	K3	3	2	2	2	-	-	-	-	-	1	-	1	2	2
CO5	K4	3	2	2	2	-	-	-	-	-	1	-	1	2	3
Weighted average		3	2	2	2	-	-	-	-	-	1	-	1	2	2

3-Substantial 2-moderate 1-low correlation ‘-‘- no correlation

Approved by BoS Chairman

M.E	M23CSE303- DATA VISUALIZATION TECHNIQUES	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To develop skills to both design and critique visualizations.
2.	To introduce visual perception and core skills for visual analysis.
3.	To understand technological advancements of data visualization.
4.	To understand various data visualization techniques.
5.	To understand the methodologies used to visualize large data sets.

UNIT - I	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 Pre-processing - 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.

Approved by BoS Chairman

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 Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Analyze the objects to visualize in different dimensions.
CO2	Develop and process the data for Visualization.
CO3	Apply the visualization techniques in physical sciences, computer science, applied mathematics and medical sciences.
CO4	Utilize the virtualization techniques for research projects.
CO5	Examine appropriate data visualization techniques given particular requirements imposed by the data.

Approved by BoS Chairman

Reference Books	
1.	Colin Ware, “Information Visualization Perception for Design”, 4th edition, Morgan Kaufmann Publishers, 2021.
2.	Matthew Ward, Georges Grinstein and Daniel Keim, “Interactive Data Visualization Foundations, Techniques, Applications”, 2010.
3.	Alexandru C. Telea, “Data Visualization: Principles and Practice,” A. K. Peters Ltd, 2008.
4.	Robert Spence “Information visualization – Design for interaction”, Pearson Education, 2nd Edition, 2007.

CO-PO mapping:

COs	K level	PO1 (K3)	PO2 (K4)	PO3 (K5)	PO4 (K5)	PO5 (K6)	PO6 (K3) (A3)	PO7 (K2) (A3)	PO8 (K3) (A3)	PO9 (A3)	PO10 (A3)	PO11 (K3) (A3)	PO12 (A3)	PSO1 (K4) (A3)	PSO2 (K3) (A3)
CO1	K4	3	3	2	2	-	-	-	-	-	1	-	1	3	3
CO2	K3	3	2	1	1	-	-	-	-	-	1	-	1	3	3
CO3	K3	3	2	2	1	-	-	-	-	-	1	-	1	2	3
CO4	K3	3	2	2	2	-	-	-	-	-	1	-	1	3	3
CO5	K4	3	2	2	2	-	-	-	-	-	1	-	1	3	3
Weighted average		3	2	2	2	-	-	-	-	-	1	-	1	3	3

3-Substantial 2-moderate 1-low correlation ‘-‘- no correlation

Approved by BoS Chairman

M.E	M23CSE304- FORMAL MODELS OF SOFTWARE SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the goals, complexity of software systems, the role of Specification activities and qualities to control complexity.
2.	To understand the fundamentals of abstraction and formal systems.
3.	To learn fundamentals of logic reasoning- Propositional Logic, temporal logic and apply to models systems.
4.	To understand formal specification models based on set theory, calculus and algebra and apply to a case study
5.	To learn Z, Object Z and B Specification languages with case studies.

UNIT - I	SPECIFICATION FUNDAMENTALS	9

Role of Specification- Software Complexity - Size, Structural, Environmental, Application, domain, Communication Complexity, how to Control Complexity. Software specification, Specification Activities- Integrating Formal Methods into the Software Lifecycle. Specification Qualities- Process Quality Attributes of Formal Specification Languages, Model of Process Quality, Product Quality and Utility, Conformance to Stated Goals Quality Dimensions and Quality Model.

UNIT - II	FORMAL METHODS	9

Abstraction- Fundamental Abstractions in Computing. Abstractions for Software Construction. Formalism Fundamentals - Formal Systems, Formalization Process in Software Engineering Components of a Formal System- Syntax, Semantics, and Inference Mechanism. Properties of Formal Systems - Consistency. Automata-Deterministic Finite Accepters, State Machine Modeling Nondeterministic Finite Accepters, Finite State Transducers Extended Finite State Machine. Case Study-Elevator Control. Classification of C Methods-Property-Oriented Specification Methods, Model-Based Specification Techniques.

UNIT - III	LOGIC	9

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Propositional Logic - Reasoning Based on Adopting a Premise, Inference Based on Natural Deduction. Predicate Logic - Syntax and Semantics, Policy Language Specification, knowledge Representation Axiomatic Specification. Temporal Logic -. Temporal Logic for Specification and Verification, Temporal Abstraction Propositional Temporal Logic (PTL), First Order Temporal Logic (FOTL). Formal Verification, Verification of Simple FOTL, Model Checking, Program Graphs, Transition Systems.

UNIT - IV	SPECIFICATION MODELS	9

Mathematical Abstractions for Model-Based Specifications-Formal Specification Based on Set Theory, Relations and Functions. Property-Oriented Specifications- Algebraic Specification, Properties of Algebraic Specifications, Reasoning, Structured Specifications. Case Study—A Multiple Window Environment: requirements, Modeling Formal Specifications. Calculus of Communicating Systems: Specific Calculus for Concurrency. Operational Semantics of Agents, Simulation and Equivalence, Derivation Trees, Labeled Transition Systems.

UNIT - V	FORMAL LANGUAGES	9

The Z Notation, abstractions in Z, Representational Abstraction, Types, Relations and Functions, Sequences, Bags. Free Types-Schemas, Operational Abstraction -Operations Schema Decorators, Generic Functions, Proving Properties from Z specifications, Consistency of Operations. Additional Features in Z. Case Study: An Automated Billing System. The Object-Z Specification Language- Basic Structure of an Object-Z, Specification. Parameterized Class, Object-Orientation, composition of Operations-Parallel Communication Operator, Nondeterministic Choice Operator, and Environment Enrichment. The B-Method -Abstract Machine Notation (AMN), Structure of a B Specification, arrays, statements. Structured Specifications, Case Study- A Ticketing System in a Parking.

Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Outline the complexity of software systems, the need for formal specifications activities and qualities to control complexity.
CO2	Interpret fundamentals of abstraction and formal systems.
CO3	Illustrate the fundamentals of logic reasoning- Propositional Logic, temporal logic and apply to models systems.

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CO4	Develop formal specification models based on set theory, calculus and algebra and apply to a typical case study.
CO5	Make use of working knowledge on Z, Object Z and B Specification languages with case studies.

Reference Books	
1.	Markus Roggenbach ,Antonio Cerone, Bernd-Holger Schlingloff, Gerardo Schneider , Siraj Ahmed Shaikh, Formal Methods for Software Engineering: Languages, Methods, Application Domains (Texts in Theoretical Computer Science. An EATCS Series) 1st ed. 2022 Edition.
2.	Mathematical Logic for computer science ,second edition, M.Ben-Ari ,Springer,2012.
3.	Specification of Software Systems, V.S. Alagar, K. Periyasamy, David Grises and Fred B Schneider, Springer –Verlag London, 2011.
4.	Logic in Computer Science- modeling and reasoning about systems, 2 nd Edition, Cambridge University Press, 2004.
5.	Using Z-Specification Refinement and Proof, Jim Woodcock and Jim Devies Prentice Hall, 1996.

CO-PO mapping:

COs	**K level**	**PO1 (K3)**	**PO2 (K4)**	**PO3 (K5)**	**PO4 (K5)**	**PO5 (K6)**	**PO6 (K3) (A3)**	**PO7 (K2) (A3)**	**PO8 (K3) (A3)**	**PO9 (A3)**	**PO10 (A3)**	**PO11 (K3) (A3)**	**PO12 (A3)**	**PSO1 (K4) (A3)**	**PSO2 (K3) (A3)**
CO1	K2	2	1	-	-	-	-	-	-	-	1	-	1	1	1
CO2	K2	2	1	-	-	-	-	-	-	-	1	-	1	1	1
CO3	K2	2	1	-	-	-	-	-	-	-	1	-	1	1	1
CO4	K3	3	2	1	-	-	-	-	-	-	1	-	1	2	2
CO5	K3	3	2	1	-	-	-	-	-	-	1	-	1	2	2
Weighted average		2	1	1	-	-	-	-	-	-	1	-	1	1	1

3-Substainability 2-moderate 1-low '-'- no correlation

Approved by BoS Chairman

M.E	M23CSE305- NATURAL LANGUAGE PROCESSING	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand basics of linguistics, probability and statistics
2.	To study statistical approaches to NLP and understand sequence labelling
3.	To outline different parsing techniques associated with NLP
4.	To explore semantics of words and semantic role labelling of sentences
5.	To understand discourse analysis, question answering and chatbots

UNIT - I	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 Labelling **–** 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 Labelling – Proposition Bank- Frame Net- Selection Restrictions - Information Extraction - Template Filling.

UNIT - V	DISCOURSE ANALYSIS AND SPEECH PROCESSING	9

Discourse Coherence – Discourse Structure Parsing – Centring and Entity Based Coherence – Question Answering – Classical QA Models – Chatbots and Dialogue systems – Frame-based Dialogue Systems – Dialogue–State Architecture. Speech Recognition and Speech-to-Text- Speaker Identification and Verification- Prosody Analysis -Emotion Recognition and Sentiment Analysis-Multimodal Discourse Analysis

Approved by BoS Chairman

Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Apply basics of linguistics, probability and statistics associated with NLP.
CO2	Make use of a Part-of-Speech Tagger.
CO3	Identify a sequence labelling problem for a given domain.
CO4	Develop semantic processing tasks and simple document indexing and searching system using the concepts of NLP.
CO5	Build a simple chatbot using dialogue system concepts.

Reference Books	
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.	Jacob Eisenstein. “Natural Language Processing “, MIT Press, 2019
3.	Samuel Burns “Natural Language Processing: A Quick Introduction to NLP with Python and NLTK, 2019
4.	Christopher Manning, “Foundations of Statistical Natural Language Processing”, MIT Press, 2009.
5.	Nitin Indurkhya,Fred J. Damerau, “Handbook of Natural Language Processing”, Second edition, Chapman & Hall/CRC: Machine Learning & Pattern Recognition, Hardcover,2010
6.	Deepti Chopra, Nisheeth Joshi, “Mastering Natural Language Processing with Python”, Packt Publishing Limited, 2016
7.	Mohamed Zakaria Kurdi “Natural Language Processing and Computational Linguistics: Speech, Morphology and Syntax (Cognitive Science)”, ISTE Ltd., 2016
8.	Atefeh Farzindar,Diana Inkpen, “Natural Language Processing for Social Media (Synthesis Lectures on Human Language Technologies)”, Morgan and Claypool Life Sciences, 2015

Approved by BoS Chairman

CO-PO mapping:

COs	K level	PO1 (K3)	PO2 (K4)	PO3 (K5)	PO4 (K5)	PO5 (K6)	PO6 (K3) (A3)	PO7 (K2) (A3)	PO8 (K3) (A3)	PO9 (A3)	PO10 (A3)	PO11 (K3) (A3)	PO12 (A3)	PSO1 (K4) (A3)	PSO2 (K3) (A3)
CO1	K3	3	2	2	-	-	-	-	-	-	1	-	1	2	2
CO2	K3	3	2	2	-	-	-	-	-	-	1	-	1	2	2
CO3	K3	3	2	2	-	-	-	-	-	-	1	-	1	2	2
CO4	K3	3	2	2	-	-	-	-	-	-	1	-	1	2	2
CO5	K3	3	2	2	-	-	-	-	-	-	1	-	1	2	2
Weighted average		3	2	2	-	-	-	-	-	-	1	-	1	2	2

3-Substainability 2-moderate 1-low '-'- no correlation

Approved by BoS Chairman

M.E	M23CSE306 - GPU COMPUTING	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the basics of GPU architectures
2.	To understand CPU GPU Program Partitioning
3.	To write programs for massively parallel processors
4.	To understand the issues in mapping algorithms for GPUs
5.	To introduce different GPU programming models

UNIT - I	GPU ARCHITECTURE	9

Evolution of GPU architectures - Understanding Parallelism with GPU –Typical GPU Architecture - CUDA Hardware Overview - 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 Instructional hours : 45

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Course Outcomes : Students will be able to	
CO1	Illustrate GPU Architecture
CO2	Develop programs using CUDA, identify issues and debug them
CO3	Apply efficient algorithms in GPUs for common application kernels, such as matrix multiplication
CO4	Build simple programs using Open CL
CO5	Identify efficient parallel programming patterns to solve problems

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

Approved by BoS Chairman

CO-PO mapping:

COs	K level	PO1 (K3)	PO2 (K4)	PO3 (K5)	PO4 (K5)	PO 5 (K6)	PO6 (K3) (A3)	PO7 (K2) (A3)	PO8 (K3) (A3)	PO9 (A3)	PO1 0 (A3)	PO1 1 (K3) (A3)	PO 12 (A 3)	PSO 1 (K4) (A3)	PS O2 (K3) (A3)
CO1	K2	2	1	1	-	-	-	-	-	-	1	-	2	2	-
CO2	K3	3	3	3	-	-	-	-	-	-	1	-	2	2	2
CO3	K3	3	3	3	-	-	-	-	-	-	1	-	2	2	2
CO4	K3	3	3	3	-	-	-	-	-	-	1	-	2	2	2
CO5	K3	3	3	3	-	-	-	-	-	-	1	-	2	2	2
Weighted average		3	3	3	-	-	-	-	-	-	1	-	2	2	2

3-Substainability 2-moderate 1-low '-'- no correlation

Approved by BoS Chairman

PROFESSIONAL ELECTIVE - IV

M.E	M23CSE307- DEVOPS AND MICROSERVICES	L	T	P	C
		3	1	0	4

Course Objectives	
1.	To learn the basic concepts and terminology of DevOps.
2.	To gain knowledge on Devops platform.
3.	To understand building and deployment of code.
4.	To be familiar with DevOps automation tools.
5.	To learn basics of ML Ops.

UNIT - I	INTRODUCTION	12

Software Engineering - traditional and Agile process models - DevOps -Definition - Practices - DevOps life cycle process - need for DevOps –Barriers

UNIT - II	DEVOPS PLATFORM AND SERVICES	12

Cloud as a platform - IaaS, PaaS, SaaS - Virtualization - Containers –Supporting Multiple Data Centers - Operation Services - Hardware provisioning- software Provisioning - IT services - SLA - capacity planning - security - Service Transition - Service Operation Concepts.

UNIT - III	BUILDING , TESTING AND DEPLOYMENT	12

Microservices architecture - coordination model - building and testing - Deployment pipeline - Development and Pre-commit Testing -Build and Integration Testing - continuous integration - monitoring - security - Resources to Be Protected - Identity Management.

UNIT - IV	DEVOPS AUTOMATION TOOLS	12

Infrastructure Automation- Configuration Management - Deployment Automation - Performance Management - Log Management -Monitoring.

UNIT - V	MLOPS	12

MLOps - Definition - Challenges -Developing Models - Deploying to production - Model Governance - Real world examples

Total Instructional hours : 60

Approved by BoS Chairman

Course Outcomes : Students will be able to	
CO1	Illustrate modern software Engineering process.
CO2	Utilize DevOps platform.
CO3	Build, test and deploy code.
CO4	Make use of DevOps tools.
CO5	Apply and correlate ML Ops concepts with real time examples.

Reference Books	
1.	Mark Treveil, and the Dataiku Team-"Introducing MLOps" - O'Reilly Media- 2020
2.	ktor Farcic -"The DevOps 2.1 Toolkit: Docker Swarm" - Packet Publishing, 2017
3.	Joakim Verona - "Practical DevOps" - Packet Publishing , 2016
4.	Len Bass, Ingo Weber and Liming Zhu, —"DevOps: A Software Architect's Perspective", Pearson Education, 2016

CO-PO mapping:

COs	K level	PO1 (K3)	PO2 (K4)	PO3 (K5)	PO4 (K5)	PO 5 (K6)	PO6 (K3) (A3)	PO7 (K2) (A3)	PO8 (K3) (A3)	PO9 (A3)	PO1 0 (A3)	PO1 1 (K3) (A3)	PO 12 (A3)	PSO 1 (K4) (A3)	PSO 2 (K3) (A3)
CO1	K2	2	1	-	-	-	-	-	-	-	1	-	1	1	1
CO2	K3	3	3	2	1	-	-	-	-	-	1	-	1	2	2
CO3	K3	3	3	3	2	-	-	-	-	-	1	-	1	2	3
CO4	K4	3	3	2	1	-	-	-	-	-	1	-	1	2	3
CO5	K3	3	2	1	-	-	-	-	-	-	1	-	1	2	3
Weighted average		3	3	2	1	-	-	-	-	-	1	-	1	2	3

3-Substainability 2-moderate 1-low '-'- no correlation

Approved by BoS Chairman

M.E	M23CSE308- MOBILE APPLICATION DEVELOPMENT	L	T	P	C
		3	1	0	4

Course Objectives	
1.	To facilitate students to understand android SDK
2.	To help students to gain basic understanding of Android application development
3.	To understand how to work with various mobile application development frameworks
4.	To inculcate working knowledge of Android Studio development tool
5.	To learn the basic and important design concepts and issues of development of mobile applications

UNIT - I	MOBILE PLATFORM AND APPLICATIONS	12

Mobile Device Operating Systems — Special Constraints & Requirements — Commercial Mobile Operating Systems — Software Development Kit: iOS, Android, BlackBerry, Windows Phone — MCommerce — Structure — Pros & Cons — Mobile Payment System — Security Issues

UNIT - II	INTRODUCTION TO ANDROID	12

Introduction to Android: The Android Platform, Android SDK, Eclipse Installation, Android Installation, building you First Android application, Understanding Anatomy of Android Application, Android Manifest file.

UNIT - III	ANDROID APPLICATION DESIGN ESSENTIALS	12

Anatomy of Android applications, Android terminologies, Application Context, Activities, Services, Intents, Receiving and Broadcasting Intents, Android Manifest File and its common settings, Using Intent Filter, Permissions.

UNIT - IV	ANDROID USER INTERFACE DESIGN & MULTIMEDIA	12

User Interface Screen elements, Designing User Interfaces with Layouts, Drawing and Working with Animation. Playing Audio and Video, Recording Audio and Video, Using the Camera to Take and Process Pictures

UNIT - V	ANDROID APIs	12

Using Android Data and Storage APIs, managing data using SQLite, Sharing Data between Applications with Content Providers, Using Android Networking APIs, Using Android Web APIs, Using Android Telephony APIs, Deploying Android Application to the World.

Approved by BoS Chairman

Total Instructional hours : 60

Course outcomes : Students will be able to	
CO1	Identify various concepts of mobile programming that make it unique from programming for other platforms.
CO2	Build, test and debug Android application by setting up Android development.
CO3	Demonstrate methods in storing, sharing and retrieving data in Android applications.
CO4	Utilize rapid prototyping techniques to design and develop sophisticated mobile interfaces.
CO5	Develop interactive applications in android using databases with multiple activities including audio, video and notifications and deploy them in marketplace.

Reference Books	
1.	Bill Phillips, Chris Stewart and Kristin Marsicano, “Android Programming: The Big Nerd Ranch Guide”, 4th Edition, Big Nerd Ranch Guides, 2019. ISBN-13: 978-0134706054
2.	Google Developer Training, "Android Developer Fundamentals Course – Concept Reference”, Google Developer Training Team, 2017.
3.	Dawn Griffiths and David Griffiths, “Head First Android Development”, 1st Edition, O"Reilly SPD Publishers, 2015. ISBN-13: 978-9352131341
4.	Erik Hellman, “Android Programming – Pushing the Limits”, 1st Edition, Wiley India Pvt Ltd, 2014. ISBN-13: 978-8126547197.
5.	Prasanth Kumar Pattnaik,Rajib Mall,”Fundamentals of Mobile Computing”,PHI Learning Pvt.Ltd,New Delhi-2012
6.	Lauren Darcey and Shane Conder, “Android Wireless Application Development”, Pearson Education, 2nd ed. (2011)
7.	Reto Meier, “Professional Android 2 Application Development”, Wiley India Pvt Ltd, 2010
8.	Mark L Murphy, “Beginning Android”, Wiley India Pvt Ltd, 2009

Approved by BoS Chairman

CO-PO mapping:

COs	K level	PO1 (K3)	PO2 (K4)	PO3 (K5)	PO4 (K5)	PO 5 (K6)	PO6 (K3) (A3)	PO7 (K2) (A3)	PO8 (K3) (A3)	PO9 (A3)	PO1 0 (A3)	PO1 1 (K3) (A3)	PO 12 (A 3)	PSO 1 (K4) (A3)	PSO 2 (K3) (A3)
CO1	K3	3	2	1	-	-	-	-	-	-	1	-	1	1	1
CO2	K3	3	3	2	1	-	-	-	-	-	1	-	1	2	2
CO3	K2	3	1	-	-	-	-	-	-	-	1	-	1	1	1
CO4	K3	3	3	2	1	-	-	-	-	-	1	-	1	3	3
CO5	K3	3	2	1	-	-	-	-	-	-	1	-	1	3	3
Weighted average		3	2	2	1	-	-	-	-	-	1	-	1	3	3

3-Substainability 2-moderate 1-low '-'- no correlation

Approved by BoS Chairman

M.E	M23CSE309- DEEP LEARNING	L	T	P	C
		3	1	0	4

Course Objectives	
1.	Develop and Train Deep Neural Networks.
2.	Develop a CNN, R-CNN, Fast R-CNN, Faster-R-CNN, Mask-RCNN for detection and recognition
3.	Build and train RNNs, work with NLP and Word Embeddings
4.	The internal structure of LSTM and GRU and the differences between them
5.	The Auto Encoders for Image Processing

UNIT - I	DEEP LEARNING CONCEPTS	12

Fundamentals about Deep Learning. Perception Learning Algorithms. Probabilistic modelling. Early Neural Networks. How Deep Learning different from Machine Learning. Scalars. Vectors. Matrixes, Higher Dimensional Tensors. Manipulating Tensors. Vector Data. Time Series Data. Image Data. Video Data.

UNIT - II	NEURAL NETWORKS	12

About Neural Network. Building Blocks of Neural Network. Optimizers. Activation Functions. Loss Functions. Data Pre-processing for neural networks, Feature Engineering. Overfitting and Underfitting. Hyperparameters.

UNIT - III	CONVOLUTIONAL NEURAL NETWORK	12

About CNN. Linear Time Invariant. Image Processing Filtering. Building a convolutional neural network. Input Layers, Convolution Layers. Pooling Layers. Dense Layers. Backpropagation Through the Convolutional Layer. Filters and Feature Maps. Backpropagation Through the Pooling Layers. Dropout Layers and Regularization. Batch Normalization. Various Activation Functions. Various Optimizers. LeNet, AlexNet, VGG16, ResNet. Transfer Learning with Image Data. Transfer Learning using Inception Oxford VGG Model, Google Inception Model, Microsoft ResNet Model. R- CNN, Fast R-CNN, Faster R-CNN, Mask-RCNN, YOLO

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UNIT - IV	NATURAL LANGUAGE PROCESSING USING RNN	12

About NLP & its Toolkits. Language Modeling . Vector Space Model (VSM). Continuous Bag of Words (CBOW). Skip-Gram Model for Word Embedding. Part of Speech (PoS) Global Co- occurrence Statistics–based Word Vectors. Transfer Learning. Word2Vec. Global Vectors for Word Representation GloVe. Backpropagation Through Time. Bidirectional RNNs (BRNN) . Long Short Term Memory (LSTM). Bi-directional LSTM. Sequence-to-Sequence Models (Seq2Seq). Gated recurrent unit GRU.

UNIT - V	DEEP REINFORCEMENT & UNSUPERVISED LEARNING	12

About Deep Reinforcement Learning. Q-Learning. Deep Q-Network (DQN). Policy Gradient Methods. Actor-Critic Algorithm. About Autoencoding. Convolutional Auto Encoding. Variational Auto Encoding. Generative Adversarial Networks. Autoencoders for Feature Extraction. Auto Encoders for Classification. Denoising Autoencoders. Sparse Autoencoders

Total Instructional hours : 60

Course Outcomes : Students will be able to	
CO1	Identify key terminology related to feature extraction in image and video processing.
CO2	Apply Image Segmentation and Instance Segmentation in Images.
CO3	Inspect image recognition and image classification using a pretrained network (Transfer Learning).
CO4	Compare and contrast various approaches to traffic information analysis using Twitter data.
CO5	Utilize Auto encoder for Classification & Feature Extraction.

Approved by BoS Chairman

Reference Books	
1.	Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020
2.	Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018
3.	Deep Learning A Practitioner's Approach Josh Patterson and Adam Gibson O'Reilly Media, Inc.2017
4.	Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND,2017
5.	Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress,2017

CO-PO mapping:

COs	K level	PO1 (K3)	PO2 (K4)	PO3 (K5)	PO4 (K5)	PO 5 (K6)	PO6 (K3) (A3)	PO7 (K2) (A3)	PO8 (K3) (A3)	PO9 (A3)	PO1 0 (A3)	PO1 1 (K3) (A3)	PO 12 (A 3)	PSO 1 (K4) (A3)	PSO 2 (K3) (A3)
CO1	K3	3	2	1	-	-	-	-	-	-	1	-	1	1	1
CO2	K3	3	3	2	1	-	-	-	-	-	1	-	1	2	2
CO3	K4	3	3	2	1	-	-	-	-	-	1	-	1	3	3
CO4	K4	3	3	2	1	-	-	-	-	-	1	-	1	3	3
CO5	K3	3	2	1	-	-	-	-	-	-	1	-	1	3	3
Weighted average		3	3	2	1	-	-	-	-	-	1	-	1	3	3

3-Substainability 2-moderate 1-low '-'- no correlation

Approved by BoS Chairman

M.E	M23CSE310- BLOCKCHAIN TECHNOLOGIES	L	T	P	C
		3	1	0	4

Course Objectives	
1.	This course is intended to study the basics of Block chain technology.
2.	During this course the learner will explore various aspects of Block chain technology like
3.	By implementing, learners will have idea about private and public Block chain, and smart contract

UNIT - I	INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN	12

Introduction to Block chain, Block chain Technology Mechanisms & Networks, Block chain Origins, Objective of Block chain, Block chain Challenges, Transactions and Blocks, P2P Systems, Keys as Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Block chain.

UNIT - II	BITCOIN AND CRYPTOCURRENCY	12

Introduction to Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Block chain and Digital Currency, Transactional Blocks, Impact of Block chain Technology on Cryptocurrency

UNIT - III	ETHEREUM PLATFORM	12

Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, , Transactions, Receiving Ethers, Smart Contracts.

UNIT - IV	HYPERLEDGER AND SOLIDITY PROGRAMMING	12

Introduction to Hyperledger, Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types.

UNIT - V	BLOCKCHAIN APPLICATIONS	12

Internet of Things, Medical Record Management System, Domain Name Service and Future of Block chain, Alt Coins.

Approved by BoS Chairman

Total Instructional hours : 60

Course outcomes : Students will be able to	
CO1	Apply the understanding of the working of Blockchain technology and explore its applications
CO2	Analyze the working of Smart Contracts
CO3	Examine the working of Hyper ledger
CO4	Simplify the learning of solidity to build de-centralized apps on Ethereum
CO5	Develop applications on Block chain

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Reference Books	
1.	Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained”, Second Edition, Packt Publishing, 2018.
2.	Antonopoulos and G. Wood, “Mastering Ethereum: Building Smart Contracts and Dapps”, O’Reilly Publishing, 2018.
3.	D. Drescher, Blockchain Basics. Apress, 2017.
4.	Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, “Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction” Princeton University Press, 2016
5.	Antonopoulos, Mastering Bitcoin, O’Reilly Publishing, 2014

Approved by BoS Chairman

CO-PO mapping:

COs	K level	PO1 (K3)	PO2 (K4)	PO3 (K5)	PO4 (K5)	PO 5 (K6)	PO6 (K3) (A3)	PO7 (K2) (A3)	PO8 (K3) (A3)	PO9 (A3)	PO1 0 (A3)	PO1 1 (K3) (A3)	PO 12 (A 3)	PSO 1 (K4) (A3)	PSO 2 (K3) (A3)
CO1	K3	3	2	1	-	-	-	-	-	-	1	-	1	1	-
CO2	K3	3	3	2	1	-	-	-	-	-	1	-	1	2	2
CO3	K4	3	3	2	1	-	-	-	-	-	1	-	1	3	3
CO4	K4	3	3	2	1	-	-	-	-	-	1	-	1	3	3
CO5	K3	3	2	1	-	-	-	-	-	-	1	-	1	3	3
Weighted average		3	3	2	1	-	-	-	-	-	1	-	1	3	3

3-Substainability 2-moderate 1-low '-'- no correlation

Approved by BoS Chairman

M.E	M23CSE311 - CYBER PHYSICAL SYSTEMS	L	T	P	C
		3	1	0	4

Course Objectives	
1.	To learn about the principles of cyber-physical systems
2.	To familiarize with the basic requirements of CPS and models.
3.	To facilitate the students to understand the CPS foundations
4.	To make the students explore the applications and platforms.
5.	To provide introduction to practical aspects of cyber physical systems.

UNIT - I	INTRODUCTION TO CYBER-PHYSICAL SYSTEMS	12

Cyber-Physical Systems(CPS)-Emergence of CPS, Key Features of Cyber-Physical Systems,, CPS Drivers-Synchronous Model : Reactive Components, Properties of Components, Composing Components, Designs- Asynchronous Model of CPS: Processes, Design Primitives, Coordination Protocols

UNIT - II	CPS - REQUIREMENTS	12

Safety Specifications: Specifications, Verifying Invariants, Enumerative Search, Symbolic Search- Liveness Requirements: Temporal Logic, Model Checking, Proving Liveness

UNIT - III	CPS MODELS	12

Dynamical Systems: Continuous, Linear Systems-Time Models, Linear Systems, Designing Controllers, Analysis Techniques- Timed Model: Processes, Protocols, Automata- Hybrid Dynamical Models

UNIT - IV	CPS FOUNDATIONS	12

Symbolic Synthesis for CPS- Security in CPS-Synchronization of CPS-Real-Time Scheduling for CPS

UNIT - V	APPLICATIONS AND PLATFORMS	12

Medical CPS- CPS Built on Wireless Sensor Networks- CyberSim User Interface- iClebo Kobuki - iRobot Create- myRIO- Cybersim- Matlab toolboxes - Simulink.

Total Instructional hours : 60

Approved by BoS Chairman

Course Outcomes : Students will be able to	
CO1	Illustrate the core principles behind CPS
CO2	Make use of the requirements of CPS.
CO3	Develop various models of CPS.
CO4	Summarize the foundations of CPS.
CO5	Utilize the various platforms to implement the CPS.

Reference Books	
1	Lee, Edward Ashford, and Sanjit Arunkumar Seshia. Introduction to embedded systems: A cyber physical systems approach. 2nd Edition, 2017
2	Raj Rajkumar, Dionisio De Niz , and Mark Klein, Cyber-Physical Systems, Addison-Wesley Professional, 2016
3	Rajeev Alur, Principles of Cyber-Physical Systems, MIT Press, 2015.
4	Jensen, Jeff, Lee, Edward, A Seshia, Sanjit, An Introductory Lab in Embedded and Cyber-Physical Systems, http://leeseshia.org/lab, 2014.
5	Jean J. Labrosse, Embedded Systems Building Blocks: Complete and Ready-To-Use Modules in C, The publisher, Paul Temme, 2011.
6	André Platzer, Logical Analysis of Hybrid Systems: Proving Theorems for Complex Dynamics., Springer, 2010. 426 pages,ISBN 978-3-642-14508-7.

CO-PO mapping:

Approved by BoS Chairman

COs	K level	PO1 (K3)	PO2 (K4)	PO3 (K5)	PO 4 (K5)	PO5 (K6)	PO 6 (K3) (A3)	PO7 (K2) (A3)	PO8 (K3) (A3)	PO9 (A3)	PO10 (A3)	PO1 1 (K3) (A3)	PO 12 (A3)	PSO1 (K4) (A3)	PSO2 (K3) (A3)
CO1	K2	2	1	-	-	-	-	-	-	-	1	-	1	1	-
CO2	K3	3	3	2	1	-	-	-	-	-	1	-	1	2	2
CO3	K3	3	2	2	1	-	-	-	-	-	1	-	1	3	3
CO4	K2	2	1	-	-	-	-	-	-	-	1	-	1	1	-
CO5	K3	3	2	1	-	-	-	-	-	-	1	-	1	3	3
Weighted average		3	2	2	1	-	-	-	-	-	1	-	1	3	3

3-Substainability 2-moderate 1-low '-'- no correlation

Approved by BoS Chairman

M.E	M23CSE312 – MIXED REALITY	L	T	P	C
		3	1	0	4

Course Objectives	
1.	To study about Fundamental Concept and Components of Virtual Reality
2.	To study about Interactive Techniques in Virtual Reality
3.	To study about Visual Computation in Virtual Reality
4.	To study about Augmented and Mixed Reality and Its Applications
5.	To know about I/O Interfaces and its functions.

UNIT - I	INTRODUCTION TO VIRTUAL REALITY	12

Introduction, Fundamental Concept and Components of Virtual Reality. Primary Features and Present Development on Virtual Reality. Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement, benefits of virtual reality, Historical development of VR, Scientific Landmark 3D Computer Graphics: Introduction, The Virtual world space, positioning the virtual observer, the perspective projection, human vision, stereo perspective projection, 3D clipping, Colour theory, Simple 3D modelling, Illumination models, Reflection models, Shading algorithms, Radiosity, Hidden Surface Removal, Realism Stereographic image.

Suggested Activities:

- Flipped classroom on uses of MR applications.
- Videos – Experience the virtual reality effect.
- Assignment on comparison of VR with traditional multimedia applications.

Suggested Evaluation Methods:

- Tutorial – Applications of MR.
- Quizzes on the displayed video and the special effects

Approved by BoS Chairman

UNIT - II	INTERACTIVE TECHNIQUES IN VIRTUAL REALITY	12

Introduction, from 2D to 3D, 3D spaces curves, 3D boundary representation Geometrical Transformations: Introduction, Frames of reference, Modeling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection Generic VR system: Introduction, Virtual environment, Computer environment, VR technology, Model of interaction, VR Systems.

Suggested Activities:

- Flipped classroom on modeling three dimensional objects.
- External learning – Collision detection algorithms.
- Practical – Creating three dimensional models.

Suggested Evaluation Methods:

- Tutorial – Three dimensional modeling techniques.
- Brainstorming session on collision detection algorithms.
- Demonstration of three dimensional scene creation.

UNIT - III	VISUAL COMPUTATION IN VIRTUAL REALITY	12

Animating the Virtual Environment: Introduction, The dynamics of numbers, Linear and Nonlinear interpolation, the animation of objects, linear and non-linear translation, shape & object inbetweening, free from deformation, particle system. Physical Simulation: Introduction, Objects falling in a gravitational field, Rotating wheels, Elastic collisions, projectiles, simple pendulum, springs, Flight dynamics of an aircraft.

Suggested Activities:

- External learning – Different types of programming toolkits and Learn different types of available VR applications.
- Practical – Create VR scenes using any toolkit and develop applications.

Suggested Evaluation Methods:

- Tutorial – VR tool comparison.
- Brainstorming session on tools and technologies used in VR.
- Demonstration of the created VR applications.

Approved by BoS Chairman

UNIT - IV	AUGMENTED AND MIXED REALITY	12

Taxonomy, technology and features of augmented reality, difference between AR and VR, Challenges with AR, AR systems and functionality, Augmented reality methods, visualization techniques for augmented reality, wireless displays in educational augmented reality applications, mobile projection interfaces, marker-less tracking for augmented reality, enhancing interactivity in AR environments, evaluating AR systems

Suggested Activities:

- External learning - AR Systems

Suggested Evaluation Methods:

- Brainstorming session different AR systems and environments.

UNIT - V	I/O INTERFACE IN VR & APPLICATION OF VR	12

Human factors: Introduction, the eye, the ear, the somatic senses. VR Hardware: Introduction, sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems. VR Software: Introduction, Modelling virtual world, Physical simulation, VR toolkits, Introduction to VRML, Input -- Tracker, Sensor, Digital globe, Movement Capture, Video-based Input, 3D Menus & 3DScanner etc. Output -- Visual /Auditory / Haptic Devices. VR Technology in Film & TV Production. VR Technology in Physical Exercises and Games. Demonstration of Digital Entertainment by VR.

Suggested Activities:

- External learning – Different types of sensing and tracking devices for creating mixed reality environments.
- Practical – Create MR scenes using any toolkit and develop applications.

Suggested Evaluation Methods:

- Tutorial – Mobile Interface Design.
- Brainstorming session on wearable computing devices and games design.
- Demonstration and evaluation of the developed MR application.

Total Instructional hours : 60

Approved by BoS Chairman

Course Outcomes : Students will be able to	
CO1	Apply the Fundamental Concept and Components of Virtual Reality
CO2	Infer the Interactive Techniques in Virtual Reality
CO3	Develop knowledge in Visual Computation in Virtual Reality
CO4	Make use of Augmented and Mixed Reality and Its Applications
CO5	Examine I/O Interfaces and its functions.

Reference Books	
1	Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann,First Edition 2013.
2	Alan Craig, William Sherman and Jeffrey Will, Developing Virtual Reality Applications, Foundations of Effective Design, Morgan Kaufmann, 2009.
3	William R. Sherman, Alan B. Craig, "Understanding Virtual Reality: Interface, Application and Design", Morgan Kaufmann, 2008
4	John Vince, "Virtual Reality Systems ", Pearson Education Asia, 2007.
5	Grigore C. Burdea, Philippe Coiffet , "Virtual Reality Technology", Wiley Inter Science, 2nd Edition, 2006.
6	Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition. Wiley-IEEE Press, 2003/2006.

CO-PO mapping:

Approved by BoS Chairman

COs	K level	PO1 (K3)	PO2 (K4)	PO3 (K5)	PO4 (K5)	PO5 (K6)	PO 6 (K3) (A3)	PO7 (K2) (A3)	PO8 (K3) (A3)	PO9 (A3)	PO1 0 (A3)	PO1 1 (K3) (A3)	PO 12 (A 3)	PSO 1 (K4) (A3)	PSO 2 (K3) (A3)
CO1	K3	3	2	1	-	-	-	-	-	-	1	-	1	1	1
CO2	K2	2	2	-	-	-	-	-	-	-	1	-	1	1	-
CO3	K3	3	2	2	1	-	-	-	-	-	1	-	1	3	2
CO4	K3	3	2	1	-	-	-	-	-	-	1	-	1	2	2
CO5	K4	3	2	1	1	-	-	-	-	-	1	-	1	3	3
Weighted average		3	2	2	1	-	-	-	-	-	1	-	1	3	3

3-Substainability 2-moderate 1-low '-'- no correlation

Approved by BoS Chairman

PROFESSIONAL ELECTIVE – V

M.E	M23CSE313- EMBEDDED SOFTWARE DEVELOPMENT	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the architecture of embedded processor, microcontroller, and peripheral devices
2.	To interface memory and peripherals with embedded systems.
3.	To study the embedded network environment.
4.	To understand challenges in Real time operating systems.
5.	To study, analyze and design applications on embedded systems.

UNIT - I	EMBEDDED PROCESSORS	9

Embedded Computers – Characteristics of Embedded Computing Applications – Challenges in Embedded Computing System Design – Embedded System Design Process- Formalism for System Design – Structural Description – Behavioural Description – ARM Processor – Intel ATOM Processor.

UNIT - II	EMBEDDED COMPUTING PLATFORM	9

CPU Bus Configuration – Memory Devices and Interfacing – Input/Output Devices and Interfacing – System Design – Development and Debugging – Emulator – Simulator – JTAG Design Example – Alarm Clock – Analysis and Optimization of Performance – Power and Program Size.

UNIT - III	EMBEDDED NETWORK ENIVIRONMENT	9

Distributed Embedded Architecture – Hardware And Software Architectures – Networks for Embedded Systems – I2C – CAN Bus – SHARC Link Supports – Ethernet – Myrinet – Internet – Network-based Design – Communication Analysis – System Performance Analysis – Hardware Platform Design – Allocation and Scheduling – Design Example – Elevator Controller.

UNIT - IV	REAL-TIME CHARACTERISTICS	9

Clock Driven Approach – Weighted Round Robin Approach – Priority Driven Approach – Dynamic versus Static Systems – Effective Release Times and Deadlines – Optimality of the Earliest Deadline First (EDF) Algorithm – Challenges in Validating Timing Constraints in Priority Driven Systems – Off-Line versus On-Line Scheduling.

Approved by BoS Chairman

UNIT - V	SYSTEM DESIGN TECHNIQUES	9
Design Methodologies – Requirement Analysis – Specification – System Analysis and Architecture Design – Quality Assurance – Design Examples – Telephone PBX – Ink jet printer – Personal Digital Assistants – Set-Top Boxes.		

Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Apply the knowledge to understand different architectures of embedded processor, microcontroller and peripheral devices. Interface memory and peripherals with embedded systems.
CO2	Summarize Interface memory and peripherals with embedded systems.
CO3	Utilize the embedded network environment.
CO4	Solve the challenges in Real time operating systems.
CO5	Analyse applications on embedded systems.

Approved by BoS Chairman

Reference Books	
1.	ArshdeepBahga, Vijay Madisetti, " Internet of Things: A Hands-on-Approach" VPT First Edition, 2014
2.	Adrian McEwen, Hakim Cassimally, "Designing the Internet of Things" Wiley Publication, First edition, 2013
3.	Michael J. Pont, “Embedded C, Pearson Education, 2007.
4.	Andrew N Sloss, D. Symes, C. Wright, Arm system developers guide, Morgan Kauffman/Elsevier, 2006.
5.	Wayne Wolf, “Computers as Components:Principles of Embedded Computer System Design, Elsevier, 2006.
6.	Steve Heath, “Embedded System Design, Elsevier, 2005.

CO-PO mapping:

COs	K level	PO1 (K3)	PO2 (K4)	PO3 (K5)	PO4 (K5)	PO 5 (K6)	PO6 (K3) (A3)	PO7 (K2) (A3)	PO8 (K3) (A3)	PO9 (A3)	PO1 0 (A3)	PO1 1 (K3) (A3)	PO 12 (A3)	PSO 1 (K4) (A3)	PSO 2 (K3) (A3)
CO1	K3	3	3	-	-	-	-	-	-	-	1	-	1	3	2
CO2	K2	3	2	-	-	-	-	-	-	-	1	-	1	3	3
CO3	K3	3	2	1	-	-	-	-	-	-	1	-	1	3	3
CO4	K3	3	2	1	-	-	-	-	-	-	1	-	1	3	3
CO5	K4	3	3	2	1	-	-	-	-	-	1	-	1	3	3
Weighted average		3	3	2	1	-	-	-	-	-	1	-	1	3	3

3-Substainability 2-moderate 1-low ‘-‘- no correlation

Approved by BoS Chairman

M.E	M23CSE314 - ETHICAL MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To help students develop knowledge and competence in ethical management and decision making in organizational contexts.

UNIT - I	ETHICAL DECISION MAKING AND MANAGEMENT IN A CRISIS	9

Ethical Management- Definition, Motivation, Advantages-Practical implications of ethical management. Managerial ethics, professional ethics, and social Responsibility-Role of culture and society's expectations- Individual and organizational responsibility to society and the community.

UNIT - II	ETHICAL DECISION MAKING AND MANAGEMENT IN A CRISIS	9

Managing in an ethical crisis, the nature of a crisis, ethics in crisis management, discuss casestudies, analyze real-world scenarios, develop ethical management skills, knowledge, and competencies. Proactive crisis management.

UNIT - III	STAKEHOLDERS IN ETHICAL MANAGEMENT	9

Stakeholders in ethical management, identifying internal and external stakeholders, nature of stakeholders, ethical management of various kinds of stakeholders: customers (product and service issues), employees (leadership, fairness, justice, diversity) suppliers, collaborators, business, community, the natural environment (the sustainability imperative, green management, Contemporary issues).

UNIT - IV	INDIVIDUAL VARIABLES IN ETHICAL MANAGEMENT	9

Understanding individual variables in ethics, managerial ethics, concepts in ethical psychologyethical awareness, ethical courage, ethical judgment, ethical foundations, ethical emotions/intuitions/intensity. Utilization of these concepts and competencies for ethical decisionmaking and management.

UNIT - V	PRACTICAL FIELD-GUIDE, TECHNIQUES AND SKILLS	9

Ethical management in practice, development of techniques and skills, navigating challenges and dilemmas, resolving issues and preventing unethical management proactively. Role modelling and creating a culture of ethical management and human flourishing.

Approved by BoS Chairman

Total Instructional hours :45

Course Outcomes : Students will be able to	
CO1	Illustrate the significance of ethical and cultural contexts.
CO2	Extend ethical crises and proactively address potential crises situations.
CO3	Relate and implement stakeholder management decisions.
CO4	Develop the ability, knowledge, and skills for ethical management.
CO5	Apply practical skills to navigate, resolve and thrive in management situations.

Reference Books	
1.	Brad Agle, Aaron Miller, Bill O' Rourke, The Business Ethics Field Guide: the essential companion to leading your career and your company, 2016.
2.	Steiner & Steiner, Business, Government & Society: A managerial Perspective, 2011.
3.	Lawrence & Weber, Business and Society: Stakeholders, Ethics, Public Policy, 2020.

CO-PO mapping:

COs	K level	PO1 (K3)	PO2 (K4)	PO3 (K5)	PO4 (K5)	PO5 (K6)	PO6 (K3) (A3)	PO7 (K2) (A3)	PO8 (K3) (A3)	PO9 (A3)	PO10 (A3)	PO11 (K3) (A3)	PO12 (A3)	PSO1 (K4) (A3)	PSO2 (K3) (A3)
CO1	K2	2	1	-	-	-	-	-	-	-	1	-	-	-	-
CO2	K3	3	2	2	1	-	-	-	-	-	1	-	-	2	2
CO3	K3	3	2	2	1	-	-	-	-	-	1	-	-	2	2
CO4	K2	2	1	-	-	-	-	-	-	-	1	-	-	1	1
CO5	K3	3	2	2	1	-	-	-	-	-	1	-	-	2	2
Weighted average		3	2	2	1	-	-	-	-	-	1	-	-	2	2

3-Substainability 2-moderate 1-low '-'- no correlation

Approved by BoS Chairman

M.E	M23CSE304- COMPILER OPTIMIZATION TECHNIQUES	L	T	P	C
		3	0	0	3

Course Objectives	
1.	To understand the optimization techniques used in compiler design.
2.	To be aware of the various computer architectures that support parallelism.
3.	To become familiar with the theoretical background needed for code optimization.
4.	To understand the techniques used for identifying parallelism in a sequential program.
5.	To learn the various optimization algorithms.

UNIT - I	INTRODUCTION	9

Language Processors - The Structure of a Compiler – The Evolution of Programming Languages- The Science of Building a Compiler – Applications of Compiler Technology Programming Language Basics - The Lexical Analyzer Generator -Parser Generator - Overview of Basic Blocks and Flow Graphs - Optimization of Basic Blocks - Principle Sources of Optimization.

UNIT - II	INSTRUCTION-LEVEL PARALLELISM	9

Processor Architectures – Code-Scheduling Constraints – Basic-Block Scheduling –Global Code Scheduling – Advanced code motion techniques – Interaction with Dynamic Schedulers- Software Pipelining.

UNIT - III	OPTIMISING FOR PARALLELISM AND LOCALITY-THEORY	9

Basic Concepts – Matrix-Multiply: An Example - Iteration Spaces - Affine Array Indexes – Data Reuse- Array data dependence Analysis.

UNIT - IV	OPTIMISING FOR PARALLELISM AND LOCALITY – APPLICATION	9

Finding Synchronisation - Free Parallelism – Synchronisation Between Parallel Loops – Pipelining – Locality Optimizations – Other Uses of Affine Transforms.

UNIT - V	INTERPROCEDURAL ANALYSIS	9

Basic Concepts – Need for Interprocedural Analysis – A Logical Representation of Data Flow – A Simple Pointer-Analysis Algorithm – Context Insensitive Interprocedural Analysis - Context-Sensitive Pointer-Analysis - Datalog Implementation by Binary Decision Diagrams.

Approved by BoS Chairman

Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Build and implement techniques used for optimization by a compiler.
CO2	Classify the existing architecture that supports parallelism.
CO3	Examine the existing data structures of an open source optimising compiler.
CO4	Apply the virtualization techniques for research projects.
CO5	Analyze different data structures and algorithms used in the building of an optimising compiler.

Reference Books	
1.	Torbengidius Mogensen, “Basics of Compiler Design”, Springer, 2011.
2.	Charles N, Ron K Cytron, Richard J LeBlanc Jr., “Crafting a Compiler”, Pearson Education, 2010.
3.	Alfred V. Aho, Monica S.Lam, Ravi Sethi, Jeffrey D.Ullman, “Compilers:Principles, Techniques and Tools”, Second Edition, Pearson Education,2008.
4.	John Hopcroft, Rajeev Motwani, Jeffrey Ullman, “Introduction To Automata Theory Languages, and Computation”, Third Edition, Pearson Education, 2007.
5.	Steven S. Muchnick, “Advanced Compiler Design and Implementation”,Morgan Kaufmann Publishers - Elsevier Science, India, 2007.

CO-PO mapping:

COs	K level	PO1 (K3)	PO2 (K4)	PO3 (K5)	PO4 (K5)	PO5 (K6)	PO6 (K3) (A3)	PO7 (K2) (A3)	PO8 (K3) (A3)	PO9 (A3)	PO10 (A3)	PO11 (K3) (A3)	PO12 (A3)	PSO1 (K4) (A3)	PSO2 (K3) (A3)
CO1	K3	3	3	2	2	-	-	-	-	-	1	-	1	3	2
CO2	K4	3	3	1	1	-	-	-	-	-	1	-	1	3	2
CO3	K4	3	3	2	1	-	-	-	-	-	1	-	1	2	2
CO4	K3	3	3	2	2	-	-	-	-	-	1	-	1	3	2
CO5	K4	3	3	2	2	-	-	-	-	-	1	-	1	3	2
Weighted average		3	3	2	2	-	-	-	-	-	1	-	1	3	2

3-Substainability 2-moderate 1-low ‘-‘- no correlation

Approved by BoS Chairman

M.E	M23CSE314- FULL STACK WEB APPLICATION DEVELOPMENT	L	T	P	C
		3	0	0	3

Course Objectives	
1.	Develop TypeScript Application
2.	Develop Single Page Application (SPA)
3.	Able to communicate with a server over the HTTP protocol
4.	Learning all the tools need to start building applications with Node.js
5.	Implement the Full Stack Development using MEAN Stack.

UNIT - I	FUNDAMENTALS & TYPESCRIPT LANGUAGE	9

Server-Side Web Applications. Client-Side Web Applications. Single Page Application. Type Script Creating TypeScript Projects. TypeScript Data Types. Variables. Expression and Operators. Functions. OOP in Typescript. Interfaces. Generics. Modules. Enums. Decorators. Enums. Iterators. Generators.

UNIT - II	ANGULAR	9

Angular CLI - Project Components - Components Interaction - Dynamic Components. Angular Elements—Forms - Template Driven Forms. Property, Style, Class and Event Binding. Two way Bindings. Reactive Forms - Group - Controls. Angular Router – Configuration - Router State Navigation Pages. Router Link. Query Parameters. URL matching. Matching Strategies. Services Dependency Injection.

UNIT - III	NODE.js	9

Node.js. Configuring - Node Package Manager NPM. Modules. Asynchronous Programming. Call Stack and Event Loop. Callback functions - errors. Abstracting & Chaining callbacks. File System - Synchronous - Asynchronous I/O. Path and directory operations - File Handle - Synchronous API - Callback API. Scheduling Timers - Timers Promises API. Node.js Events. Event Emitter. Event Target and Event API. Buffers and TypedArrays. Buffers and iteration. Buffers for binary data. Flowing vs. non-flowing streams. JSON.

UNIT - IV	EXPRESS.js	9

Express.js - Configuring Express.js App Settings. Defining Routes. Starting the App. Express.js Application Structure. Configuration, Settings. Middleware. body-parser. cookie-parser. express-session. response-time. Template Engine. Jade. EJS. Parameters. Routing. router.route(path). Router Class. Request Object. Response Object. Error Handling. RESTful.

UNIT - V	MONGODB	9

Approved by BoS Chairman

Introduction to MongoDB. Documents. Collections. Sub collections. Database. Data Types. Dates. Arrays. Embedded Documents. CRUD Operations. Batch Insert. Insert Validation. Querying The Documents. Cursors. Indexing. Unique Indexes. Sparse Indexes. Special Index and Collection Types. Full-Text Indexes. Geospatial Indexing. Aggregation framework.

Total Instructional hours : 60

Course Outcomes : Students will be able to	
CO1	Develop basic programming skills using Javascript.
CO2	Apply knowledge to build a front-end web application using Angular.
CO3	Develop the modules to organise the server.
CO4	Build RESTful APIs with Node, Express and MongoDB with confidence.
CO5	Make use of Store complex, relational data in MongoDB using Mongoose.

Reference Books	
1.	Adam Freeman, Essential TypeScript, Apress, 2019
2.	Mark Clow, Angular Projects, Apress, 2018
3.	MongoDB in Action, Kyle Banker, Peter Bakkum, Shaun Verch, Douglas Garrett, Tim Hawkins, Manning Publication, Second edition, 2016
4.	Pro Express.js, Azat Mardan, Apress, 2015
5.	Alex R. Young, Marc Harter,Node.js in Practice, Manning Publication, 2014

CO-PO mapping

COs	**K level**	**PO1 (K3)**	**PO2 (K4)**	**PO3 (K5)**	**PO4 (K5)**	**PO 5 (K6)**	**PO6 (K3) (A3)**	**PO7 (K2) (A3)**	**PO8 (K3) (A3)**	**PO9 (A3)**	**PO1 0 (A3)**	**PO1 1 (K3) (A3)**	**PO 12 (A 3)**	**PSO 1 (K4) (A3)**	**PSO 2 (K3) (A3)**
CO1	K3	3	2	1	-	-	-	-	-	-	1	-	1	2	2
CO2	K3	3	3	2	1	-	-	-	-	-	1	-	1	2	2
CO3	K3	3	2	2	1	-	-	-	-	-	1	-	1	3	3
CO4	K3	3	2	2	1	-	-	-	-	-	1	-	1	3	3
CO5	K3	3	2	1	-	-	-	-	-	-	1	-	1	3	3
Weighted average		3	2	2	1	-	-	-	-	-	1	-	1	3	3

Approved by BoS Chairman

M.E	M23CSE317- INTELLECTUAL PROPERTY RIGHTS	L	T	P	C
		3	0	0	3

Course Objective	
1.	To Understand Intellectual Property Rights and its valuation.
2.	To Understand process of IPR
3.	To Understand legal aspects of IPR.
4.	To Understand the methods involved in IPR for research based products
5.	To Understand the design, develop, market aspects of products.

UNIT - I	INTRODUCTION	9

Intellectual property rights - Introduction, Basic concepts, Patents, Copyrights, Trademarks, Trade Secrets, Geographic Indicators; Nature of Intellectual Property, Technological Research, Inventions and Innovations, History - the way from WTO to WIPO, TRIPS

UNIT - II	PROCESS	9

New Developments in IPR, Procedure for grant of Patents, TM, GIs, Patenting under Patent Cooperation Treaty, Administration of Patent system in India, Patenting in foreign countries.

UNIT - III	STATUTES	9

International Treaties and conventions on IPRs, The TRIPs Agreement, PCT Agreement, The Patent Act of India, Patent Amendment Act (2005), Design Act, Trademark Act, Geographical Indication Act, Bayh- Dole Act and Issues of Academic Entrepreneurship.

UNIT - IV	STRATEGIES IN INTELLECTUAL PROPERTY	9

Strategies for investing in R&D, Patent Information and databases, IPR strength in India, Traditional Knowledge, Case studies.

UNIT - V	MODELS	9

The technologies Know-how, concept of ownership, Significance of IP in Value Creation, IP Valuation and IP Valuation Models, Application of Real Option Model in Strategic Decision Making, Transfer and Licensing

Approved by BoS Chairman

Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Summarize the intellectual property and appreciation of the need to protect it
CO2	Inference about the process of patenting
CO3	Outline of the statutes related to IPR
CO4	Show the ability to apply strategies to protect intellectual property
CO5	Illustrate the ability to apply models for making strategic decisions related to IPR

Reference Books	
1.	Sople Vinod, Managing Intellectual Property by (Prentice hall of India Pvt.Ltd), 2006
2.	Intellectual Property rights and copyrights, EssEss Publications.
3.	Primer, R. Anita Rao and Bhanoji Rao, Intellectual Property Rights, Lastain Book company. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2006.
4.	WIPO Intellectual Property Hand book.

CO-PO mapping:

COs	K level	PO1 (K3)	PO2 (K4)	PO3 (K5)	PO4 (K5)	PO 5 (K6)	PO6 (K3) (A3)	PO7 (K2) (A3)	PO8 (K3) (A3)	PO9 (A3)	PO1 0 (A3)	PO1 1 (K3) (A3)	PO 12 (A 3)	PSO 1 (K4) (A3)	PSO 2 (K3) (A3)
CO1	K2	2	1	-	-	-	-	-	-	-	1	-	1	1	-
CO2	K2	2	1	-	-	-	-	-	-	-	1	-	1	1	-
CO3	K2	2	1	-	-	-	-	-	-	-	1	-	1	1	-
CO4	K2	2	1	-	-	-	-	-	-	-	1	-	1	1	-
CO5	K2	2	1	-	-	-	-	-	-	-	1	-	1	1	-
Weighted average		2	1	-	-	-	-	-	-	-	1	-	1	1	-

3-Substainability 2-moderate 1-low '-'- no correlation

Approved by BoS Chairman

M.E	M23CSE318-SOFT COMPUTING	L	T	P	C
		3	0	0	3

Course Objectives	
1.	Understanding about the learning problem and algorithms.
2.	Providing insight about neural networks.
3.	Introducing the machine learning fundamentals and significance.
4.	Enabling the students to acquire knowledge about pattern recognition.
5.	Motivating the students to apply deep learning algorithms for solving real life problems.

UNIT - I	LEARNING PROBLEMS AND ALGORITHMS	9

Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms.

UNIT - II	NEURAL NETWORKS	9

Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net, Perceptron, Adaline, Standard Back propagation Training Algorithms for Pattern Association - Hebb rule and Delta rule, Hetero associative, Auto associative, Kohonen Self Organising Maps, Examples of Feature Maps, Learning Vector Quantization, Gradient descent, Boltzmann Machine Learning.

UNIT - III	MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS	9

Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering**.**

UNIT - IV	DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS	9

Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs.

Approved by BoS Chairman

UNIT - V	DEEP LEARNING: RNNS, AUTOENCODERS AND GANS	9
State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Autoencoders: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs .Introduction to LLM (GPT,BERT,XLM-RoBERTiot)- Training and Fine-tuning LLMs		

Total Instructional hours : 45

Course Outcomes : Students will be able to	
CO1	Identify the categorization of machine learning algorithms.
CO2	Compare and contrast the types of neural network architectures, activation functions.
CO3	Extend pattern association using neural networks.
CO4	Analyze various terminologies related with pattern recognition and architectures of convolutional neural networks.
CO5	Construct different feature selection and classification techniques and advanced neural network architectures such as RNN, Autoencoders, and GANs.

Reference Books	
1.	J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning.
2.	Deep Learning, Ian Good fellow, YoshuaBengio and Aaron Courville, MIT Press, ISBN: 9780262035613, 2016.
3.	The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.
4.	Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.
5.	Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.

Approved by BoS Chairman

CO-PO mapping:

COs	K level	PO1 (K3)	PO2 (K4)	PO3 (K5)	PO4 (K5)	PO 5 (K6)	PO6 (K3) (A3)	PO7 (K2) (A3)	PO8 (K3) (A3)	PO9 (A3)	PO1 0 (A3)	PO1 1 (K3) (A3)	PO 12 (A 3)	PSO 1 (K4) (A3)	PSO 2 (K3) (A3)
CO1	K3	3	2	1	-	-	-	-	-	-	1	-	1	1	1
CO2	K4	3	3	2	1	-	-	-	-	-	1	-	1	3	2
CO3	K5	3	3	3	2	-	-	-	-	-	1	-	1	2	2
CO4	K4	3	3	2	1	-	-	-	-	-	1	-	1	3	3
CO5	K3	3	2	1	-	-	-	-	-	-	1	-	1	3	3
Weighted average		3	3	2	1	-	-	-	-	-	1	-	1	3	2

3-Substainability 2-moderate 1-low '-'- no correlation

Approved by BoS Chairman

M.E.	M23CSP301 - PROJECT WORK (PHASE I)	L	T	P	C
		0	12	0	6

Course Objectives	
1.	To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
2.	To develop the methodology to solve the identified problem.
3.	To train the students in preparing project reports and to face reviews and viva-voce examination.
4.	To enable a student to do an individual project work which may involve design, modelling, simulation and/or fabrication.
5.	To motivate the students to involve in research activities leading to innovative solutions for industrial and societal problems.

Course Description:

Project work shall be carried out by each and every individual student under the supervision of a faculty of this department. A student may however, in certain cases, be permitted to work for the project in association with other departments or in an Industrial/Research Organization, on the recommendation of the Head of the Department. In such cases, the project work shall be jointly supervised by a faculty of the Department and an Engineer / Scientist from the organization. The student shall meet the supervisor periodically and attend the periodic reviews for evaluating the progress.

Project work will be carried out in two phases,

- Phase-I during the third semester and Phase-II during the final semester.

Phase-I shall be pursued for 12 periods per week. In phase I also, there will be three reviews for continuous internal assessment and one final review and viva voce at the end of the semesters. The Project Report prepared according to approved guidelines and duly signed by the supervisor(s) and the Head of the Department shall be submitted to the concerned department.

Course Outcomes : Students will be able to	
CO1	**I**dentify the problem by applying acquired knowledge
CO2	Construct and organize executable project modules through proper designing.
CO3	Choose efficient tools for implementation of the designed modules.
CO4	Analyze and categorize the outcomes of the implementation and derive inferences.
CO5	Examine the completed task and compile the project report.

Approved by BoS Chairman

Semester - IV

M.E.	M23CSP401 - PROJECT WORK (PHASE II)	L	T	P	C
		0	24	0	12

Course Objectives	
1.	To solve the identified problem based on the formulated methodology.
2.	To develop skills to analyze and discuss the test results, and make conclusions
3.	To enable a student to do an individual project work which may involve design, modelling, simulation and/or fabrication.
4.	To analyse a problem both theoretically and practically.
5.	To motivate the students to involve in research activities leading to innovative solutions for industrial and societal problems.

Course Description:

Project work shall be carried out by each and every individual student under the supervision of a faculty of this department. A student may however, in certain cases, be permitted to work for the project in association with other departments or in an Industrial/Research Organization, on the recommendation of the Head of the Department. In such cases, the project work shall be jointly supervised by a faculty of the Department and an Engineer / Scientist from the organization. The student shall meet the supervisor periodically and attend the periodic reviews for evaluating the progress.

Phase-2 during the final semester. Phase-II shall be pursued for 24 periods per week. In phase II also, there will be three reviews for continuous internal assessment and one final review and viva voce at the end of the semesters. The Project Report prepared according to approved guidelines and duly signed by the supervisor(s) and the Head of the Department shall be submitted to the concerned department.

Course Outcomes : Students will be able to	
CO1	Design and develop the project, creativity and choose the most appropriate option for the Phase II project
CO2	Effectively communicate technical project information in writing/Seminar Presentation/ Technical Discussion.
CO3	Apply modern engineering tools for simulation, analysis and Solution.
CO4	Present the findings of the project by attending conference and communicate to journals for publication.
CO5	Engage in continuously learning the new practices, principles, and techniques

Approved by BoS Chairman