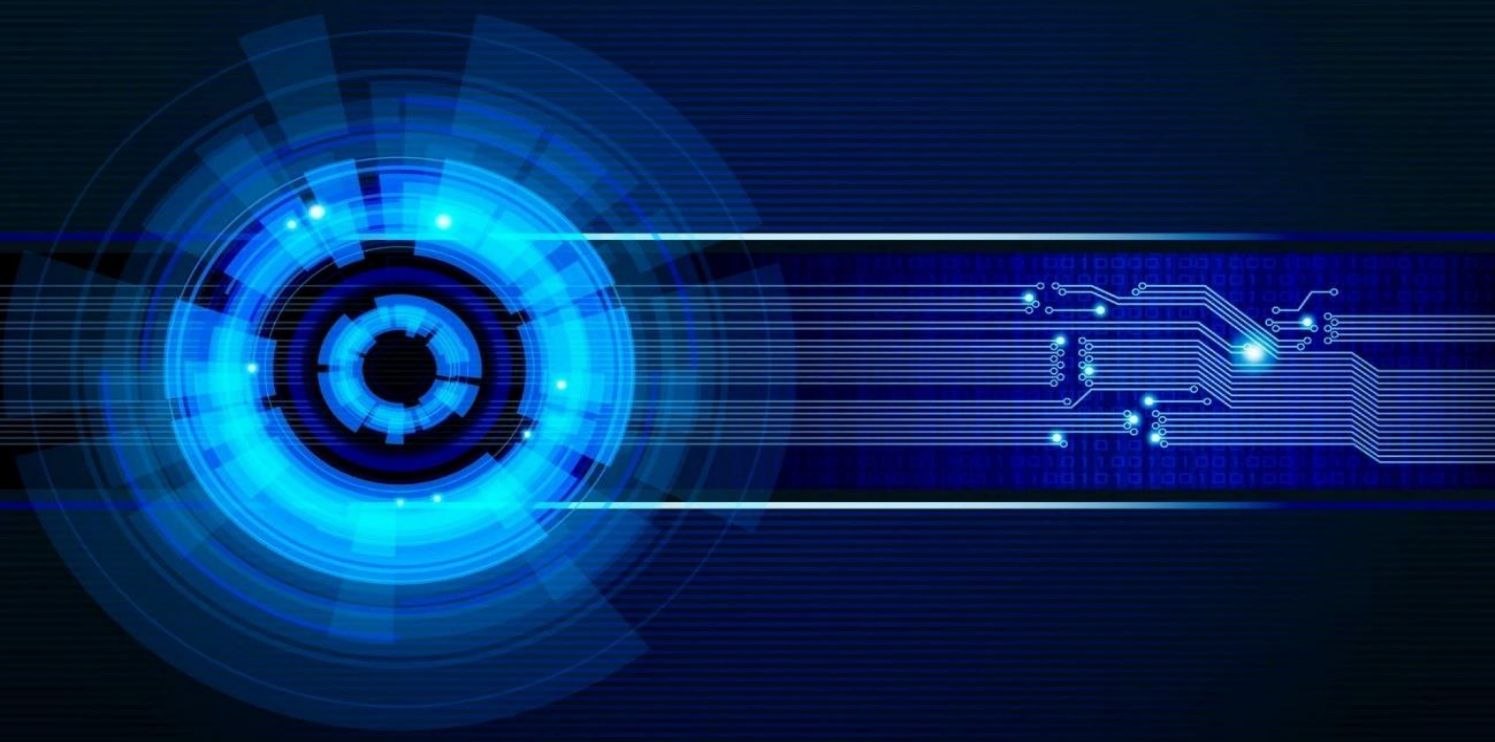




M.I.E.T. ENGINEERING COLLEGE (Autonomous)

Curriculum & Syllabus (Regulations 2024)

A decorative graphic featuring a large, glowing blue circular pattern on the left, resembling a stylized eye or a lens. To the right, there are horizontal lines and circuit-like patterns in blue and white, suggesting a technological or digital theme. The background is dark blue with a subtle grid pattern.

M.E. Computer Science and Engineering



M.I.E.T. ENGINEERING COLLEGE

(AUTONOMOUS)

(Approved by AICTE, New Delhi and Affiliated to Anna University, Chennai)
Accredited by NBA (CIVIL, CSE, ECE, EEE & MECH)
Accredited with 'A+' grade by NAAC
(An ISO 9001:2015 Certified Institution)
(Recognized by UGC under section 2(f) & 12(B) of UGC Act, 1956)
TRICHY - PUDUKKOTTAI MAIN ROAD, TRICHY - 620 007



DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING



CURRICULUM AND SYLLABUS **M.E. COMPUTER SCIENCE AND ENGINEERING** **(Regulations 2024)**

Vision

To attain excellence in Computer Science and Engineering field so as to address societal problems through active research, maintaining ethical standards.

Mission

- ❖ To empower with technical skills to solve the real time problems through interdisciplinary approach.
- ❖ Expose to international ethical practices.
- ❖ Provide personality development for an effective leader and individual member of a team.

Program Outcomes (POs)

At the time of their graduation students of Computer Science and Engineering Program should be in possession of the following Program Outcomes

1. An ability to independently carry out research / investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area of Computer Science and Engineering.
4. Efficiently design, build and develop system application software for distributed and centralized computing environments in varying domains and platforms.
5. Understand the working of current Industry trends, the new hardware architectures, the software components and design solutions for real world problems by Communicating and effectively working with professionals in various engineering fields and pursue research orientation for a lifelong professional development in computer and automation arenas.
6. Model a computer-based automation system and design algorithms that explore the understanding of the tradeoffs involved in digital transformation.

Program Educational Objectives (PEOs)

1. To accomplish applications of current technologies and exhibit technical skills to develop and implement strategies for solutions in Computer Science and Engineering problems.
2. To inculcate high level of professionalism, ethical attitude, effective communication skills, team spirit, multidisciplinary approach to take on to the challenging environment in the IT industries.
3. To nurture leadership qualities, intellectual curiosity for social needs.

PO-PEO MAPPING

Program Educational Objectives	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
PEO1	2	2	3	3	3	3
PEO2	3	3	3	3	2	3
PEO3	3	2	3	3	3	3

1 - Low, 2 - Medium, 3 – High



CHOICE BASED CREDIT SYSTEM

I TO IV SEMESTERS (REGULAR) CURRICULUM AND SYLLABUS

SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
THEORY								
1.	24CT1101	Advanced Algorithms & Data Structures	PCC	3	0	0	3	3
2.	24CT1102	Network Technologies	PCC	3	0	0	3	3
3.	24CT1103	Database Design & Practices	PCC	3	0	0	3	3
4.	24CT1104	Advanced Operating Systems	PCC	3	0	0	3	3
5.	24CT1105	Multicore Architecture	PCC	3	0	0	3	3
6.	24RE1101	Research Methodology and IPR	RMC	2	0	0	2	2
PRACTICAL								
7.	24CT1201	Advanced Data Structures and Algorithms Laboratory	PCC	0	0	4	4	2
8.	24CT1202	Database Practices Laboratory	PCC	0	0	4	4	2
							Total	21

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
THEORY								
1.	24CT2101	Virtualization & Cloud Computing	PCC	3	0	0	3	3
2.	24CT2102	Advanced Software Engineering	PCC	3	0	0	3	3
3.	-	Professional Elective- I	PEC	3	0	0	3	3
4.	-	Professional Elective - II	PEC	3	0	0	3	3
5.	-	Professional Elective - III	PEC	3	0	0	3	3
6.	-	Professional Elective - IV	PEC	3	0	0	3	3
7.	24RE2101	Scientific Report Writing	RMC	2	0	0	2	2

PRACTICAL								
7.	24CT2201	Cloud Computing Laboratory	PCC	0	0	4	4	2
8.	24CT2202	Software Engineering Laboratory	PCC	0	0	4	4	2
9.	24CT2203	Seminar	FC	0	0	2	2	1
Total								25

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
THEORY								
1.	24CT3101	Cyber Security and Protocols	PCC	3	0	0	3	3
2.	-	Professional Elective-V	PEC	3	0	0	3	3
3.	-	Open Elective	OEC	3	0	0	3	3
PRACTICAL								
4.	24CT3501	Project Work Phase - I	EEC	0	0	12	12	6
5.	24RE3201	Research Article Review	RMC	0	0	4	4	2
Total								17

SEMESTER-IV

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
PRACTICAL								
1.	24CT4501	Project Work Phase -II	EEC	0	0	24	24	12
Total								12

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 75

PROFESSIONAL CORE COURSES (PCC)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
1.	24CT1101	Advanced Algorithms & Data Structures	PCC	3	0	0	3	3
2.	24CT1102	Network Technologies	PCC	3	0	0	3	3
3.	24CT1103	Database Design & Practices	PCC	3	0	0	3	3
4.	24CT1104	Advanced Operating Systems	PCC	3	0	0	3	3
5.	24CT1105	Multicore Architecture	PCC	3	0	0	3	3
6.	24CT2101	Virtualization & Cloud Computing	PCC	3	0	0	3	3
7.	24CT2102	Advanced Software Engineering	PCC	3	0	0	3	3
8.	24CT3101	Cyber Security and Protocols	PCC	3	0	0	3	3
9.	24CT1201	Advanced Data Structures and Algorithms Laboratory	PCC	0	0	4	4	2
10.	24CT1202	Database Practices Laboratory	PCC	0	0	4	4	2
11.	24CT2202	Software Engineering Laboratory	PCC	0	0	4	4	2
12.	24CT2201	Cloud Computing Laboratory	PCC	0	0	4	4	2
Total								32

PROFESSIONAL ELECTIVES COURSES (PEC)
SEMESTER II, PROFESSIONAL ELECTIVE I, II & III

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
1.	24CT2301	Digital Image and Video Processing	PEC	3	0	0	3	3
2.	24CT2302	Human Computer Interaction	PEC	3	0	0	3	3
3.	24CT2303	Big Data Mining and Analytics	PEC	3	0	0	3	3
4.	24CT2304	Natural Language Processing	PEC	3	0	0	3	3
5.	24CT2305	Compiler Optimization Techniques	PEC	3	0	0	3	3

SEMESTER II & III, PROFESSIONAL ELECTIVE IV & V

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
1.	24CT2306	Multimedia Systems & Applications	PEC	3	0	0	3	3
2.	24CT2307	Block Chain Technologies	PEC	3	0	0	3	3
3.	24CT2308	Full Stack Web Application Development	PEC	3	0	0	3	3
4.	24CT2309	Web Services and API Design	PEC	3	0	0	3	3
5.	24CT2310	Quantum Computing	PEC	3	0	0	3	3

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
1.	24RE1101	Research Methodology and IPR	RMC	2	0	0	2	2
2.	24RE2101	Scientific Report Writing	RMC	2	0	0	2	2
3.	24RE3101	Research Article Review	RMC	0	0	4	4	2

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
1.	24PE1201	Seminar	EEC	0	0	2	2	1
2.	24PE3501	Project Work Phase I	EEC	0	0	12	12	6
3.	24PE4501	Project Work Phase II	EEC	0	0	24	24	12



COURSE OBJECTIVES

- To understand the usage of algorithms in computing.
- To learn and use hierarchical data structures and its operations.
- To learn the usage of graphs and its applications.
- To study about NP Completeness of problems.

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

Algorithms – Algorithms as a Technology – Time and Space complexity of algorithms - Asymptotic Analysis -Average and worst-case analysis -Asymptotic notation - Importance of efficient algorithms- Program performance measurement - Recurrences: The Substitution Method – The Recursion-Tree Method- Data structures and algorithms.

UNIT II HIERARCHICAL DATA STRUCTURES**9**

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

UNIT III GRAPHS**9**

Elementary Graph Algorithms: Representations of Graphs – Breadth-First Search – Depth-First Search – Topological Sort – Strongly Connected Components- Minimum Spanning Trees: Growing a Minimum Spanning Tree – Kruskal and Prim- Single-Source Shortest Paths: The Bellman-Ford algorithm – Single-Source Shortest paths in Directed Acyclic Graphs – Dijkstra 's Algorithm; Dynamic Programming - All-Pairs Shortest Paths: Shortest Paths and Matrix Multiplication – The Floyd-Warshall Algorithm

UNIT IV ALGORITHM DESIGN TECHNIQUES**9**

Dynamic Programming: Matrix-Chain Multiplication – Elements of Dynamic Programming – Longest Common Subsequence- Greedy Algorithms: – Elements of the Greedy Strategy- An Activity-Selection Problem - Huffman Coding.

UNIT V NP COMPLETE AND NP HARD**9**

NP-Completeness: Polynomial Time–Polynomial -Time Verification–NP-Completeness and Reducibility–NP-Completeness Proofs–NP-Complete Problems.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Design data structures and algorithms to solve computing problems.
- CO2: Choose and implement efficient data structures and apply them to solve problems.
- CO3: Design algorithms using graph structure and various string-matching algorithms to solve real-life problems.
- CO4: Design one's own algorithm for an unknown problem.
- CO5: Apply suitable design strategy for problem solving.

TEXT BOOKS

1. Algorithms and Data Structures for Massive “Datasets Dzejla Medjedovic “Manning Pubns Co (5 July 2022).
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.

REFERENCE BOOKS

1. Mark Allen Weiss, “Data Structures and Algorithms in C++”, Pearson Education, 3rd Edition, 2009.
2. E. Horowitz, S. Sahni and S. Rajasekaran, “Fundamentals of Computer Algorithms”, University Press, 2nd Edition, 2008.
3. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, “Data Structures and Algorithms”, Pearson Education, Reprint 2006.
4. “Advanced Algorithms and Data Structures” Manning; 1st edition (29 June 2021)
5. Introduction To Algorithms, Fourth Edition Thomas H. Cormen is Emeritus Professor of Computer Science at Dartmouth College. MIT Press; 4th edition (5 April 2022)

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	1	3
CO2	3	1	-	-	2	3
CO3	3	-	1	1	-	2
CO4	3	2	1	-	2	1
CO5	3	3	1	1	-	1
AVG	3	2	1.25	1	1	2

1 - Low, 2 - Medium, 3 – High, ‘-’ - No correlation

COURSE OBJECTIVES

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

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 And Broadcast Domains. LAN Vs WAN. Network Adapter. Hub. Switch. Router. Firewall, IP addressing.

UNIT II WIRELESS NETWORKS**9**

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

UNIT III MOBILE DATA NETWORKS**9**

4G Networks and Composite Radio Environment – Protocol Boosters – Hybrid 4G Wireless Networks Protocols – Green Wireless Networks – Physical Layer and Multiple Access – Channel Modelling for 4G – Concepts of 5G – channel access –air interface -Cognitive Radio- spectrum management – C-RAN architecture - Vehicular communications-protocol – Network slicing – MIMO, 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. OpenFlow Logical Network Device. Flow Table Structure. Flow Table Pipeline. The Use of Multiple Tables. Group Table. OpenFlow Protocol. SDN Control Plane Architecture. Control Plane Functions. Southbound Interface. Northbound Interface. Routing. ITU-T Model. Open Day light. Open Day light Architecture. Open Day light Helium. SDN Application Plane Architecture. Northbound Interface. Network Services Abstraction Layer. Network Applications. User Interface.

UNIT V NETWORK FUNCTIONS VIRTUALIZATION**9**

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

TOTAL:45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Explain basic networking concepts.
- CO2: Compare different wireless networking protocols.
- CO3: Describe the developments in each generation of mobile data networks.
- CO4: Explain and develop SDN based applications.
- CO5: Explain the concepts of network function virtualization.

TEXT BOOKS

1. James Bernstein, “NetworkingmadeEasy”,2018.
2. Houda Labiod, Costantino de Santis, Hossam Afifi “Wi-Fi, Bluetooth, Zigbee and WiMax”, Springer 2007
3. Erik Dahlman, StefanParkvall, JohanSkold,4G: LTE/LTE-Advanced for Mobile Broadband, Academic Press, 2013

REFERENCE BOOKS

1. SaadZ.Asif“5GMobileCommunicationsConceptsandTechnologies” CRC press– 2019.
2. William Stallings “Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud” 1st Edition, Pearson Education, 2016.
3. Thomas D.Nadeau and Ken Gray,SDN–Software Defined Networks, O’Reilly Publishers, 2013.
4. Guy Pujolle, “Software Networks”, Second Edition, Wiley-ISTE,2020.
5. Research Advances in Network Technologies, Dr. Anshul Verma, Dr. Pradeepika Verma and Dr. Kiran Kumar Pattanaik.

Mapping of COs and Pos

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	3	2	-	1	-
CO2	1	3	3	3	-	1
CO3	1	3	3	2	2	2
CO4	1	2	2	1	2	1
CO5	1	3	1	1	1	2
AVG	1	2.8	2.2	1.75	1.5	1.5

1 - Low, 2 - Medium, 3 – High, ‘-’ - No correlation

COURSE OBJECTIVES

- Describe the fundamental elements of relational database management systems
- Explain the basic concepts of relational data model, entity-relationship model, relational database design, relational algebra and SQL.
- Understand query processing in a distributed database system.

UNIT I RELATIONAL DATA MODEL**9**

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

UNIT II DISTRIBUTED DATABASES, ACTIVE DATABASES AND OPEN DATABASE CONNECTIVITY**9**

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.

UNIT III XML DATABASES**9**

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.

UNIT IV NOSQL DATABASES AND BIG DATA STORAGE SYSTEMS**9**

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.

UNIT V DATABASE SECURITY**9**

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.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Convert the ER-model to relational tables, populate relational databases and formulate SQL queries on data.
- CO2: Understand and write well-formed XML documents.
- CO3: Be able to apply methods and techniques for distributed query processing.
- CO4: Design and implement secure database systems.
- CO5: Use the data control, definition, and manipulation languages of the NoSQL databases.

TEXT BOOKS

1. R. Elmasri, S.B. Navathe, “Fundamentals of Database Systems”, Seventh Edition, Pearson Education 2016.
2. Henry F. Korth, Abraham Silberschatz, S. Sudharshan, “Database System Concepts”, Seventh Edition, McGraw Hill, 2019.
3. C.J.Date, A.Kannan, S.Swamynathan, “An Introduction to Database Systems, Eighth Edition, Pearson Education, 2006.

REFERENCE BOOKS

1. Raghu Ramakrishnan, Johannes Gehrke “Database Management Systems”, Fourth Edition, McGraw Hill Education, 2015.
2. Harrison, Guy, “Next Generation Databases, NoSQL and Big Data”, First Edition, Apress publishers, 2015.
3. Thomas Cannolly and Carolyn Begg, “Database Systems, A Practical Approach to Design, Implementation and Management”, Sixth Edition, Pearson Education, 2015.
4. Database Design, second edition of Database Design, Adrienne Watt holds a computer systems diploma (BCIT), a bachelor’s degree in technology (BCIT) and a master’s degree in business administration (City University).
5. Database Design and Implementation: Second Edition (Data-Centric Systems and Applications), Springer Nature Switzerland AG; 1st ed. 2020 edition (28 February 2020).

Mapping of COs and Pos

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	3	1	2
CO2	2	2	-	2	1	1
CO3	3	1	2	1	-	1
CO4	3	2	2	1	1	1
CO5	2	3	1	1	-	1
AVG	2.4	2	1.5	1.6	1	1.2

1 - Low, 2 - Medium, 3 – High, ‘-’ - No correlation

COURSE OBJECTIVES

- Populate and query a database using SQL DDL/DML Commands.
- Declare and enforce integrity constraints on a database.
- Writing Queries using advanced concepts of SQL.

LIST OF EXERCISES

1. Creation, altering and dropping of tables and inserting rows into a table (use constraints while creating tables) examples using SELECT command.
2. Queries (along with sub-Queries) using ANY, ALL, IN, EXISTS, NOTEXISTS, UNION, INTERSET, Constraints. Example: - Select the roll number and name of the student who secured fourth rank in the class.
3. i. Create a simple PL/SQL program which includes declaration section, executable section and exception –Handling section (Ex. Student marks can be selected from the table and printed for those who secured first class and an exception can be raised if no records were found).
ii. Insert data into student table and use COMMIT, ROLLBACK and SAVEPOINT in PL/SQL block.
4. Develop a program that includes the features NESTED IF, CASE and CASE expression. The program can be extended using the NULLIF and COALESCE functions.
5. Program development using WHILE LOOPS, numeric FOR LOOPS, nested loops using ERROR Handling, BUILT –IN Exceptions, USE defined Exceptions, RAISEAPPLICATION ERROR.
6. Programs development using creation of procedures, passing parameters IN and OUT of PROCEDURES.
7. Program development using creation of stored functions, invoke functions in SQL Statements and write complex functions.
8. Develop programs using features parameters in a CURSOR, FOR UPDATE CURSOR, WHERE CURRENT of clause and CURSOR variables.
9. Develop Programs using BEFORE and AFTER Triggers, Row and Statement Triggers and INSTEAD OF Triggers
10. Create a table and perform the search operation on table using indexing and non-indexing techniques.

TOTAL: 60 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Convert the ER-model to relational tables, populate relational databases and formulate SQL queries on data.

CO2: Understand and write well-formed XML documents.

CO3: Be able to apply methods and techniques for distributed query processing.

CO4: Design and implement secure database systems.

CO5: Use the data control, definition, and manipulation languages of the NoSQL databases.

Mapping of COs and Pos

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	3	1	2
CO2	2	2	-	2	1	1
CO3	3	1	2	1	-	1
CO4	3	2	2	1	1	1
CO5	2	3	1	1	-	1
AVG	2.4	2	1.2	1.6	0.6	1.2

1 - Low, 2 - Medium, 3 – High, '-' - No correlation

**24CT1201 ADVANCED DATA STRUCTURES AND ALGORITHMS
LABORATORY**

**L T P C
0 0 4 2**

COURSE OBJECTIVES

- To acquire the knowledge of using advanced tree structures.
- To learn the usage of heap structures.
- To understand the usage of graph structures and spanning trees.

LIST OF EXPERIMENTS

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

11. Implementation of Matrix Chain Multiplication.
12. Activity Selection and Huffman Coding Implementation.

HARDWARE/SOFTWARE REQUIREMENTS

1. 64-bit Open-source Linux or its derivative
2. Open-Source C++ Programming tool like G++/GCC

TOTAL: 60 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

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

Mapping of COs and Pos

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	-	1	1	-
CO2	1	-	1	2	2	1
CO3	1	1	1	1	2	1
CO4	1	2	2	2	2	1
CO5	1	2	3	1	3	1
AVG	1	1.5	1.75	1.4	2	1

1 - Low, 2 - Medium, 3 – High, '-' - No correlation

24CT1104

ADVANCED OPERATING SYSTEMS

**L T P C
3 0 0 3**

COURSE OBJECTIVES

- To get a comprehensive knowledge of the architecture of distributed systems.
- To understand the deadlock and shared memory issues and their solutions in distributed environments.
- To know the security issues and protection mechanisms for distributed environments.

UNIT I INTRODUCTION 9

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

UNIT II DISTRIBUTED OPERATING SYSTEMS 9

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

UNIT III DISTRIBUTED RESOURCE MANAGEMENT 9

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

UNIT IV REAL TIME OPERATING SYSTEMS 9

Basic Model of Real - Time Systems – Characteristics – Application of Real - Time Systems– Real - Time Task Scheduling – Handling Resource Sharing.

UNIT V MOBILE AND CLOUD OPERATING SYSTEMS 9

Android – Overall Architecture – Linux Kernel – Hardware Support – Native User-Space – Dalvik and Android’s Java – System Services – Introduction to Cloud Operating Systems

TOTAL:45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Identify the features of distributed operating systems.
- CO2: Demonstrate the various protocols of distributed operating systems.
- CO3: Identify the different features of real time operating systems.
- CO4: Discuss the features of mobile operating systems.
- CO5: Discuss the features of cloud operating systems.

TEXT BOOKS

1. Mukesh Singhal and Niranjana G. Shivaratri, “Advanced Concepts in Operating Systems – Distributed, Database and Multiprocessor Operating Systems”, Tata MC Graw-Hill, 2001.

2. Rajib Mall, “Real-Time Systems: Theory and Practice”, Pearson Education India, 2006.
3. Karim Yaghmour, “Embedded Android”, O’Reilly, First Edition, 2013.

REFERENCE BOOKS

1. Nikolay Elenkov, “Android Security Internals: An In-Depth Guide to Android’s Security Architecture”, No Starch Press, 2014.
2. Advanced Concepts In Operating Systems, by Mukesh Singhal, Niranjan G. Shivaratri, Niranjan Shivaratri, January 1, 1994 by McGraw-Hill Science/Engineering/Math.
3. ADVANCED CONCEPTS IN OPERATING SYSTEMS, by Mukesh Singhal (Author), Niranjan Shivaratri (Author), McGraw Hill Education (1 July 2017).
4. Advanced Concepts in Operating Systems, Mukesh Singhal, Niranjan G. Shivaratri, Tata McGraw-Hill Edition 2001.
5. Distributed Systems: Andrew S. Tanenbaum, Maarten Van Steen, Pearson Prentice Hall, Edition.

Mapping of COs and Pos

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	-	-
CO2	3	-	3	2	-	-
CO3	3	-	2	2	2	-
CO4	3	-	2	2	-	-
CO5	3	-	2	3	-	-
AVG	5	-	2.4	2.4	2	-

1 - Low, 2 - Medium, 3 – High, ‘-’ - No correlation

24CT1105

MULTICORE ARCHITECTURES

**L T P C
3 0 0 3**

COURSE OBJECTIVES

- To understand the need for multi-core processors, and their architecture.
- To understand the challenges in parallel and multi-threaded programming.
- To learn about the various parallel programming paradigms.

UNIT I FUNDAMENTALS OF COMPUTER DESIGN AND ILP

9

Fundamentals of Computer Design – Measuring and Reporting Performance – Instruction Level Parallelism and its Exploitation – Concepts and Challenges – Limitations of ILP – Multithreading SMT and CMP Architectures – The Multicore era.

UNIT II MEMORY HIERARCHY DESIGN 9

Introduction– Optimizations of Cache Performance – Memory Technology and Optimizations – Protection: Virtual Memory and Virtual Machines – Design of Memory Hierarchies – Case Studies.

UNIT III MULTIPROCESSOR ISSUES 9

Symmetric and Distributed Shared Memory Architectures – Cache Coherence Issues – Performance Issues – Synchronization Issues – Models of Memory Consistency – Interconnection Networks – Buses, Crossbar and Multi-stage Interconnection Networks.

UNIT IV EXPLOITING DIFFERENT TYPES OF PARALLELISM 9

Homogeneous and Heterogeneous Multi - core Architectures – Intel Multicore Architectures – SUN CMP architecture – IBM Cell Architecture. Introduction to Warehouse – Scale computers, Cloud Computing – Architectures and Issues. Vector, SIMD and GPU Architectures – Vector Architecture – SIMD Extensions for Multimedia – Graphics Processing Units – Case Studies – GPGPU Computing.

UNIT V DOMAIN SPECIFIC ARCHITECTURES 9

Introduction to Domain Specific Architectures - Guidelines for DSAs. Case Studies – Domain: Deep Neural Networks - Google’s Tensor Processing Unit - Microsoft Catapult - Intel Crest - Pixel Visual Core. CPUs Versus GPUs Versus DSAs.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Discuss and evaluate the performance of computer systems.
- CO2: Discuss and point out the various ways of exploiting ILP.
- CO3: Point out the various optimizations that can be performed to improve the memory hierarchy design.
- CO4: Discuss the issues related to multiprocessing and suggest solutions.
- CO5: Point out the salient features of different multicore architectures and how they exploit different types of parallelism.

TEXT BOOKS

1. John L. Hennessey and David A. Patterson, “Computer Architecture Quantitative Approach”, Morgan Kaufmann / Elsevier, 6th edition, 2019.
2. Wen–mei W.Hwu,“GPU Computing Gems”, Morgan Kaufmann / Elsevier, 2011.
3. Yan Solihin, “Fundamentals of Parallel Multicore Architecture”, Chapman & Hall/CRC Press, 2016.

REFERENCE BOOKS

1. David B. Kirk, Wen-mei W. Hwu, "Programming Massively Parallel Processors", Morgan Kaufman, 2010.
2. Multi Core Architectures & Programming, Vijay Nicole Imprints Private Limited, Dr. M. Shyamala Devi.
3. Advanced Computer Organization & Architecture, 1st Edition, By Smruti Ranjan Sarangi, Published: June 25, 2021.
4. Fundamentals of Parallel Multicore Architecture by Yan Solihin, Released November 2015, Chapman and Hall/CRC.
5. Fundamentals of Parallel Multicore Architecture Hardcover – Illustrated, 24 November 2015 by Yan Solihin (Author), Chapman & Hall; Illustrated edition (24 November 2015).

Mapping of COs and Pos

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	1	2
CO2	3	3	3	2	1	2
CO3	3	3	3	2	1	2
CO4	3	3	3	2	1	2
CO5	3	3	3	2	1	2
AVG	3	3	3	2	1	2

1 - Low, 2 - Medium, 3 - High, '-' - No correlation

24RE1101

RESEARCH METHODOLOGY AND IPR

L T P C
2 0 0 2

COURSE OBJECTIVES

- To acknowledge the importance of intellectual property and teach students the fundamental concepts of Intellectual Property Rights (IPR).
- To highlight the significance of understanding the practices and procedures for obtaining patents, copyrights, trademarks, and industrial designs.
- To simplify the statutory provisions of various forms of IPR and empower students to effectively maintain and manage their intellectual property rights.

UNIT I RESEARCH DESIGN

9

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys, Research problem formulation, Research gap identification, Formulation of materials and methods.

UNIT II DATA COLLECTION AND SOURCES **9**

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

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, Computer aided Research – Simulation – Case study.

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: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Differentiate and describe various types of intellectual property rights (IPRs).

CO2: Determine how to classify one's own intellectual work under specific form of IPRs.

CO3: Apply legal provisions to safeguard particular forms of IPRs.

CO4: Examine the rights and responsibilities associated with patents, copyrights, trademarks, industrial designs, and other IPRs.

CO5: Identify the procedures for protecting different forms of IPRs at both national and international levels.

TEXT BOOKS

1. "Research Methodology: Concepts and Cases" by Deepak Chawla and Neena Sondhi
Year: 2011
2. "Research Methodology: A Step-by-Step Guide for Beginners" by Ranjit Kumar
Year: 2019
3. "Intellectual Property Rights: Unleashing the Knowledge Economy" by Prabha Shukla
Year: 2018.

REFERENCES BOOKS

1. Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11e (2012).
2. Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.
3. Daniel Riordan - Technical Report Writing Today (1998)
4. Darla-Jean Weatherford - Technical Writing for Engineering Professionals (2016) Penwell Publishers.
5. "Intellectual Property Rights: A Global Vision" by R. P. Singh Year: 2016 Secrets” Entrepreneur Press, 2007.

Mapping of COs and Pos

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	1	2
CO2	3	3	3	2	1	2
CO3	2	3	2	2	1	2
CO4	3	3	3	2	1	2
CO5	2	3	2	2	1	2
AVG	2.6	5	2.6	2	1	2

1 - Low, 2 - Medium, 3 – High, ‘-’ - No correlation

24CT2101

VIRTUALIZATION & CLOUD COMPUTING

**L T P C
3 0 0 3**

COURSE OBJECTIVES

- To gain expertise in Virtualization, Virtual Machines and deploy practical virtualization solution.
- To understand the architecture, infrastructure and delivery models of cloud computing and AWS cloud platform.
- To gain knowledge in the working of Windows Azure and programming model of Hadoop and Aneka.

UNIT I VIRTUALIZATION AND VIRTUALIZATION INFRASTRUCTURE 6

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

UNIT II CLOUD PLATFORM ARCHITECTURE

12

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

UNIT III AWS CLOUD PLATFORM – IAAS

9

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

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: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1:Employ 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.

TEXT 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 Advanced Level, Amazon Asia- Pacific Holdings Private Limited, 2019.
3. Sriram Krishnan, Programming: Windows Azure, O'Reilly,2010.

REFERENCE BOOKS

1. Danielle Ruest, Nelson Ruest, —Virtualization: A Beginner's Guide, McGraw-Hill Osborne Media, 2009.
2. Jim Smith, Ravi Nair, "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.
3. John Rittenhouse and James Ransome, "Cloud Computing: Implementation,
4. Management, and Security", CRC Press, 2010.
5. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", McGraw-Hill Osborne Media, 2009.

Mapping of COs and Pos

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	-	2	2	1
CO2	2	3	1	-	-	1
CO3	3	-	3	-	1	3
CO4	-	-	-	2	-	3
CO5	3	2	-	-	-	-
AVG	2.6	1	2	2	1.5	2

1 - Low, 2 - Medium, 3 - High, '-' - No correlation

24CT2102

ADVANCED SOFTWARE ENGINEERING

L T P C
3 0 0 3

COURSE OBJECTIVES

- To understand the rationale for software development process models.
- To understand why the architectural design of software is important.
- To understand the five important dimensions of dependability, namely, availability, reliability, safety, security, and resilience.

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 – Behavioral Modelling.

UNIT II SOFTWARE DESIGN

9

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

UNIT III SYSTEM DEPENDABILITY AND SECURITY

9

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

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

9

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

UNIT V SOFTWARE TESTING AND SOFTWARE CONFIGURATION MANAGEMENT

9

Software Testing Strategy – Unit Testing – Integration Testing – Validation Testing – System Testing – Debugging – White-Box Testing – Basis Path Testing – Control Structure Testing – Black-Box Testing – Software Configuration Management (SCM) – SCM Repository – SCM Process – Configuration Management for Web and Mobile Apps.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Identify appropriate process models based on the Project requirements.
- CO2: Understand the importance of having a good Software Architecture.
- CO3: Understand the five important dimensions of dependability, namely, availability, reliability, safety, security, and resilience.
- CO4: Understand the basic notions of a web service, web service standards and service-oriented architecture.
- CO5: Be familiar with various levels of Software testing

TEXT BOOKS

1. Software Engineering: A Practitioner's Approach, 9th Edition. Roger Pressman and Bruce Maxim, McGraw-Hill 2019.
2. Software Engineering, 10th Edition, Ian Sommerville, Pearson Education Asia 2016.
3. Software Architecture in Practice, 3rd Edition, Len Bass, Paul Clements and Rick Kazman, Pearson India 2018

REFERENCE BOOKS

1. An integrated approach to Software Engineering, 3rd Edition, Pankaj Jalote, Narosa Publishing House, 2018.
2. Fundamentals of Software Engineering, 5th Edition, Rajib Mall, PHI Learning Private Ltd, 2018.
3. C.Easteal and G.Davis, Software Engineering Analysis and Design, Tata McGraw Hill.
4. Richard Fairley, Software Engineering Concepts, Tata McGraw Hill.
5. Pankaj Jalote, An Integrated Approach to Software engineering, Narosa Publication.

Mapping of COs and Pos

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2	-	2
CO2	2	1	3	2	-	2
CO3	1	1	3	2	-	2
CO4	3	1	3	3	-	2
CO5	1	1	3	1	-	1
AVG	2	1	5	2	-	1.8

1 - Low, 2 - Medium, 3 – High, '-' – No correlation

24RE2101

SCIENTIFIC REPORT WRITING

L T P C
2 0 0 2

COURSE OBJECTIVES

- Understand the essentials of project writing.
- Perceive the difference between general writing and technical writing.
- Assimilate the fundamental features of report writing.

UNIT I WRITING SKILL

9

Writing Skills – Essential Grammar and Vocabulary – Passive Voice, Reported Speech, Concord, Signpost words, Cohesive Devices – Paragraph writing – Technical Writing vs. General Writing.

UNIT II PROJECT REPORT

9

Project Report – Definition, Structure, Types of Reports, and Purpose – Intended Audience – Plagiarism – Report Writing in STEM fields – Experiment Statistical Analysis.

UNIT III STRUCTURE OF PROJECT REPORT

9

Structure of the Project Report: Framing a Title – Content – Acknowledgement – Funding Details -Abstract – Introduction – Aim of the Study – Background - Writing the research

question – Need of the Study/Project Significance, Relevance – Determining the feasibility – Theoretical Framework

UNIT IV REPORT WRITING

9

Literature Review, Research Design, Methods of Data Collection - Tools and Procedures Data Analysis - Interpretation - Findings – Limitations - Recommendations – Conclusion – Bibliography.

UNIT V PROOF READING

9

Proof reading a report –Avoiding Typographical Errors –Bibliography in required Format – Font Spacing – Checking Tables and Illustrations – Presenting a Report Orally – Techniques.

TOTAL: 30 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Write effective project reports.

CO2: Use statistical tools with confidence.

CO3: Explain the purpose and intension of the proposed project coherently and with clarity.

CO4: Create writing texts to suit achieve the intended purpose.

CO5: Master the art of writing winning proposals and projects.

TEXT BOOKS

1. "Scientific Writing and Communication in Agriculture and Natural Resources" C. Choudhury Publisher: New India Publishing Agency Year: 2018.
2. "Technical Writing: A Practical Guide for Engineers and Scientists" by Phillip A. LaPlante (with contributions from Indian authors) Publisher: Wiley Year: 2016.
3. "Effective Technical Communication" by M. Ashraf Rizvi Publisher: Tata McGraw Hill Year: 2008.

REFERENCE BOOKS

1. Gerson and Gerson - Technical Communication: Process and Product, 7th Edition, Prentice Hall (2012).
2. Virendra K. Pamecha - Guide to Project Reports, Project Appraisals and Project Finance (2012).
3. Daniel Riordan - Technical Report Writing Today (1998).
4. Darla-Jean Weatherford - Technical Writing for Engineering Professionals (2016) Penwell Publishers.
5. "Writing Scientific Research Articles: Strategy and Steps" by S.R.K.Rao Publisher: Springer Year: 2019

Mapping of COs and Pos

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	-	-	1	-
CO2	3	3	-	-	1	-
CO3	3	3	-	-	1	-
CO4	3	3	-	-	1	-
CO5	3	3	-	-	1	-
AVG	3	3	-	-	1	-

1 - Low, 2 - Medium, 3 – High, '-' – No correlation

24CT2202

SOFTWARE ENGINEERING LABORATORY

L T P C
0 0 4 2

COURSE OBJECTIVES

- To impart state-of-the-art knowledge on Software Engineering and UML in an interactive manner through the Web.
- Present case studies to demonstrate practical applications of different concepts.
- Provide a scope to students where they can solve small, real-life problems.

LIST OF EXPERIMENTS

1. Write a Problem Statement to define a title of the project with bounded scope of project.
2. Select relevant process model to define activities and related task set for assigned project.
3. Prepare broad SRS (Software Requirement Specification) for the above selected projects.
4. Prepare USE Cases and Draw Use Case Diagram using modelling Tool.
5. Develop the activity diagram to represent flow from one activity to another for software development.
6. Develop data Designs using DFD Decision Table & ER Diagram.
7. Draw class diagram, sequence diagram, Collaboration Diagram, State Transition Diagram for the assigned project.
8. Write Test Cases to Validate requirements of assigned project from SRS Document.
9. Evaluate Size of the project using function point metric for the assigned project.
10. Estimate cost of the project using COCOMO and COCOCMOII for the assigned project.
11. Use CPM/PERT for scheduling the assigned project.
12. Use timeline Charts or Gantt Charts to track progress of the assigned project.

TOTAL: 60 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Can produce the requirements and use cases the client wants for the software being produced.
- CO2: Participate in drawing up the project plan. The plan will include at least extent and work assessments of the project, the schedule, available resources, and risk management can model and specify the requirements of mid-range software and their architecture.
- CO3: Create and specify such software design based on the requirement specification that the software can be implemented based on the design.
- CO4: Can assess the extent and costs of a project with the help of several different assessment methods.
- CO5: Be familiar with various levels of Software testing.

Mapping of COs and Pos

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	2	3	3	3	2	2
CO3	3	1	2	2	1	2
CO4	2	3	1	2	-	-
CO5	1	1	3	1	-	1
AVG	2	1	5	2	-	1.8

1 - Low, 2 - Medium, 3 – High, '-' – No correlation

24CT2201

CLOUD COMPUTING LABORATORY

L T P C

0 0 4 3

COURSE OBJECTIVES

- To understand the principles of cloud architecture, models and infrastructure.
- To familiarize the concepts of cloud computing and services.
- To explain cloud platform and types of cloud IV. To explain resource management in cloud.

LIST OF EXPERIMENTS

1. Install Virtual box/VMware Workstation with different flavours of Linux or windows OS on top of windows7 or 8.
2. Install a C compiler in the virtual machine created using virtual box and execute Simple Programs.
3. Install Google App Engine. Create hello world app and other simple web applications using python/java.

4. Use GAE launcher to launch the web applications.
5. Simulate a cloud scenario using Cloud Sim and run a scheduling algorithm that is not present in Cloud Sim.
6. Find a procedure to transfer the files from one virtual machine to another virtual machine.
7. Find a procedure to launch virtual machine using try stack (Online Open stack Demo Version),
8. Install Hadoop single node cluster and run simple applications like wordcount.
9. Run a Container from Docker Hub.

TOTAL:30 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Understand the fundamental principles of distributed computing.
- CO2: Create virtual machines and virtual templates.
- CO3: Create Cloud platform using Virtual machines.
- CO4: Identify suitable business models of cloud computing.
- CO5: Develop services using various Cloud computing programming models.

TEXT 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 Advanced Level, Amazon Asia- Pacific Holdings Private Limited, 2019.
3. Sriram Krishnan, Programming: Windows Azure, O'Reilly,2010.

REFERENCE BOOKS

1. Rajkumar Buyya, Christian Vacchiola, S.Thamarai Selvi, Mastering Cloud Computing , McGraw Hill Education (India) Pvt. Ltd., 2013.
2. Danielle Ruest, Nelson Ruest, —Virtualization: A Beginner's Guide, McGraw-Hill Osborne Media, 2009.
3. Jim Smith, Ravi Nair, "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.
4. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010.
5. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach",McGraw-Hill Osborne Media, 2009.

Mapping of COs and Pos

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	2	3	3	3	2	2
CO3	3	1	2	2	1	2
CO4	2	3	1	2	-	-
CO5	2	1	1	-	-	-
AVG	2.4	2	2	2	2	2.3

1 - Low, 2 - Medium, 3 – High, '-' – No correlation

24CT2203

SEMINAR

**L T P C
0 0 2 1**

COURSE OBJECTIVES

- To encourage the students to study advanced engineering developments.
- To prepare and present technical reports.
- To encourage the students to use various teaching aids such as overhead projectors,
- Power point presentation and demonstrative models.

METHOD OF EVALUATION

During the seminar session each student is expected to prepare and present a topic on engineering/ technology, for a duration of about 45 minutes. Each student is expected to present minimum 10 topics during the semester and the student is evaluated based on that. At the end of the semester, he / she can submit a report on his / her topic of seminar and marks are given based on the report. A Faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain attendance also. Evaluation is 100% internal.

TOTAL: 30 PERIODS

COURSE OUTCOMES

- On successful completion of this course, the student will be able to
- CO1: Review, prepare and present technological developments.
 - CO2: Face the placement interviews.
 - CO3: Develop presentation skills.
 - CO4: Develop report writing.
 - CO5: Present ideas in conferences.

Mapping of COs and Pos

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	1	1	2	2
CO2	2	1	1	1	2	2
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	-	-	-	-	-	-
AVG	2	1	1	1	2	2

1 - Low, 2 - Medium, 3 – High, ‘-’ – No correlation

24CT3101

CYBER SECURITY AND PROTOCOLS

L T P C

3 0 0 3

COURSE OBJECTIVES

- To become familiar with forensics tools.
- To learn to analyze and validate forensics data.
- Understand key terms and concepts in Cryptography, Governance and Compliance.

UNIT I INTRODUCTION

9

Need for Cyber security - History of Cyber security - Defining Cyberspace and Cyber security- Standards - CIA Triad – Cyber security Framework.

UNIT II ATTACKS AND COUNTERMEASURES

9

Malicious Attacks, Threats, and Vulnerabilities – Scope of cyber-attacks – Tools used to attack Computer systems –security breach – Risks, vulnerabilities and threats. Malware – malicious Software attack – social engineering attack – wireless network attack – web application attack Access control - Audit – Authentication - Biometrics - Denial of Service Filters - Ethical Hacking -Firewalls - Scanning, Security policy, Threat Management - Applying software update and patches- Intrusion Detection Systems -Virtual Private Networks –Cryptographic Techniques.

UNIT III SECURING THE INFRASTRUCTURE

9

Infrastructure Security in the Real World - Understanding Access -Control and Monitoring Systems Understanding Video Surveillance Systems - Understanding Intrusion - Detection and Reporting Systems.

UNIT IV SECURING LOCAL HOSTS AND NETWORKS

9

Local Host Security in the Real World - Securing Devices - Protecting the Inner Perimeter Protecting Remote Access Local Network Security in the Real World -

Networking Basics –Understanding Networking Protocols - Understanding Network Servers
- Understanding Network Connectivity Devices - Understanding Network Transmission
Media Security.

UNIT V TOOLS

9

Zenmap – Hydra –Kismet – John the Ripper – Airedddon – Deauther Board – Aircrack-ng –
EvilOSX

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Analyze and evaluate the cyber security needs of an organization.

CO2: Analyze the security issues in networks and computer systems to secure an
infrastructure.

CO3: Design operational cyber security strategies and policies.

CO4: Understand the functionality of cyber security tools.

CO5: Critical thinking and problem-solving skills to detect current and future attacks on an
organization's computer systems and networks.

TEXT BOOKS

1. Network Protocols for Security Professionals Paperback – Import, 26 October 2022
by Yoram Orzach (Author, Contributor), Packet Publishing (26 October 2022)
2. INTRODUCTION TO CYBER SECURITY Paperback – 25 April 2024 by Ajay
Singh (Author), Universities Press (25 April 2024).
3. Cyber Security for Beginners Lucas Glisson: Comprehensive and Essential Guide
for Newbies to Understand and Master Cybersecurity (2022 Crash Course).

REFERENCES

1. William Stallings, Effective Cybersecurity: A Guide to Using Best Practices and
Standards, 1st edition, 2019.
2. Charles J. Brooks, Christopher Grow, Philip A. Craig, Donald Short, Cybersecurity
Essentials, Wiley Publisher, 2018.
3. Yuri Diogenes, ErdalOzkaya, Cyber security - Attack and Defense Strategies, Packt
Publishers, 2018.
4. Carol C. Woody, Nancy R. Mead, Cyber Security Engineering: A Practical
Approach for Systems and Software Assurance, Addison-Wesley, 2016.
5. Thomas A. Johnson Cyber Security- Protecting Critical Infrastructures from Cyber
Attack and Cyber Warfare, CRC Press, 2015.

Mapping of COs and Pos

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	1	1	2	1
CO2	2	1	3	1	1	2
CO3	-	-	2	3	3	3
CO4	2	2	1	2	1	3
CO5	1	-	1	1	2	3
AVG	1.5	1	1.6	1.6	1.8	2.4

1 - Low, 2 - Medium, 3 – High, '-' – No correlation

24RE3201

RESEARCH ARTICLE REVIEW

**L T P C
0 0 4 2**

COURSE OBJECTIVES

- To gain knowledge on collecting the research articles.
- To read and understand the various literatures related to the research.
- To write the review article for publication.

STAGES OF REVIEW

- Stage-1: Collection of latest Research articles.
- Stage-2: Read the entire article and take a note in his/her own words.
- Stage-3: Summarize the literature in his/her own words.
- Stage-4: Classify and arrange the literatures with template.
- Stage-5: Preparation of review article.
- Stage-6: Plagiarism checked by the department and it must be less than 10%.
- Stage-7: Article must be communicated to the journal.

The students must do the above work individually by the guidance of faculty members and one coordinator is required to monitor the work progress. The evaluation will be done based on the following

- | | |
|---------------------------------|-----|
| a) Review of work after stage 3 | 10% |
| b) Review of work after stage 5 | 20% |
| c) Review of work after stage 7 | 20% |
| d) Final examination | 50% |

TOTAL: 60 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Understand the technique to collect the literatures from various resources.

CO2: Apply the knowledge for collecting the required research data from the articles.

CO3: Formulate the research problem.

CO4: Analyze the research gap from various researchers work.

CO5: Create the new article to publish in the research journals.

Mapping of COs and Pos

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	-	-	2	-
CO2	2	2	-	-	-	-
CO3	2	2	-	-	-	-
CO4	2	2	-	-	2	-
CO5	2	2	-	-	2	-
AVG	2	2	-	-	2	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24CT2301

DIGITAL IMAGE AND VIDEO PROCESSING

L T P C
3 0 0 3

COURSE OBJECTIVES

- Provide the student with the fundamentals of digital image processing.
- Introduce the students to some advanced topics in digital image processing.
- Give the students a useful skill base that would allow them to carry out further study should they be interested and to work in the field.

UNIT I FUNDAMENTALS OF IMAGE PROCESSING

9

Introduction – Elements of visual perception, Steps in Image Processing Systems – Digital Imaging System – Image Acquisition – Sampling and Quantization – Pixel Relationships – File Formats color images and models – Image Operations.

UNIT II IMAGE ENHANCEMENT AND RESTORATION

9

Image Transforms – Enhancement in the Spatial Domain – Enhancement in the Frequency Domain Image restoration.

UNIT III IMAGE SEGMENTATION AND MORPHOLOGY

9

Detection of Discontinuities–Edge operators- Edge Linking and Boundary Detection – Thresholding –Region Based Segmentation – Motion Segmentation - Binary and Gray level morphology Operations – Erosion, Dilation, Opening and Closing Operations Distance Transforms - Basic Morphological Algorithms. Features – Textures – Boundary representations and Descriptions - Component Labeling – Regional Descriptors and Feature Selection Techniques.

UNIT IV BASICS OF VIDEO PROCESSING

9

Introduction – Video Sampling and Interpolation- Motion Detection and Estimation – Video Enhancement and Restoration.

UNIT V VIDEO SEGMENTATION, TRACKING &APPLICATIONS

9

Video Segmentation- Motion Segmentation- Motion Tracking in Video-Video Quality Assessment- Case Studies –Image processing in Biometrics, Image Security, Steganography and Watermarking, Stereo vision, Object Segmentation and Tracking in the Presence of Complex Background in video, Forensic video analysis.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Have a clear impression of the breadth and practical scope of digital image processing and have arrived at a level of understanding that it is the foundation for most of the work currently underway in this field.
- CO2: Critically analyze the role of video in modern technologies.
- CO3: Implement basic image and video processing algorithms.
- CO4: Design and develop various applications that incorporate different techniques of Image and Video processing.
- CO5: Apply and explore new techniques in the areas of Image and Video Processing.

TEXT BOOKS

1. Rafael C.Gonzalez and Richard E.Woods, “Digital Image Processing”, Third Edition, Pearson Education, New Delhi, 2008.
2. Al Bovik (Alan C Bovik, “The Essential Guide to Video Processing”, Academic Press, Second Edition, 2009.
3. S. Sridhar, “Digital Image Processing”, Oxford University Press, New Delhi, 2011.

REFERENCE BOOKS

1. Murat Tekalp, “Digital Video Processing”, Prentice Hall, 2015.
2. Oges Marques, “Practical Image and Video Processing Using MATLAB”, Wiley-IEEE Press, 2011.
3. Handbook of Image and Video Processing A volume in Communications, Networking and Multimedia Book • Second Edition • 2005.
4. Digital Video Processing, Second Edition by A. Murat Tekalp Released June Publisher(s): Pearson ISBN: 9780133991116.

5. Digital Image and Video Processing for GTU B.E. E &TC Engineering Sem Paperback – 2 October 2023 by Dhananjay K. Theckedath (Author).

Mapping of COs and Pos

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	1	1	2	1
CO2	2	1	3	1	1	2
CO3	-	-	2	3	3	3
CO4	2	2	1	2	1	3
CO5	1	-	1	1	2	3
AVG	1.5	1.6	1.6	1.6	1.6	2.4

1 - Low, 2 - Medium, 3 – High, '-' - No correlation

24CT2303

HUMAN COMPUTER INTERACTION-

L T P C
3 0 0 3

COURSE OBJECTIVES

- To learn the foundations of Human Computer Interaction
- Understanding Interaction Styles and to become familiar with the design technologies for individuals and persons with disabilities.
- To understand the process of Evaluation of Interaction Design.

UNIT I FOUNDATIONS OF HCI

9

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

UNIT II INTERACTION STYLES

9

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

UNIT III EVALUATION OF INTERACTION

9

Evaluation Techniques- assessing user experience- usability testing – Heuristic evaluation and walkthroughs, analytics predictive models. Cognitive models, Socio-organizational issues and stakeholder requirements, Communication and collaboration models.

UNIT IV MODELS AND THEORIES-

9

Task analysis, dialog notations and design, Models of the system, Modeling rich interaction, Ubiquitous computing.

UNIT V WEB AND MOBILE INTERACTION

9

Hypertext, Multimedia and WWW, Designing for the web Direct Selection, Contextual Tools, Overlays, Inlays and Virtual Pages, Process Flow. Use Transitions-Lookup Patterns-Feedback patterns Mobile apps, Mobile navigation, content and control idioms, multi-touch gestures, Inter- app integration, Mobile web.

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Understand the basics of human computer interactions via usability engineering and cognitive modeling.
- CO2: Understand the basic design paradigms, complex interaction styles.
- CO3: Understand the models and theories for user interaction.
- CO4: Examine the evaluation of interaction designs and implementations.
- CO5: Elaborate the above issues for web and mobile applications.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Ben Shneiderman, Catherine Plaisant, Maxine Cohen, Steven Jacobs, NiklasElmqvist, “Designing the User Interface: Strategies for Effective Human-Computer Interaction”, Sixth Edition, Pearson Education, 2016.
2. Alan Dix, Janet Finlay, G D Abowd and Russel Beale, "Human Computer Interaction", Pearson Education, Third Edition, 2004.
3. Helen Sharp Jennifer Preece Yvonne Rogers, “Interaction Design: Beyond Human- Computer Interaction”, Wiley, 5th Edition, 2019.

REFERENCE BOOKS

1. Alan Cooper, Robert Reimann, David Cronin, Christopher Noessel, “About Face: The Essentials of Interaction Design”, 4th Edition, Wiley, 2014.
2. Donald A. Norman, “Design of Everyday Things”, MIT Press, 2013.
3. Wilbert O Galitz, "The Essential Guide to User Interface Design", Third Edition, Wiley India Pvt., Ltd., 2007.
4. B. Shackel, editors, Human-Computer Interaction - Proceedings INTERACT'90, pages 143-146. North-Holland, Amsterdam, 1990.
5. L. Allinson and N. Hammond. A learning support environment: the hitch-hiker's guide. In R. McAleese, editor, Hypertext: Theory into Practice. Intellect, 1993.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	1	-	1	2	2	1
CO3	2	3	2	2	-	1
CO4	2	3	1	2	-	2
CO5	2	2	3	3	3	3
AVG	2	2.7	2	2.4	1.6	2

1 - Low, 2 - Medium, 3 – High, '-' - No Correlation

24CT2303

BIG DATA MINING AND ANALYTICS

L T P C
3 0 0 3

COURSE OBJECTIVES

- To understand the computational approaches to Modeling, Feature Extraction.
- To understand the need and application of Map Reduce.
- To understand the various search algorithms applicable to Big Data.

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 FREQUENT ITEMSETS

9

Page Rank –Efficient Computation - Topic Sensitive Page Rank – Link Spam – Market Basket Model – A-priori algorithm – Handling Larger Datasets in Main Memory – Limited Pass Algorithm – Counting Frequent Item sets.

UNIT V CLUSTERING

9

Introduction to Clustering Techniques – Hierarchical Clustering – Algorithms – K-Means – CURE – Clustering in Non – Euclidean Spaces – Streams and Parallelism – Case Study: Advertising on the Web – Recommendation Systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Design algorithms by employing Map Reduce technique for solving Big Data problems.
- CO2: Design algorithms for Big Data by deciding on the apt Features set.
- CO3: Design algorithms for handling petabytes of datasets.
- CO4: Design algorithms and propose solutions for Big Data by optimizing main memory Consumption.
- CO5: Design solutions for problems in Big Data by suggesting appropriate clustering techniques.

TEXT BOOKS

1. Jure Leskovec, AnandRajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 3rd Edition, 2020.
2. Jiawei Han, MichelineKamber, 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.

REFERENCE BOOKS

1. Michael Minelli, Michelle Chambers, and AmbigaDhiraj, “Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today’s Businesses”, Wiley, 2013.
2. Eric Sammer, “Hadoop Operations”, O’Reilly, 2012.
3. Sadalage, Pramod J. “NoSQL distilled”, 2013.
4. David Hand, HeikkiMannila and Padhraic Smyth, “Principles of Data Mining”, MIT PRESS, 2001.
5. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/106104189/lec1.pdf.

Mapping of COs and Pos

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	-	2	3	3
CO2	-	-	-	-	2	2
CO3	-	-	-	2	3	3
CO4	1	-	2	2	3	3
CO5	2	3	2	2	3	3
AVG	1	3	2	2	2.8	2.8

1 - Low, 2 - Medium, 3 – High, '-' - No Correlation

24CT2304

NATURAL LANGUAGE PROCESSING

L T P C

3 0 0 3

COURSE OBJECTIVES

- To understand basics of linguistics, probability and statistics.
- To study statistical approaches to NLP and understand sequence labeling.
- To outline different parsing techniques associated with NLP.

UNIT I INTRODUCTION

Natural Language Processing – Components - Basics of Linguistics and Probability and Statistics – Words-Tokenization-Morphology-Finite State Automata. **9**

UNIT II STATISTICAL NLP AND SEQUENCE LABELING

N-grams and Language models –Smoothing -Text classification- Naïve Bayes classifier – Evaluation - Vector Semantics – TF-IDF - Word2Vec- Evaluating Vector Models -Sequence Labeling – Part of Speech – Part of Speech Tagging -Named Entities –Named Entity Tagging. **9**

UNIT III CONTEXTUAL EMBEDDING

Constituency –Context Free Grammar –Lexicalized Grammars- CKY Parsing – Earley's Algorithm-Evaluating Parsers -Partial Parsing – Dependency Relations- Dependency Parsing - Transition Based - Graph Based. **9**

UNIT IV COMPUTATIONAL SEMANTICS

Word Senses and WordNet – Word Sense Disambiguation – Semantic Role Labeling – Proposition Bank- Frame Net- Selection Restrictions - Information Extraction - Template Filling. **9**

UNIT V DISCOURSE ANALYSIS AND SPEECH PROCESSING

Discourse Coherence – Discourse Structure Parsing – Centering and Entity Based Coherence – **9**

Question Answering –Factoid Question Answering – Classical QA Models – Chatbots and Dialogue systems – Frame-based Dialogue Systems – Dialogue–State Architecture

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Understand basics of linguistics, probability and statistics associated with NLP.
- CO2: Implement a Part-of-Speech Tagger.
- CO3: Design and implement a sequence labeling problem for a given domain.
- CO4: Implement semantic processing tasks and simple document indexing and searching system using the concepts of NLP.
- CO5: Implement a simple chatbot using dialogue system concepts.

TEXT BOOKS

1. Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition 2/e Paperback – 1 January 2013 by Jurafsky / Martin (Author).
2. Handbook Of Natural Language Processing Second Edition, Ralf herbrich and thore graepel, Microsoft research ltd, Cambridge.
3. 5 Free Books on Natural Language Processing to Read in 2023 By Nisha Arya, Contributing Editors & Marketing and Client Success Manager on June 29, 2023 in Natural Language Processing.

REFERENCE BOOKS

1. Building Natural Language Generation Systems (Studies in Natural Language Processing) Paperback – 9 March 2006 by Ehud Reiter (Author), Robert Dale (Author).
2. Natural Language Processing in Artificial Intelligence Hardcover – Import, 2 November 2020 by Brojo Kishore Mishra (Editor), Raghvendra Kumar (Editor) , Apple Academic Press; 1st edition.
3. Natural Language Processing with Transformers: Building Language Applications with Hugging Face, Revised Colour Edition Paperback – 27 June 2022 by Lewis Tunstall (Author), Leondro von Werra (Author), Thomas Wolf (Author) Shroff/O'Reilly; First Edition (27 June 2022); Shroff Publishers & Distributors Pvt. Ltd..

Mapping of COs and Pos

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	2	3	1	1	-
CO2	2	2	2	3	-	3
CO3	3	-	3	3	-	3
CO4	1	-	2	3	-	3
CO5	1	-	2	3	-	3
AVG	1.7	2	2.4	2.6	1	3

1 - Low, 2 - Medium, 3 – High, ‘-’ - No Correlation

24CT2305

COMPILER OPTIMIZATION TECHNIQUES

L T P C

3 0 0 3

COURSE OBJECTIVES

- To understand the optimization techniques used in compiler design.
- To be aware of the various computer architectures that support parallelism.
- To become familiar with the theoretical background needed for code optimization.

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

UNIT V INTERPROCEDURAL ANALYSIS

9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Design and implement techniques used for optimization by a compiler.

CO2: Modify the existing architecture that supports parallelism.

CO3: Modify the existing data structures of an open-source optimizing compiler.

CO4: Design and implement new data structures and algorithms for code optimization.

CO5: Critically analysis different data structures and algorithms used in the building of an optimizing compiler.

TEXT BOOKS

1. Alfred V. Aho, Monica S.Lam, Ravi Sethi, Jeffrey D.Ullman, “Compilers: Principles, Techniques and Tools”, Second Edition, Pearson Education,2008.
2. Randy Allen, Ken Kennedy, “Optimizing Compilers for Modern Architectures: A Dependence-based Approach”, Morgan Kaufmann Publishers, 2002.
3. Steven S. Muchnick, “Advanced Compiler Design and Implementation”, Morgan Kaufmann Publishers - Elsevier Science, India, 2007.

REFERENCE BOOKS

1. John Hopcroft, Rajeev Motwani, Jeffrey Ullman, “Introduction to Automata Theory Languages, and Computation”, Third Edition, Pearson Education, 2007.
2. Torbengidius Mogensen, “Basics of Compiler Design”, Springer, 2011.
3. Aho, A., Lam, M., Sethi, R., Ullman, J., Compilers: Principles, Techniques, & Tools, Addison Wesley, 2007.
4. Y. N. Srikant, Priti Shankar, The Compiler Design Handbook: Optimizations and Machine Code Generation, CRC Press, 2008
5. Randy Allen, Ken Kennedy, Optimizing Compilers for Modern Architectures: A Dependence-based Approach, Morgan Kaufmann, 2001.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	3	2	2
CO2	-	-	3	3	-	3
CO3	3	-	3	3	-	3
CO4	3	3	3	3	-	-
CO5	-	3	3	3	3	-
AVG	2.6	2.6	2.8	3	2.5	1.6

1 - Low, 2 - Medium, 3 – High, '-' - No Correlation

24CT2306

MULTIMEDIA SYSTEMS AND APPLICATIONS

**L T P C
3 0 0 3**

COURSE OBJECTIVES

- Understanding the role of World Wide Web.
- Study the Structuring Information in a Multimedia Form.
- Know about Multimedia Systems and Application.

UNIT I MULTIMEDIA ELEMENTS

9

Principles – Cognition, Learning, Interaction, Medium of Consumption: Elements - Text – characteristics, standards, formats; Graphics – representation, file formats, Image / Graphics – file formats, standards; Digital Audio – Characteristics, formats, standards, Speech, Video – characteristics, formats; Animation – characteristics, formats; Multidimensional Data Structures, k- d trees, Quad Trees, R-trees.

UNIT II MULTIMEDIA TOOLS and AUTHORING

9

Hardware – Display Devices, wearables, Graphics cards, I/O devices, software – Editing tools For Text, Image, Audio, Video and animation. Authoring tools, Authoring Multimedia presentations, Authoring Metaphors.

UNIT III MULTIMEDIA COMPRESSION

9

Symmetric and Asymmetric methods, Lossy and Lossless Compression, Text compression – RLE, Huffman, Arithmetic, Dictionary based; Document Image compression standards – CCITT and Color Image Compression – JPEG, Audio Compression – PCM, ADPCM, MPEG, AAC, AC3, speech compression; Video Compression-MPEG-4, H.265, DVI.

UNIT IV MULTIMEDIA COMMUNICATION SYSTEMS

9

Multimedia Communication Standards, Transport Protocols, streaming protocols, Internet Protocols Wireless multimedia communications, synchronization and QOS, security, Entertainment networks, Collaborative multimedia support, Real-time distributed multimedia networks, Hypertext, Hypermedia.

UNIT V MULTIMEDIA APPLICATIONS

9

Applications for WWW - Multimedia databases—Indexing and Retrieval, Visualization, Virtual, Augmented and Mixed Reality, Interactive E-learning, HCI and UX design, Games and Animation, Real-Time video conferencing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Handle the multimedia elements effectively

CO2: Use Multimedia Hardware and Software for Editing and Authoring multimedia applications.

CO3: Implement Compression algorithms for various multimedia applications.

CO4: Develop effective strategies to deliver Quality-of-Experience in networked Multimedia applications.

CO5: Design and develop multimedia applications in various domains.

TEXT BOOKS

1. Ze-Nian Li, Mark S. Drew, Jiangchuan Liu, “Fundamentals of Multimedia”, Second Edition, Springer Nature (Texts in Computer Science), 2014.
2. Prabhat K. Andleigh, Kiran Thakrar, “Multimedia Systems Design”, Pearson Education India, 1st Edition, 2015.
3. Ralf Steinmetz and KlaraNahrstedt, “Multimedia computing, communications, and applications”, Pearson India, Pearson, 2002.

REFERENCE BOOKS

1. FredHalsall, “Multimedia Communications: Applications, Networks, Protocols and Standards”, Pearson Education, 2002.
2. Khalid Sayood, “Introduction to Data Compression”, 4th Edition, Morgan Kauffman, 2012.
3. K.R. Rao, Zoran S. Bojkovic, Bojan M. Bakmaz, “Wireless Multimedia Communication systems: Design, Analysis and Implementation”, CRC press, 2017.
4. V.S. Subrahmanian, “Principles of Multimedia Database Systems”, Elsevier / Morgan Kauffmann, 2008.
5. Kiran Thakrar, Prabhat k.andleigh, “Multimedia System Design”, Prentice Hall India.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	-	-
CO2	2	1	3	2	-	-
CO3	1	1	3	2	-	-
CO4	3	1	3	3	-	-
CO5	1	1	3	1	-	1
AVG	2		3	2	-	1

0 - Low, 2 - Medium, 3 – High, '-' - No Correlation

24CT2307

BLOCKCHAIN TECHNOLOGIES

L T P C
3 0 0 3

COURSE OBJECTIVES

- Explain the objectives of Cryptography.
- To Introduce block chain technology and Crypto currency.
- Explain the importance and application of Bitcoin 2.0 protocols, smart tracts.

UNIT I INTRODUCTION

9

Blockchain Overview-History and Origin of Blockchain - Technical Concepts of Blockchain Systems: Physical Ledger Technology and Security - Digital Ledger Technology, Digital Security Technology: Cryptographic Hash Functions - Digital Signatures.

UNIT II FOUNDATIONS

9

Centralization vs. Decentralization of Blockchain - Distributed Ledger Technology (DLT) Technical Concepts: Mining - Distributed Consensus- Incentives - Proof of Work - Cryptosystems in practice- Distributed Networks – Attacks - Consensus Protocols.

UNIT III WEB3 AND HYPERLEDGER

9

Web 3 Contract deployment – POST requests – Frontend – Development framework – Hyperledger Projects – Protocol – Reference architecture – Hyperledger Fabric – Corda.

UNIT IV SMART CONTRACTS & ETHEREUM

9

Smart Contracts – Definition – Ricardian contracts - Ethereum blockchain –Ethereum network – Components of Ethereum ecosystem –Programming languages - Ethereum development environment - Non-Fungible Token (NFT).

UNIT V ALTERNATIVE BLOCKCHAINS AND APPLICATIONS

9

Alternative blockchains – Applications, Internet of Things, Government, Health, Finance – Scalability -Privacy.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Explain cryptocurrencies and their relationship with the blockchain technology.

CO2: Explain the different steps in the use of Bitcoins.

CO3: Relate Web 3 and Hyperledger to concepts in blockchain technologies.

CO4: Apply blockchains to different real-life problems.

CO5: Implement a simple application using Ethereum.

TEXT BOOKS

1. Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained”, Second Edition, Packt Publishing, 2018.
2. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, “Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction” Princeton University Press, 2016.
3. Alex Leverington, “Ethereum Programming” Packt Publishing Limited, 2017.

REFERENCE BOOKS

1. Andreas Antonopoulos, Satoshi Nakamoto, “Mastering Bitcoin”, O’Reilly Publishing, 2014.
2. Roger Wattenhofer, “The Science of the Blockchain” Create Space Independent Publishing Platform, 2016.
3. Arshdeep Bahga and Vijay Madisetti, “Blockchain Applications: A Hands- On Approach”, 2017.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	2	2	3
CO2	2	1	2	3	2	2
CO3	2	1	3	1	2	1
CO4	2	1	2	3	2	2
CO5	-	-	-	-	-	-
AVG	2	1	2.5	2.25	2	2

1 - Low, 2 - Medium, 3 – High, ‘-’ - No Correlation

COURSE OBJECTIVES

- Develop Type Script Application.
- Develop Single Page Application (SPA).
- Able to communicate with a server over the HTTP protocol.

UNIT I FUNDAMENTALS & TYPESCRIPT LANGUAGE**9**

Server-Side Web Applications. Client-Side Web Applications. Single Page Application. About TypeScript. 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**

About Angular. Angular CLI. Creating an Angular Project. Components. Components Interaction. Dynamic Components. Angular Elements. Angular Forms. Template Driven Forms. Property, Style, Class and Event Binding. Two-way Bindings. Reactive Forms. Form Group. Form Controls. About Angular Router. Router Configuration. Router State. Navigation Pages. Router Link. Query Parameters. URL matching. Matching Strategies. Services. Dependency Injection. HttpClient. Read Data from the Server. CRUD Operations. Http Header Operations. Intercepting requests and responses.

UNIT III NODE.js**9**

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

UNIT IV EXPRESS.Js**9**

Express.js. How Express.js Works. 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**

Introduction to MongoDB. Documents. Collections. Subcollections. 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:45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Develop basic programming skills using JavaScript.
- CO2: Implement a front-end web application using Angular.
- CO3: Will be able to create modules to organize the server.
- CO4: Build RESTful APIs with Node, Express and MongoDB with confidence.
- CO5: Will learn to Store complex, relational data in MongoDB using Mongoose.

TEXT BOOKS

1. Adam Freeman, Essential TypeScript, Apress, 2019.
2. Mark Clow, Angular Projects, Apress, 2018.
3. Alex R. Young, Marc Harter, Node.js in Practice, Manning Publication, 2014.

REFERENCE BOOKS

1. Full Stack Development with Angular and Spring Boot: Build scalable, responsive. dynamic enterprise-level web applications (English Edition) Paperback – 16 August 2024 by Sangeeta Joshi (Author).
2. Full-Stack Web Development with Jakarta EE and Vue.js: Your One-Stop Guide to Building Modern Full-Stack Applications with Jakarta EE and Vue.js Paperback – Import, 11 December 2020 by Daniel Andres Pelaez Lopez (Author).
3. Full Stack Web Development Paperback – 29 April 2024 by Yerragudipadu Subbarayudu (Author), Suresh Kumar Kanaparathi (Author) .
4. Pro Express.js, Azat Mardan, Apress, 2015.
5. MongoDB in Action, Kyle Banker, Peter Bakkum, Shaun Verch, Douglas Garrett, Tim Hawkins, Manning Publication, Second edition, 2016.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	1	-	1	-
CO2	3	1	1	1	-	1
CO3	2	2	3	1	-	2
CO4	3	1	1	-	-	1
CO5	3	1	1	1	1	1
AVG	2.8	1.2	1.4	1	1	1.25

1 - Low, 2 - Medium, 3 – High, '-' - No Correlation

COURSE OBJECTIVES

- To learn the basics of Web service.
- To become familiar with the Web Services building blocks.
- To learn to work with RESTful web services.

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.

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: 45 PERIODS**COURSE OUTCOMES**

On successful completion of this course, the student will be able to

- CO1: Explain how to write XML documents.
- CO2: Apply the web service building blocks such as SOAP, WSDL and UDDI.
- CO3: Describe the REST ful web services.
- CO4: Implement the RESTful web service with Spring Boot MVC.
- CO5: Discuss Resource-oriented Architecture.

TEXT BOOKS

1. Leonard Richardson and Sam Ruby, RESTful Web Services, O'Reilly Media, 2007
2. McGovern, et al., "Java Web Services Architecture", Morgan Kaufmann Publishers, 2005.
3. Lindsay Bassett, Introduction to JavaScript Object Notation, O'Reilly Media, 2015.

REFERENCE BOOKS

1. Craig Walls, "Spring in Action, Fifth Edition", Manning Publications, 2018
2. Raja CSP Raman, Ludovic Dewailly, "Building A RESTful Web Service with Spring 5", Packt Publishing, 2018.
3. Bogunova 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.
4. 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.
5. XML, Web Services, and the Data Revolution, F.P.Coyle, Pearson Education.

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	2	2	3
CO2	2	1	2	3	2	2
CO3	2	1	3	1		1
CO4	2	1	2	3	2	2
CO5	-	-	-	-	-	-
AVG	2	1	2.5	2.25	2	2

1 - Low, 2 - Medium, 3 – High, '-' - No Correlation

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QUANTUM COMPUTING

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3 0 0 3

COURSE OBJECTIVES

- To introduce the building blocks of Quantum computers and highlight.
- The paradigm changes between conventional computing and quantum computing.
- To understand the Quantum state transformations and the algorithms.

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**

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

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Understand the basic principles of quantum computing.

CO2: Gain knowledge of the fundamental differences between conventional computing and quantum computing.

CO3: Understand several basic quantum computing algorithms.

CO4: Understand the classes of problems that can be expected to be solved well by quantum computers.

CO5: Simulate and analyze the characteristics of Quantum Computing Systems.

TEXT 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.

REFERENCE BOOKS

1. Eleanor Rieffel and Wolfgang Polak, QUANTUM COMPUTING A Gentle Introduction, 2011.
2. Nielsen M. A., Quantum Computation and Quantum Information, Cambridge University Press.2002.
3. 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.
4. Pittenger A. O., An Introduction to Quantum Computing Algorithms 2000
5. Eric R. Johnston, Nic Harrigan, Mercedes Gimeno-Segovia : Programming Quantum Computers. 2019.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	3	-	1	-
CO2	1	2	3	-	2	-
CO3	-	1	3	2	3	2
CO4	2	-	2	2	1	3
CO5	3	-	1	2	3	3
AVG	1.7	1.6	2.4	2	2	2.6

1 - Low, 2 - Medium, 3 – High, ‘-’ - No Correlation

