S.A ENGINEERING COLLEGE, CHENNAI – 77
(An Autonomous Institution Affiliated to Anna University)
M.E COMPUTER SCIENCE AND ENGINEERING
REGULATION-2023
CHOICE BASED CREDIT SYSTEM

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

1. Develop proficiency as a computer science engineer with an ability to solve a wide range of computational problems and have sustainable development in industry or any other work environment.
2. Analyze and adapt quickly to new environments and technologies, gather new information, and work on emerging technologies to solve multidisciplinary engineering problems.
3. Possess the ability to think analytically and logically to understand technical problems with computational systems for a lifelong learning which leads to pursuing research.
4. Adopt ethical practices to collaborate with team members and team leaders to build technology with cutting-edge technical solutions for computing systems
5. Strongly focus on design thinking and critical analysis to create innovative products and become entrepreneurs.

PROGRAM OUTCOMES (POs):

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.

S.A ENGINEERING COLLEGE, CHENNAI – 77
(An Autonomous Institution Affiliated to Anna University)
M.E COMPUTER SCIENCE AND ENGINEERING
REGULATION-2023
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA AND SYLLABI
SEMESTER – I

S.NO	SUBJECT CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY:								
1.	MA4101	Mathematical Foundation of Computer Science	FC	4	3	1	0	4
2.	RM4101	Research Methodologies and IPR	RMC	3	3	0	0	3
3.	CS4101	Advanced Data Structures and Algorithms	PCC	3	3	0	0	3
4.	CS4102	Advanced Database Systems(Lab Integrated)	PCC	5	3	0	2	4
5.	CS4103	Network Technologies	PCC	3	3	0	0	3
6.	CS4104	High Performance Computing	PCC	3	3	0	0	3
		Audit Course-I	AC	2	2	0	0	0
PRACTICALS:								
7.	CS4105	Advanced Data Structures and Algorithms Laboratory	PCC	4	0	0	4	2
			TOTAL	28	20	1	6	22

SEMESTER – II

S.NO	SUBJECT CODE	COURSE TITLE	CATEG ORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	CS4201	Internet of Things (Lab Integrated)	PCC	5	3	0	2	4
2.	CS4202	Advanced Operating Systems (Lab Integrated)	PCC	5	3	0	2	4
3.	CS4203	Machine Learning (Lab Integrated)	PCC	5	3	0	2	4
4.	CS4204	Advanced Software Engineering	PCC	3	3	0	0	3
5.		Professional Elective-I	PEC	3	3	0	0	3
6.		Professional Elective-II	PEC	3	3	0	0	3
7.		Audit Course II	AC	2	2	0	0	0
PRACTICALS								
8.	CS4205	Term Paper Writing and Seminar	EEC	2	0	0	2	1
			TOTAL	28	20	0	8	22

SEMESTER-III

S.NO	SUBJECT CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	CS4301	Security Practices	PCC	3	3	0	0	3
2.		Professional Elective-III	PEC	3	3	0	0	3
3.		Professional Elective-IV	PEC	5	3	0	2	4
4.		Open Elective	OEC	3	3	0	0	3
PRACTICALS								
5.	CS4302	Project Work-I	EEC	12	0	0	12	6
			TOTAL	26	12	0	14	19

SEMESTER-IV

S.NO	SUBJECT CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICALS								
1.	CS4401	Project Work-II	EEC	24	0	0	24	12
			TOTAL	24	0	0	24	12

TOTAL NO. OF CREDITS: 75

PROFESSIONAL ELECTIVES SEMESTER-II,
ELECTIVE-I

S.NO	SUBJECT CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	CS4206	Human Computer Interaction	PEC	3	3	0	0	3
2.	CS4207	Cloud Computing Technologies	PEC	3	3	0	0	3
3.	CS4208	Foundations of Data Science	PEC	3	3	0	0	3
4.	CS4209	Wireless Communications	PEC	3	3	0	0	3
5.	CS4210	Agile Methodologies	PEC	3	3	0	0	3
6.	CS4211	Performance Analysis of Computer Systems	PEC	3	3	0	0	3
7.	CS4212	Multicore Architecture and Programming	PEC	3	3	0	0	3
8.	CS4213	Digital Image Processing	PEC	3	3	0	0	3

SEMESTER-II,
ELECTIVE-II

S.NO	SUBJECT CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	CS4214	High Performance Computing for Big Data	PEC	3	0	0	3	3
2.	CS4215	Information Retrieval Techniques	PEC	3	0	0	3	3
3.	CS4216	Software Quality Assurance	PEC	3	0	0	3	3
4.	CS4217	Autonomous Systems	PEC	3	0	0	3	3
5.	CS4218	Web Analytics	PEC	3	0	0	3	3
6.	CS4219	Cognitive Computing	PEC	3	0	0	3	3
7.	CS4220	Compiler Optimization Techniques	PEC	3	0	0	3	3
8.	CS4221	Big Data Mining and Analytics	PEC	3	0	0	3	3

SEMESTER-III,
ELECTIVE-III

S.NO	SUBJECT CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	CS4303	Mobile and Pervasive Computing	PEC	3	3	0	0	3
2.	CS4304	Web Services and API Design	PEC	3	3	0	0	3
3.	CS4305	Data Visualization Techniques	PEC	3	3	0	0	3
4.	CS4306	Quantum Computing	PEC	3	3	0	0	3
5.	CS4307	Formal Models of Software Systems	PEC	3	3	0	0	3
6.	CS4308	Robotics	PEC	3	3	0	0	3
7.	CS4309	Natural Language Processing	PEC	3	3	0	0	3
8.	CS4310	GPU Computing	PEC	3	3	0	0	3

SEMESTER-III,
ELECTIVE-IV

S.NO	SUBJECT CODE	COURSE TITLE	CATEGO RY	CONTACT PERIODS	L	T	P	C
1.	CS4311	Devops and Microservices(Lab Integrated)	PEC	5	3	0	2	4
2.	CS4312	Mobile Application Development(Lab Integrated)	PEC	5	3	0	2	4
3.	CS4313	Deep Learning(Lab Integrated)	PEC	5	3	0	2	4
4.	CS4314	Blockchain Technologies	PEC	5	3	0	2	4
5.	CS4315	Embedded Software Development(Lab Integrated)	PEC	5	3	0	2	4
6.	CS4316	Full Stack Web Application Development(Lab Integrated)	PEC	5	3	0	2	4
7.	CS4317	Bioinformatics	PEC	5	3	0	2	4
8.	CS4318	Cyber Physical Systems(Lab Integrated)	PEC	5	3	0	2	4
9.	CS4319	Mixed Reality(Lab Integrated)	PEC	5	3	0	2	4

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	AC4001	English for Research Paper Writing	2	0	0	0
2.	AC4002	Disaster Management	2	0	0	0
3.	AC4003	Constitution of India	2	0	0	0
4.	AC4004	நற்றமிழ் இலக்கியம்	2	0	0	0

LIST OF SELF LEARNING COURSES FOR PG PROGRAMMES

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	SS4211	Software Defined Networks	3	0	0	3
2.	SS4212	Software Security	3	0	0	3
3.	SS4213	Software Reliability Metrics and Models	3	0	0	3
4.	SS4214	Social Network Analysis	3	0	0	3
5.	SS4215	Semantic Web	3	0	0	3

LIST OF OPEN ELECTIVES FOR PG PROGRAMMES

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	OC4301	Machine Learning and Deep Learning	3	0	0	3
2.	OC4302	Big Data Analytics	3	0	0	3

FOUNDATION COURSES (FC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEM
			Lecture	Tutorial	Practical		
1.	MA4101	Mathematical Foundations of Computer Science	3	1	0	4	1

PROFESSIONAL CORE COURSES (PCC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEM
			Lecture	Tutorial	Practical		
1.	CS4101	Advanced Data Structuresand Algorithms	3	0	0	3	I
2.	CS4102	Advanced Database Systems	3	0	2	4	I
3.	CS4103	Network Technologies	3	0	0	3	I
4.	CS4104	High Performance Computing	3	0	0	3	I
5.	CS4105	Advanced Data Structuresand Algorithms Laboratory	0	0	4	2	I
6.	CS4201	Internet of Things	3	0	2	4	II
7.	CS4202	Advanced Operating Systems	3	0	2	4	II
8.	CS4203	Machine Learning	3	0	2	4	II
9.	CS4204	Advanced Software Engineering	3	0	0	3	II
11.	CS4301	Security Practices	3	0	0	3	III

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEM
			Lecture	Tutorial	Practical		
1.	RM4101	Research Methodologies and IPR	3	0	0	3	I

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	CS4205	Term Paper writing and Seminar	0	0	2	1	2
2.	CS4302	Project Work I	0	0	12	6	3
3.	CS4401	Project Work II	0	0	24	12	4

SUMMARY

Sl. No.	NAME OF THE PROGRAMME: M.E COMPUTER SCIENCE AND ENGINEERING					
	SUBJECT AREA	CREDITS PER SEMESTER				CREDITS TOTAL
		I	II	III	IV	
1.	FC	04	00	00	00	04
2.	PCC	15	15	03	00	33
3.	PEC	00	06	07	00	13
4.	RMC	03	00	00	00	03
5.	OEC	00	00	03	00	03
6.	EEC	00	01	06	12	19
7.	Non Credit/Audit Course	✓	✓	00	00	
8.	**TOTAL CREDIT**	**22**	**22**	**19**	**12**	**75**

MA4101	MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

- To encourage students to develop a working knowledge of the central ideas of Linear Algebra.
- To enable students to understand the concepts of Probability and Random Variables.
- To apply the small / large sample tests through Tests of hypothesis.
- Be familiar with the most fundamental Graph Theory topics and results
- To construct automata for any given pattern and find its equivalent regular expressions.

UNIT I	LINEAR ALGEBRA	12

Vector spaces – norms – Inner Products – Eigenvalues using QR transformations – QR factorization – generalized eigenvectors – Canonical forms – singular value decomposition and applications – pseudo inverse – least square approximations.

UNIT II	PROBABILITY AND RANDOM VARIABLES	12

Probability – Axioms of probability – Conditional probability – Baye's theorem – Random variables – Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a random variable.

UNIT III	TESTING OF HYPOTHESIS	12

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

UNIT IV	TREES AND CONNECTIVITY	12

Graphs – Introduction – Isomorphism – Sub graphs – Walks, Paths, Circuits –Connectedness – Components Trees – Properties of trees – Distance and centers in tree-Spanning trees – Fundamental circuits – Spanning trees in a weighted graph – cut sets – Properties of cut set– Fundamental circuits and cut sets – Connectivity and separability.

UNIT V	FINITE STATE AUTOMATA	12

Finite State Automata-Deterministic Finite State Automata(DFA), Non Deterministic Finite State Automata (NFA)-Equivalence of DFA and NFA-Equivalence of NFA and Regular Languages.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

- Apply the concepts of Linear Algebra to solve practical problems.
- Use the ideas of probability and random variables in solving engineering problems.
- Use statistical tests in testing hypotheses on data.
- Write precise and accurate mathematical definitions of objects in graph theory and Use mathematical definitions to identify and construct examples and to distinguish examples from non- examples
- Construct automata, regular expression for any pattern

TEXT BOOK AND REFERENCES:

1. Bronson, R.,"Matrix Operation" Schaum's outline series, Tata McGraw Hill, New York, 2011.
2. Oliver C. Ibe, "Fundamentals of Applied probability and Random Processes", Academic Press, Boston, 2014.
3. Johnson R. A. and Gupta C.B., "Miller and Freund's Probability and Statistics for Engineers", Pearson India Education, Asia, 9th Edition, New Delhi, 2017.

RM4101	RESEARCH METHODOLOGY AND IPR	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Identify an appropriate research problem in their research domain
- Understand the preparation of a well-structured research paper and scientific presentations without violating professional ethics
- Understand the Data Analysis and Interpretation
- Understand the law of Patent and copyrights
- Understand the adequate knowledge on Patent rights and to know the new developments in IPR.

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. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

UNIT II	DATA COLLECTION AND SOURCES	9

Effective literature studies approaches, analysis Plagiarism, Effective technical writing, how to write report, Paper Developing a Research Proposal, a presentation and assessment by a review committee, 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. Data Analysis using Software Package-SPSS and R.

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. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

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. New Developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs..

TOTAL : 45 PERIODS

COURCE OUTCOMES:

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

- Ability to understand research problem formulation.
- Ability to understand the way of doing Literature review and to write proposal in an effective way
- Ability to understand the data collection, data analysis, data presentation and statistical software.
- Ability to understand the nature of Intellectual Property Rights, Patenting process and IPR in national and international level collaborations
- Ability to understand about Patent rights, Patent systems and new developments in IPR

REFERENCES:

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. David Hunt, Long Nguyen,Matthew Rodgers, "Patent searching: tools& techniques", Wiley, 2007
4. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013
5. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'.
6. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.

CS4101	ADVANCED DATA STRUCTURES AND ALGORITHMS	L	T	P	C
		3	0	0	3

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 select and design data structures and algorithms that is appropriate for problems
- 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:

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

REFERENCES:

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, 2009.
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.

CS4102	ADVANCED DATABASE SYSTEMS(Lab Integrated)	L	T	P	C
		3	0	2	4

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
- Understand the basics of XML and create well-formed and valid XML documents.
- Distinguish the different types of NoSQL databases
- To understand the different models involved in database security and their applications in real time world to protect the database and information associated with them

UNIT I	RELATIONAL DATA MODEL	15

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

Suggested Activities:

Data Definition Language

- Create, Alter and Drop
- Enforce Primary Key, Foreign Key, Check, Unique and Not Null Constraints
- Creating Views

Data Manipulation Language

- Insert, Delete, Update
- Cartesian Product, Equi Join, Left Outer Join, Right Outer Join and Full Outer Join
- Aggregate Functions
- Set Operations
- Nested Queries

Transaction

Control Language

Commit, Rollback and Save Points

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

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

Suggested Activities:

- Distributed Database Design and Implementation
- Row Level and Statement Level Triggers
- Accessing a Relational Database using PHP, Python and R

UNIT III	XML DATABASES	15

Structured, Semi structured, and Unstructured Data – XML Hierarchical Data Model – XML Documents – Document Type Definition – XML Schema – XML Documents and Databases – XML Querying – XPath – XQuery

Suggested Activities:

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

UNIT IV	NOSQL DATABASES AND BIG DATA STORAGE SYSTEMS	15

NoSQL – Categories of NoSQL Systems – CAP Theorem – Document-Based NoSQL Systems and MongoDB – MongoDB Data Model – MongoDB Distributed Systems Characteristics – NoSQL KeyValue 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**	**15**

Database Security Issues – Discretionary Access Control Based on Granting and Revoking Privileges – Mandatory Access Control and Role-Based Access Control for Multilevel Security – SQL Injection – Statistical Database Security – Flow Control – Encryption and Public Key Infrastructures – Preserving Data Privacy – Challenges to Maintaining Database Security – Database Survivability – Oracle Label-Based Security.

Suggested Activities:

Implementing Access Control in Relational Databases

TOTAL: 75 PERIODS

COURSE OUTCOMES:

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

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

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

HARDWARE: 30 Terminals.

SOFTWARE: Front end: VB/VC ++/JAVA or Equivalent Back end: Oracle / SQL / MySQL/ PostGress / DB2 or Equivalent.

REFERENCES:

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

CS4103	NETWORK TECHNOLOGIES	L	T	P	C
		3	0	0	3

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

UNIT II	WIRELESS NETWORKS	9

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

UNIT III	MOBILE DATA NETWORKS	9

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

UNIT IV	SOFTWARE DEFINED NETWORKS	9

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

UNIT V	NETWORK FUNCTIONS VIRTUALIZATION	9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Explain basic networking concepts
- Compare different wireless networking protocols
- Describe the developments in each generation of mobile data networks
- Explain and develop SDN based applications
- Explain the concepts of network function virtualization

SUGGESTED ACTIVITIES:

1. Execute various network utilities such as tracert, pathping, ipconfig
2. Implement the Software Defined Networking using Mininet
3. Implement routing in Mininet
4. Install a virtual machine and study network virtualization
5. Simulate various network topologies in Network Simulator

REFERENCES:

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. Erik Dahlman, 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)
6. Thomas D.Nadeau and Ken Gray, SDN – Software Defined Networks, O"Reilly Publishers, 2013.
7. Guy Pujolle, "Software Networks", Second Edition, Wiley-ISTE, 2020.

CS4104	HIGH PERFORMANCE COMPUTING	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 multithreaded programming.
- To learn about the various parallel programming paradigms,
- To develop multicore programs and design parallel solutions

UNIT I	HIGH PERFORMANCE COMPUTING ARCHITECTURE	9

Introduction - Key properties-Flynn's Taxonomy– SIMD and MIMD systems – Vector and Pipelining-Multiprocessors– Shared Memory Multiprocessors-Massively Parallel processors-Commodity .Clusters-Performance issues– Heterogeneous Computer Structures

UNIT II	PARALLEL ALGORITHMS AND CHALLENGES	9

Fork-join – Divide and Conquer - Halo Exchange – Cannon's Algorithm-Performance – Scalability – Synchronization and data sharing – Data races – deadlocks and live locks– communication between threads (condition variables, signals, message queues and pipes).

UNIT III	SHARED MEMORY PROGRAMMING WITH Open MP	9

OpenMP Execution Model – Memory Model – Open MP Directives – Work-sharing Constructs – Library functions – Handling Data and Functional Parallelism – Handling Loops – Performance Considerations.

UNIT IV	DISTRIBUTED MEMORY PROGRAMMING WITH MPI	9
MPI program execution – MPI constructs – libraries – MPI send and receive – Point-to-point and Collective communication – MPI derived data types– Performance evaluation		
UNIT V	**PARALLEL PROGRAM DEVELOPMENT**	**9**
Case studies – n-Body solvers – Tree Search – OpenMP and MPI implementations and comparison		

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- Describe multicore architectures and identify their characteristics and challenges
- Identify the issues in programming Parallel Processors.
- Write programs using OpenMP and MPI.
- Design parallel programming solutions to common problems.
- Compare and contrast programming for serial processors and programming for parallel processors

REFERENCES:

1. Peter S. Pacheco, "An Introduction to Parallel Programming, Morgan-Kauffman/Elsevier, 2021.

2. Darryl Gove, "Multicore Application Programming for Windows, Linux, and Oracle Solaris, Pearson, 2011 (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.

CS4105	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
- To understand the problems such as matrix chain multiplication, activity selection and Huffman coding
- To understand the necessary mathematical abstraction to solve problems

LIST OF EXPERIMENTS

1. Implementation of recursive function for tree traversal and Fibonacci
2. Implementation of iteration function for tree traversal and Fibonacci
3. Implementation of Merge Sort and Quick Sort
4. Implementation of 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

64-bit Open source Linux or its derivative

Open Source C++ Programming tool like G++/GCC

TOTAL: 60 PERIODS

REFERENCES:

1. Lipschutz Seymour, “Data Structures Schaum's Outlines Series”, Tata McGraw Hill, 3rd Edition, 2014.
2. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, “Data Structures and Algorithms”, Pearson Education, Reprint 2006
3. http://www.coursera.org/specializations/data-structures-algorithms
4. http://www.tutorialspoint.com/data_structures_algorithms
5. http://www.geeksforgeeks.org/data-structures/

CS4201	INTERNET OF THINGS(Lab Integrated)	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To Understand the Architectural Overview of IoT
- To Understand the IoT Reference Architecture and Real World Design Constraints
- To Understand the various IoT levels
- To understand the basics of cloud architecture
- To gain experience in Raspberry PI and experiment simple IoT application on it

UNIT I	INTRODUCTION	9

Internet of Things- Domain Specific IoTs - IoT and M2M-Sensors for IoT Applications–Structure of IoT– IoT Map Device- IoT System Management with NETCONF-YANG

UNIT II	**IoT ARCHITECTURE, GENERATIONS AND PROTOCOLS**	**9**

IETF architecture for IoT - IoT reference architecture -First Generation – Description & Characteristics– Advanced Generation – Description & Characteristics–Integrated IoT Sensors – Description & Characteristics

UNIT III	**IoT PROTOCOLS AND TECHNOLOGY**	**9**

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**	**9**

The Cloud types; IaaS, PaaS, SaaS.- Development environments for service development; Amazon, Azure, Google Appcloud platform in industry

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

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 - Persisting data - External representation of sensor values - Exporting sensor data

SUGGESTED ACTIVITIES:

1. Develop an application for LED Blink and Pattern using Arduino or Raspberry Pi
2. Develop an application for LED Pattern with Push Button Control using Arduino or Raspberry Pi
3. Develop an application for LM35 Temperature Sensor to display temperature values using arduino or Raspberry Pi
4. Develop an application for Forest fire detection end node using Raspberry Pi device and sensor
5. Develop an application for home intrusion detection web application
6. Develop an application for Smart parking application using python and Django for web application

COURSE OUTCOMES:

CO1: Understand the various concept of the IoT and their technologies
CO2: Develop the IoT application using different hardware platforms
CO3: Implement the various IoT Protocols
CO4: Understand the basic principles of cloud computing
CO5: Develop and deploy the IoT application into cloud environment

THEORY:45 PERIODS
PRACTICAL: 30 PERIODS
TOTAL: 75 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

HARDWARE:

Arduino Uno R3 board with cable
Raspberry Pi 4 board 8GB RAM with cable
Sensors kit
Breadboard & Jumper wires
NodeMCU
7 segment LCD display
Servo motor
LEDs (white, red, green)
Buzzer
Switches

Bluetooth module
Generic 9V battery with connector
Flame sensor

REFERENCES:

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, 'Learning Internet of Things', Packt Publishing, 2015
4. Ovidiu Vermesan Peter Friess, 'Internet of Things – From Research and Innovation to Market Deployment', River Publishers, 2014
5. N. Ida, Sensors, Actuators and Their Interfaces: A Multidisciplinary Introduction, 2nd EditionScitech Publishers, 202014
6. Reese,G.(2009).Cloud Application Architectures:Building Applications and Infrastructure in the Cloud. Sebastopol, CA: O'Reilly Media, Inc. (2009)

CS4202	ADVANCED OPERATING SYSTEM(Lab Integrated)	L	T	P	C
		3	0	2	4

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.
- 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.

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.

SUGGESTED ACTIVITIES

1. Installation of LINUX using Virtual Machine
2. Basics of UNIX and LINUX commands
3. Write programs using the following system calls of UNIX operating system fork, exec, getpid, exit, wait, close, stat, opendir, readdir
4. Implementation of Deadlock Avoidance Algorithms
5. Implementation of Deadlock Detection Algorithms
6. Implementation of Shared memory and IPC
7. Perform encryption, decryption using the following substitution techniques
   (i) Ceaser cipher, (ii) playfair cipher iii) Hill Cipher iv) Vigenere cipher
8. Perform encryption and decryption using following transposition techniques
   (i) Rail fence ii) row & Column Transformation

THEORY:45 PERIODS
PRACTICAL: 30 PERIODS
TOTAL: 75 PERIODS

COURSE OUTCOMES:

After the completion of this course, student will be able to

CO1:Understand and explore the working of Theoretical Foundations of OS.

CO2:Analyze the working principles of Distributed Deadlock Detection and resource management

CO3:Understand the concepts of distributed shared memory and scheduling mechanisms

CO4:Understand and analyze the working of Data security

CO5:Apply the learning into multiprocessor system architectures.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

HARDWARE: 30 Terminals.
SOFTWARE: 1. C / C++ / Java / Python / Equivalent Compiler 30.2. Network simulator like NS2/Glomosim/OPNET/ Packet Tracer / Equivalent

REFERENCES:

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.
4. Andrew S.Tanenbaum,Distributed operating system, Pearson education, 2003.

CS4203	MACHINE LEARNING(Lab Integrated)	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

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

UNIT I	INTRODUCTION AND MATHEMATICAL FOUNDATIONS	9

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

UNIT II	SUPERVISED LEARNING	9

Introduction-Discriminative and Generative Models -Linear Regression - Least Squares -Under-fitting / Overfitting -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	9

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	9

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	9

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

SUGGESTED ACTIVITIES:

1. Give an example from our daily life for each type of machine learning problem.
2. Study at least 3 Tools available for Machine Learning and discuss pros & cons of each
3. Take an example of a classification problem. Draw different decision trees for the example and explain the pros and cons of each decision variable at each level of the tree
4. Outline 10 machine learning applications in healthcare
5. Give 5 examples where sequential models are suitable.
6. Give at least 5 recent applications of CNN

PRACTICAL EXERCISES

1. Implement a Linear Regression with a Real Dataset (https://www.kaggle.com/harrywang/housing). Experiment with different features in building a model. Tune the model's hyperparameters.
2. Implement a binary classification model. That is, answers a binary question such as "Are houses in this neighborhood above a certain price?"(use data from exercise 1). Modify the classification threshold and determine how that modification influences the model. Experiment with different classification metrics to determine your model's effectiveness.
3. Classification with Nearest Neighbors. In this question, you will use the scikit-learn's KNN classifier to classify real vs. fake news headlines. The aim of this question is for you to read the scikit-learn API and get comfortable with training/validation splits. Use California Housing Dataset
4. In this exercise, you'll experiment with validation sets and test sets using the dataset. Split a training set into a smaller training set and a validation set. Analyze deltas between training set and validation set results. Test the trained model with a test set to determine whether your trained model is overfitting. Detect and fix a common training problem.
5. Implement the k-means algorithm using https://archive.ics.uci.edu/ml/datasets/Codon+usage dataset
6. Implement the Naïve Bayes Classifier using https://archive.ics.uci.edu/ml/datasets/Gait+Classificat on dataset

Project - (in Pairs) Your project must implement one or more machine learning algorithms and apply them to some data.

a. Your project may be a comparison of several existing algorithms, or it may propose a new algorithm in which case you still must compare it to at least one other approach.
b. You can either pick a project of your own design, or you can choose from the set of pre-defined projects.
c. You are free to use any third-party ideas or code that you wish as long as it is publicly available.
d. You must properly provide references to any work that is not your own in the write-up.
e. Project proposal You must turn in a brief project proposal. Your project proposal should describe the idea behind your project. You should also briefly describe software you will need to write, and papers (2-3) you plan to read.

List of Projects (datasets available)

1. Sentiment Analysis of Product Reviews
2. Stock Prediction
3. Sales Forecasting
4. Music Recommendation
5. Handwriting Digit Classification

6. Fake News Detection
7. Sports Prediction
8. Object Detection
9. Disease Prediction

COURSE OUTCOMES:

Upon the completion of course, students will be able to

CO1: Understand and outline problems for each type of machine learning

CO2: Design a Decision tree and Random forest for an application

CO3: Implement Probabilistic Discriminative and Generative algorithms for an application and analyze the results.

CO4: Use a tool to implement typical Clustering algorithms for different types of applications.

CO5: Design and implement an HMM for a Sequence Model type of application and identify applications suitable for different types of Machine Learning with suitable justification.

THEORY:45 PERIODS
PRACTICAL: 30 PERIODS
TOTAL:75 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

HARDWARE: 30 Terminals.

SOFTWARE: Python/Java with ML Package/R

REFERENCES

1. Stephen Marsland, "Machine Learning: An Algorithmic Perspective", Chapman & Hall/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.
6. Shai Shalev-Shwartz and Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press, 2015
7. Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 2007.
8. Hal Daumé III, "A Course in Machine Learning", 2017 (freely available online)
9. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Springer, 2009 (freely available online)
10. Aurélien Géron , Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems 2nd Edition, o'reilly, (2017)

CS4204	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.
- To understand the basic notions of a web service, web service standards, and service-oriented architecture.

- To understand the different stages of testing from testing during development of a software system.

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 – 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

45 PERIODS

SUGGESTED ACTIVITIES:

1. Comparatively analysing different Agile methodologies.
2. Describing the scenarios where ‘Scrum’ and ‘Kanban’ are used.
3. Mapping the data flow into suitable software architecture.
4. Developing behavioural representations for a class or component.
5. Implementing simple applications as RESTful service.

COURSE OUTCOMES:

The Students 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

REFERENCES

1. Software Engineering: A Practitioner's Approach, 9th Edition. Roger Pressman and Bruce Maxim, McGraw-Hill 2019.
2. Software Engineering, 10th Edition, Ian Somerville, Pearson Education Asia 2016.
3. Software Architecture In Practice, 3rd Edition, Len Bass, Paul Clements and Rick Kazman, Pearson India 2018
4. An integrated approach to Software Engineering, 3rd Edition, Pankaj Jalote, Narosa Publishing House, 2018
5. Fundamentals of Software Engineering, 5th Edition, Rajib Mall, PHI Learning Private Ltd, 2018

CS4205	TERM PAPER WRITING AND SEMINAR	L T P C 0 0 2 1

In this course, students will develop their scientific and technical reading and writing skills that they need to understand and construct research articles. A term paper requires a student to obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and then place it in logically developed ideas. The work involves the following steps:

Activity	Instructions	Submission week	Evaluation
Selection of area of interest and Topic Stating an Objective	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 area & topic	1. List 1 Special Interest Groups or professional society 2. List 2 journals 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) 8. from your area.	3rd week	**3%** (the selected information must be area specific and of internation al 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 "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 notes for first 5 papers	Reading Paper Process ● 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?	5th week	**8%** (the table given should indicate your understanding of the

	• 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)		paper and the evaluation is based on your conclusions about each paper)
Reading and notes for next5 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 notes for final 5 papers	Repeat Reading Paper Process	7th week	**8%** (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	11thweek	**10%**(this component will be evaluated based on the linking and classification among 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 & 15th week	**10%** (based on presentation and Viva-voce)

CS4206	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.
- To clarify the significance of task analysis for ubiquitous computing
- To get insight on web and mobile interaction.

UNIT I	FOUNDATIONS OF HCI	9

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

UNIT II	INTERACTION STYLES	9

GUI: Popularity of graphics - The concept of direct manipulation - Graphical system -Characteristics - Web user - Interface Popularity - Characteristics and Principles of User Interface. Understanding interaction styles, Direct Navigation and Immersive environments, Fluid navigation,Expressive Human and Command Languages, Communication and Collaboration Advancing theuser 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

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Understand the basics of human computer interactions via usability engineering andcognitive 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.

REFERENCES

1. Ben Shneiderman, Catherine Plaisant, Maxine Cohen, Steven Jacobs, Niklas Elmqvist, "Designing the User Interface: Strategies for Effective Human-Computer Interaction", Sixth Edition, Pearson Education, 2016.
2. Alan Dix, Janet Finlay, G D Abowd and Russel Beale, "Human Computer Interaction", Pearson Education, Third Edition, 2004.
3. Helen Sharp Jennifer Preece Yvonne Rogers, "Interaction Design: Beyond Human- Computer Interaction", Wiley, 5th Edition, 2019.
4. Alan Cooper, Robert Reimann, 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.
6. Wilbert O Galitz, "The Essential Guide to User Interface Design", Third Edition, Wiley India Pvt., Ltd., 2007.

CS4207	CLOUD COMPUTING TECHNOLOGIES	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.
- To explore the roster of AWS services and illustrate the way to make applications in AWS
- To gain knowledge in the working of Windows Azure and Storage services offered by Windows Azure
- To develop the cloud application using various programming model of Hadoop and Aneka

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	6

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 StorageCharacteristics-Storage Services-REST API- Blops

UNIT V	PROGRAMMING MODEL	9

Introduction to Hadoop Framework - Mapreduce, Input splitting, map and reduce functions, specifying inpu and output parameters, configuring and running a job –Developing Map Reduce Applications - Design o Hadoop file system –Setting up Hadoop Cluster- Aneka: Cloud ApplicationPlatform, Thread Programming, Task Programming and Map-Reduce Programming in Aneka

COURSE OUTCOMES:

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.

TOTAL : 45 PERIODS

REFERENCES

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.
4. Rajkumar Buyya, Christian Vacchiola, S.Thamarai Selvi, Mastering Cloud Computing , MCGraw Hill Education (India) Pvt. Ltd., 2013.
5. Danielle Ruest, Nelson Ruest, ―Virtualization: A Beginner"s Guide‖, McGraw-Hill Osborne Media, 2009.
6. Jim Smith, Ravi Nair , "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.
7. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010
8. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach",
9. McGraw-Hill Osborne Media, 2009.
10. Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2012

CS4208	FOUNDATIONS OF DATA SCIENCE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To apply fundamental algorithms to process data.
- Learn to apply hypotheses and data into actionable predictions.
- Document and transfer the results and effectively communicate the findings usingvisualization techniques.
- To learn statistical methods and machine learning algorithms required for Data Science.
- To develop the fundamental knowledge and understand concepts to become a datascience professional.

UNIT I	INTRODUCTION TO DATA SCIENCE	9

Data science process – roles, stages in data science project – working with data from files – working with relational databases – exploring data – managing data – cleaning and sampling for modeling and validation – introduction to NoSQL.

UNIT II	MODELING METHODS	9

Choosing and evaluating models – mapping problems to machine learning, evaluating clusteringmodels, validating models – cluster analysis – K-means algorithm, Naïve Bayes – MemorizationMethods – 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.

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 HadoopMapReduce Programs - Loading data into HDFS - Executing the Map phase - Shuffling and sorting - Reducing phase execution.

UNIT V	DATA VISUALIZATION	9

Documentation and deployment – producing effective presentations – Introduction to graphicalanalysis – plot() function – displaying multivariate data – matrix plots – multiple plots in one window - exporting graph using graphics parameters - Case studies.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Obtain, clean/process and transform data.

CO2: Analyze and interpret data using an ethically responsible approach.

CO3: Use appropriate models of analysis, assess the quality of input, derive insight from results, and investigate potential issues.

CO4: Apply computing theory, languages and algorithms, as well as mathematical and statistical models, and the principles of optimization to appropriately formulate and use data analyses.

CO5: Formulate and use appropriate models of data analysis to solve business-related challenges.

REFERENCES:

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 DataScience Cookbook”, Packt Publishing Ltd., 2014.
5. Nathan Yau, “Visualize This: The Flowing Data Guide to Design, Visualization, andStatistics”, Wiley, 2011.

CS4209	WIRELESS COMMUNICATIONS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

UNIT I	CELLULAR CONCEPTS	9

Frequency Reuse – Channel Assignment Strategies – Handoff Strategies – Interference and system capacity- Co-Channel Interference- Adjacent Channel Interference – Trunking and Grade of service – Improving coverage & capacity in cellular systems-Cell Splitting- Sectoring- Repeaters for Range Extension-Microcell Zone Concept

UNIT II	THE WIRELESS CHANNEL	9

Overview of wireless systems – Physical modeling for wireless channels – Time and Frequency coherence – Statistical channel models – Capacity of wireless Channel- Capacity of Flat Fading Channel – Channel Side Information at Receiver – Channel Side Information at Transmitter and Receiver –Capacity comparisons – Capacity of Frequency Selective Fading channels.

UNIT III	PERFORMANCE OF DIGITAL MODULATION OVER WIRELESSCHANNELS	9

Performance of flat fading and frequency selective fading – Impact on digital modulation techniques –- Outage Probability– Average Probability of Error — Combined Outage and Average Error Probability – Doppler Spread – Inter symbol Interference.

UNIT IV	DIVERSITY TECHNIQUES	9

Realization of Independent Fading Paths – Receiver Diversity – Selection Combining – Threshold Combing – Maximal-Ratio Combining – Equal - Gain Combining – Capacity with Receiver diversity – Transmitter Diversity – Channel known at Transmitter – Channel unknownat Transmitter – The Alamouti Scheme– Transmit & Receive Diversity-MIMO Systems.

UNIT V	MULTICARRIER MODULATION	9

Data Transmission using Multiple Carriers – Multicarrier Modulation with Overlapping Subchannels – Mitigation of Subcarrier Fading – Discrete Implementation of Multicarrier Modulation

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Design solutions for cellular communication

CO2: Determine the capacity of wireless channels

CO3: Analyze the performance of the digital modulation techniques in fading channels

CO4: Apply various diversity techniques in wireless communication

CO5: Design multicarrier systems in wireless communication

REFERENCES:

1. Theodore.S. Rappaport, “Wireless Communications: Principles and Practice", 2nd Edition, Pearson Education, India, 2010.
2. Andrea Goldsmith, “Wireless Communications”, Cambridge University Press, 2005.
3. David T and Pramod Viswanath, “Fundamentals of Wireless Communication”, WileySeries in Telecommunications, Cambridge University Press, 2005.
4. Saad Z. Asif, “5G Mobile Communications Concepts and Technologies” CRC press –2019.
5. Keith Q. T. Zhang, “Wireless Communications: Principles, Theory and Methodology” 1stedition, John Wiley & Sons, 2016.
6. Ramjee Prasad, "OFDM for Wireless Communication Systems", Artech House, 2004.
7. Boris Lublinsky, Kevin T. Smith, Alexey Yakubovich, “Professional Hadoop Solutions”,JohnWiley & Sons Inc., 2013.

CS4210	AGILE METHODOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

UNIT I	AGILE SOFTWARE DEVELOPMENT	9

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

UNIT II	AGILE AND SCRUM PRINCIPLES	9

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

UNIT III	AGILE PRODUCT MANAGEMENT	9

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

UNIT IV	AGILE REQUIREMENTS AND AGILE TESTING	9

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

UNIT V	AGILE REVIEW AND SCALING AGILE FOR LARGE PROJECTS	9

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

COURSE OUTCOMES:

CO1: Analyze 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: Judge and craft appropriate adaptations to existing practices or processes depending upon analysis of typical problems.

CO5: Evaluate successes and formulate plans to manage risks or problems.

TOTAL: 45 PERIODS

REFERENCES

1. Robert C. Martin ,Agile Software Development, Principles, Patterns, and Practices Alan AptSeries (2011)
2. Succeeding with Agile : Software Development Using Scrum, Pearson (2010)
3. David J. Anderson and Eli Schragenheim, "Agile Management for Software Engineering:Applying the Theory of Constraints for Business Results, Prentice Hall, 2003.
4. Hazza and Dubinsky, "Agile Software Engineering, Series: Undergraduate Topics in Computer Science, Springer, 2009.
5. Craig Larman, "Agile and Iterative Development: A Managers Guide, Addison-Wesley,2004.
6. Kevin C. Desouza, "Agile Information Systems: Conceptualization, Construction, and Management, Butterworth-Heinemann, 2007.

CS4211	PERFORMANCE ANALYSIS OF COMPUTER SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

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

COURSE OUTCOMES:

Upon completion of this course, the students should 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: Use discrete-time and continuous-time Markov chains to model real world systems.

CO5: Develop analytical techniques for evaluating scheduling policies.

TOTAL: 45 PERIODS

REFERENCES

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.

CS4212	MULTICORE ARCHITECTURE AND PROGRAMMING	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 multithreaded programming.
- To learn about the various parallel programming paradigms,
- To develop multicore programs and design parallel solutions

UNIT I	MULTI-CORE PROCESSORS	9

Single core to Multi-core architectures – SIMD and MIMD systems – Interconnection networks – Symmetric and Distributed Shared Memory Architectures – Cache coherence – PerformanceIssues – Parallel program design.

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

Performance – Scalability – Synchronization and data sharing – Data races – Synchronization primitives (mutexes, locks, semaphores, barriers) – deadlocks and livelocks – communication between threads (condition variables, signals, message queues and pipes).

UNIT III	SHARED MEMORY PROGRAMMING WITH OpenMP	9

OpenMP Execution Model – Memory Model – OpenMP Directives – Work-sharing Constructs – Library functions – Handling Data and Functional Parallelism – Handling Loops – Performance .Considerations.

UNIT IV	DISTRIBUTED MEMORY PROGRAMMING WITH MPI	9

MPI program execution – MPI constructs – libraries – MPI send and receive – Point-to-point and Collective communication – MPI derived datatypes – Performance evaluation.

UNIT V	PARALLEL PROGRAM DEVELOPMENT	9

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

COURSE OUTCOMES:

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

CO1: Describe multicore architectures and identify their characteristics and challenges.

CO2: Identify the issues in programming Parallel Processors.

CO3: Write programs using OpenMP and MPI.

CO4: Design parallel programming solutions to common problems.

CO5: Compare and contrast programming for serial processors and programming for parallelprocessors.

TOTAL : 45 PERIODS

REFERENCES

1. Peter S. Pacheco, "An Introduction to Parallel Programming, Morgan-Kauffman/Elsevier, 2021.
2. Darryl Gove, "Multicore Application Programming for Windows, Linux, and Oracle Solaris, Pearson, 2011 (unit 2)
3. Michael J Quinn, "Parallel programming in C with MPI and OpenMP, Tata McGrawHill,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

CS4213	DIGITAL IMAGE PROCESSING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study fundamental concepts of digital image processing.
- To understand and learn image processing operations and restoration.
- To use the concepts of Feature Extraction
- To study the concepts of Image Compression.
- 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. Digital Image Fundamentals: A simpleimage formation model, image sampling and quantization, basic relationships between pixels.

Image enhancement in the spatial domain: Basic gray-level transformation, histogram processing, enhancement using arithmetic and logic operators, basic spatial filtering, smoothing, and sharpening spatial filters, combining the spatial enhancement methods.

UNIT II	IMAGE RESTORATION	9

Performance – Scalability – Synchronization and data sharing – Data races – Synchronization primitives (mutexes, locks, semaphores, barriers) – deadlocks and livelocks – communication between threads (condition variables, signals, message queues and pipes).

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

UNIT III	FEATURE EXTRACTION	9

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**.**

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 andclosing, hit or miss transformation, basic morphological algorithms

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, neural networks, structural methods – matching shape numbers, string matching.

COURSE OUTCOMES:

CO1: Apply knowledge of Mathematics for image processing operations

CO2: Apply techniques for image restoration.

CO3: Identify and extract salient features of images.

CO4: Apply the appropriate tools (Contemporary) for image compression and analysis.

CO5: Apply segmentation techniques and do object recognition.

TOTAL : 45 PERIODS

REFERENCES

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

CS4214	HIGH PERFORMANCE COMPUTING FOR BIG DATA	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn the fundamental concepts of High-Performance Computing.
- To learn the network & software infrastructure for high performance computing.
- To understand real time analytics using high performance computing.
- To learn the different ways of security perspectives and technologies used in HPC.
- 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

Security, Privacy and Trust for user – generated content: The challenges and solutions – Role of real time big data processing in the IoT – End to End Security Framework for big sensing data streams – Clustering in big data.

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.

COURSE OUTCOMES:

Upon completion of the course, the student should be able to:

CO1: Understand the basics concepts of High Performance computing systems.

CO2: Apply the concepts of network and software infrastructure for high performance computing

CO3: Use real time analytics using high performance computing.

CO4: Apply the security models and big data applications in high performance computing

CO5: Understand the emerging big data applications.

TOTAL : 45 PERIODS

REFERENCES

1. Pethuru Raj, Anupama Raman, Dhivya Nagaraj and Siddhartha Duggirala, "High-Performance Big-Data Analytics: Computing Systems and Approaches", Springer, 1st Edition, 2015.
2. "Big Data Management and Processing", Kuan-Ching Li , Hai Jiang, Albert Y. Zomaya, CRC Press,1st Edition,2017.
3. "High Performance Computing for Big Data: Methodologies and Applications", Chao wang ,CRC Press,1st Edition,2018
4. "High-Performance Data Mining And Big Data Analytics" , Khosrow Hassibi, Create Space Independent Publishing Platform,!st Edition,2014
5. "High performance computing: Modern systems and practices", Thomas Sterling, Matthew Anderson, Morgan Kaufmann publishers,1st Edition,2017

WEB REFERENCES:

1. *https://www.hpcwire.com/*

ONLINE RESOURCES:

1. *http://hpc.fs.uni-lj.si/sites/default/files/HPC_for_dummies.pdf*
2. *https://www.nics.tennessee.edu/computing-resources/what-is-hpc*

CS4215	INFORMATION RETRIEVAL TECHNIQUES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

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

UNIT III	INDEXING	9

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

Traditional Effectiveness Measures – Statistics in Evaluation – Minimizing Adjudication Effect – Nontraditional Effectiveness Measures – Measuring Efficiency – Efficiency Criteria–Queueing Theory – Query Scheduling – Parallel Information Retrieval – Parallel QueryProcessing – MapReduce

UNIT V	SEARCHING THE WEB	9

Searching the Web –Structure of the Web –IR and web search – Static and Dynamic Ranking – Web Crawling and Indexing – Link Analysis - XML Retrieval Multimedia IR: Models and Languages – Indexing and Searching Parallel and Distributed IR – Digital Libraries

COURSE OUTCOMES:

Upon completion of the course, the student should 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: Categorize the different types of IR Models.

CO4: Apply machine learning techniques to text classification and clustering which isused for efficient Information Retrieval.

CO5: Design an efficient search engine and analyze the Web content structure

TOTAL: 45 PERIODS

REFERENCES

1. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schutze, "Introduction toInformation Retrieval, Cambridge University Press, First South Asian Edition.
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.
4. Stefan Buttcher, Charles L. A. Clarke, Gordon V. Cormack, "Information Retrieval"

CS4216	SOFTWARE QUALITY ASSURANCE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

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	SOFTWARE QUALITY MANAGEMENT & METRICS	9

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

UNIT V	STANDARDS, CERTIFICATIONS & ASSESSMENTS	9

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

COURSE OUTCOMES

Upon completion of the course, the student should be able to:

CO1: Utilize the concepts of SQA in software development life cycle

CO2: Demonstrate their capability to adopt quality standards.

CO3: Assess the quality of software products.

CO4: Apply the concepts in preparing the quality plan & documents.

CO5: Ensure whether the product meets company's quality standards and client'sexpectations and demands

TOTAL : 45 PERIODS

REFERENCES

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

CS4217	AUTONOMOUS SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To impart knowledge on the functional architecture of autonomous vehicles
- To impart knowledge on Localization and mapping fundamentals
- To impart knowledge on process end effectors and robotic controls
- To learn Robot cell design, Robot Transformation and Sensors
- 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 SYSTEMS	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, LVDT Motion 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.

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.

COURSE OUTCOMES

Upon completion of the course, the student should be able to:

CO1: Understand architecture and modeling of autonomous systems.

CO2: Employ localization mapping techniques for autonomous systems

CO3: Design solutions for autonomous systems control.

CO4: Analyze Robot Transformations, Sensors and Cell Design

CO5: Explain the working principles of Micro/Nano Robotic system

TOTAL : 45 PERIODS

REFERENCES

1. S.R. Deb, Robotics Technology and flexible automation, Tata McGraw-HillEducation.,2009
2. Mikell P Groover & Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, Industrial Robotics, Technology programming and Applications, McGraw Hill, 2012.
3. Karsten Berns, Ewald Puttkamer, Springer, Autonomous Land Vehicles: Steps towards Service Robots, 2009
4. Sebastian Thrun, Wolfram Burgard, Dieter Fox., Probabilistic robotics. MIT Press, 2005
5. Steven M. LaValle., Planning algorithms, Cambridge University Press, 2006
6. Daniel Watzenig and Martin Horn (Eds.), Automated Driving: Safer and More Efficient Future Driving, Springer, 2017
7. Markus Maurer, Autonomous driving: technical, legal and social aspects. Springer, 2016
8. Jha, Theory, Design and Applications of Unmanned Aerial Vehicles, CRC Press, 2016

CS4218	WEB ANALYTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the Web analytics platform, and their evolution.
- To learn about the various Data Streams Data.
- To learn about the benefits of surveys and capturing of data
- To understand Common metrics of web as well as KPI related concepts.
- 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**

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, Competitiveintelligence 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 siteoverlap 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**.**

COURSE OUTCOMES

Upon completion of this course, the students should be able to:

CO1: Understand the Web analytics platform, and their evolution.

CO2: Use the various Data Streams Data.

CO3: Know how the survey of capturing of data will benefit.

CO4: Understand Common metrics of web as well as KPI related concepts.

CO5: Apply various Web analytics versions in existence.

TOTAL : 45 PERIODS

REFERENCES

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 ofCustomer Centricity, Wiley Publishing, Inc. 1st ed, 2010.
3. Sterne J., Web Metrics: Proven methods for measuring web site success, John Wiley andSons, 2002

CS4219	**COGNITIVE COMPUTING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

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

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 marketThe process of building a cognitive application: Emerging cognitive platform, defining the objective,defining the domain, understanding the intended users and their attributes, questions and exploringinsights, training and testing

UNIT V	APPLICATION OF COGNITIVE COMPUTING	9

Building a cognitive health care application: Foundations of cognitive computing for healthcare, constituents in healthcare ecosystem, learning from patterns in healthcare Data, Building on a foundation of big data analytics, cognitive applications across the health care eco system, starting with a cognitive application for healthcare, using cognitive applications to improve health and wellness, using a cognitive application to enhance the electronic medical record Using cognitive application to improve clinical teaching

COURSE OUTCOMES

Upon completion of this course, the students should be able to:

CO1: Explain applications in Cognitive Computing.

CO2: Describe Natural language processor role in Cognitive computing.

CO3: Explain future directions of Cognitive Computing

CO4: Evaluate the process of taking a product to market

CO5: Comprehend the applications involved in this domain.

TOTAL : 45 PERIODS

REFERENCES

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

CS4220	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.
- To understand the techniques used for identifying parallelism in a sequential program.
- 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 – DataReuse- 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.

COURSE OUTCOMES

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 optimising compiler.

CO4: Design and implement new data structures and algorithms for codeoptimization.

CO5: Critically analyse different data structures and algorithms used in the building of an optimising compiler

TOTAL : 45 PERIODS

REFERENCES:

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.
Steven S. Muchnick, "Advanced Compiler Design and Implementation",Morgan KaufmannPublishers - Elsevier Science, India, 2007
John Hopcroft, Rajeev Motwani, Jeffrey Ullman, "Introduction To Automata TheoryLanguages, and Computation", Third Edition, Pearson Education, 2007.
Torbengidius Mogensen, "Basics of Compiler Design", Springer, 2011.
6.Charles N, Ron K Cytron, Richard J LeBlanc Jr., "Crafting a Compiler", Pearson Education,2010.

CS4221	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
- To analyze and interpret streaming data
- To learn how to handle large data sets in main memory and learn the various clusteringtechniques 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.

COURSE OUTCOMES

Upon completion of this course, the students 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

TOTAL: 45 PERIODS

REFERENCES:

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.
4. David Hand, HeikkiMannila and Padhraic Smyth, "Principles of Data Mining", MIT PRESS, 2001

WEB REFERENCES:

1. *https://swayam.gov.in/nd2_arp19_ap60/preview*
2. *https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/106104189/lec1.pdf*

ONLINE RESOURCES:

1. *https://examupdates.in/big-data-analytics/*
2. *https://www.tutorialspoint.com/big_data_analytics/index.htm*

3.https://www.tutorialspoint.com/data_mining/index.htm

CS4301	SECURITY PRACTICES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn the core fundamentals of system and web security concepts
- To have through understanding in the security concepts related to networks
- To deploy the security essentials in IT Sector
- To be exposed to the concepts of Cyber Security and cloud security
- 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. Case study: DVWA

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.

		45 PERIODS

COURSE OUTCOMES:

CO1: Understand the core fundamentals of system security
CO2: Apply the security concepts to wired and wireless networks
CO3: Implement and Manage the security essentials in IT Sector
CO4: Explain the concepts of Cyber Security and Cyber forensics
CO5: Be aware of Privacy and Storage security Issues.

REFERENCES

1. John R. Vacca, Computer and Information Security Handbook, Third Edition, Elsevier 2017
2. Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, Seventh Edition, Cengage Learning, 2022

3. Richard E. Smith, Elementary Information Security, Third Edition, Jones and Bartlett Learning, 2019
4. Mayor, K.K.Mookhey, Jacopo Cervini, Fairuzan Roslan, Kevin Beaver, Metasploit Toolkit for Penetration Testing, Exploit Development and Vulnerability Research, Syngress publications, Elsevier, 2007. ISBN : 978-1-59749-074-0
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.
7. Siani Pearson, George Yee "Privacy and Security for Cloud Computing" Computer Communications and Networks, Springer, 2013.

CS4303	MOBILE AND PERVASIVE COMPUTING	L T P C 3 0 0 3

COURSE OBJECTIVES:

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

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	3G AND 4G CELLULAR NETWORKS	9

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

UNIT III	SENSOR AND MESH NETWORKS	9

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

UNIT IV	CONTEXT AWARE COMPUTING & WEARABLE COMPUTING	9

Adaptability – Mechanisms for Adaptation - Functionality and Data – Transcoding – LocationAware Computing – Location Representation – Localization Techniques – Triangulation and Scene

Analysis – Delaunay Triangulation and Voronoi graphs – Types of Context – Role of Mobile Middleware – Adaptation and Agents – Service Discovery Middleware Health BAN- Medical and Technological Requirements-Wearable Sensors-Intra-BAN communications

UNIT V	APPLICATION DEVELOPMENT	9

Three tier architecture - Model View Controller Architecture - Memory Management – Information Access Devices – PDAs and Smart Phones – Smart Cards and Embedded Controls – J2ME – Programming for CLDC – GUI in MIDP – Application Development ON Android and iPhone

COURSE OUTCOMES:

CO1: Design a basic architecture for a pervasive computing environment**CO2:** Design and allocate the resources on the 3G-4G wireless networks **CO3**: Analyze the role of sensors in Wireless networks

CO4: Work out the routing in mesh network

CO5: Deploy the location and context information for application development

CO6: Develop mobile computing applications based on the paradigm of context aware computing and wearable computing

TOTAL:45 PERIODS

REFERENCES

1. Asoke K Talukder, Hasan Ahmed, Roopa R Yavagal, "Mobile Computing: Technology, Applications and Service Creation", 2nd ed, Tata McGraw Hill, 2017.
2. Reto Meier, "Professional Android 2 Application Development", Wrox Wiley,2010.
3. Pei Zheng and Lionel M Li, 'Smart Phone & Next Generation Mobile Computing', Morgan Kaufmann Publishers, 2006.
4. Frank Adelstein, 'Fundamentals of Mobile and Pervasive Computing', TMH, 2005
5. Jochen Burthardt et al, 'Pervasive Computing: Technology and Architecture of MobileInternet Applications', Pearson Education, 2003
6. Feng Zhao and Leonidas Guibas, 'Wireless Sensor Networks', Morgan KaufmannPublishers, 2004
7. Uwe Hansmaan et al, 'Principles of Mobile Computing', Springer, 2nd edition,2006
8. Reto Meier, "Professional Android 2 Application Development", Wrox Wiley,2010.
9. Mohammad s. Obaidat et al, "Pervasive Computing and Networking" ,John wiley, 2011
10. Stefan Poslad, "Ubiquitous Computing: Smart Devices, Environments and Interactions",Wiley, 2009
11. Frank Adelstein Sandeep K. S. Gupta Golden G. Richard III Loren Schwiebert "Fundamentals of Mobile and Pervasive Computing, ", McGraw-Hill, 2005

CS4304	WEB SERVICES AND API DESIGN	L T P C 3 0 0 3

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.
- To implement the RESTful web services.
- 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.		
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 intoResources- Name the Resources - Design Representation- Link the Resources to Each Other- TheHTTP Response		

COURSE OUTCOMES:

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

TOTAL: 45 PERIODS

REFERENCES

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
4. Craig Walls, "Spring in Action, Fifth Edition", Manning Publications, 2018
5. Raja CSP Raman, Ludovic Dewailly, "Building A RESTful Web Service with Spring 5",Packt Publishing, 2018.

6. 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.
7. 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.

CS4305	DATA VISUALIZATION TECHNIQUES	L T P C 3 0 0 3

COURSE OBJECTIVES:

- To develop skills to both design and critique visualizations.
- To introduce visual perception and core skills for visual analysis.
- To understand technological advancements of data visualization
- To understand various data visualization techniques
- To understand the methodologies used to visualize large data sets

UNIT I	INTRODUCTION AND DATA FOUNDATION	9

Basics - Relationship between Visualization and Other Fields -The Visualization Process - Pseudocode Conventions - The Scatter plot. Data Foundation - Types of Data - Structure within and between Records - Data Preprocessing - Data Sets

UNIT II	FOUNDATIONS FOR VISUALIZATION	9

Visualization stages - Semiology of Graphical Symbols - The Eight Visual Variables – Historical Perspective - Taxonomies - Experimental Semiotics based on Perception Gibson's Affordance theory – A Model of Perceptual Processing.

UNIT III	VISUALIZATION TECHNIQUES	9

Spatial Data: One-Dimensional Data - Two-Dimensional Data – Three Dimensional Data - DynamicData - 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 - LineBased Techniques - Region-Based Techniques - Combinations of Techniques – Trees Displaying Hierarchical Structures – Graphics and Networks- Displaying Arbitrary Graphs/Networks.

UNIT IV	INTERACTION CONCEPTS AND TECHNIQUES	9

Text and Document Visualization: Introduction - Levels of Text Representations - The Vector Space Model - Single Document Visualizations -Document Collection Visualizations – Extended Text Visualizations Interaction Concepts: Interaction Operators - Interaction Operands and Spaces
- A Unified Framework. Interaction Techniques: Screen Space - Object-Space –Data Space - Attribute Space- Data Structure Space - Visualization Structure – Animating Transformations - Interaction Control.

UNIT V	RESEARCH DIRECTIONS IN VISUALIZATIONS	9

Steps in designing Visualizations – Problems in designing effective Visualizations- Issues of Data. Issues of Cognition, Perception, and Reasoning. Issues of System Design Evaluation , Hardware and Applications

COURSE OUTCOMES:

CO1: Visualize the objects in different dimensions.

CO2: Design and process the data for Visualization.

CO3: Apply the visualization techniques in physical sciences, computer science, applied mathematics and medical sciences.

CO4: Apply the virtualization techniques for research projects.

CO5: Identify appropriate data visualization techniques given particular requirements imposed bythe data.

TOTAL: 45 PERIODS

REFERENCES

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

CS4306	QUANTUM COMPUTING	L T P C 3 0 0 3

COURSE OBJECTIVES:

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

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

COURSE OUTCOMES:

CO1: Understand the basic principles of quantum computing.

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

CO3: Understand several basic quantum computing algorithms.

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

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

TOTAL: 45 PERIODS

REFERENCES

1. John Gribbin, Computing with Quantum Cats: From Colossus to Qubits, 2021
2. William (Chuck) Easttom, Quantum Computing Fundamentals, 2021
3. Parag Lala, Quantum Computing, 2019
4. Eleanor Rieffel and Wolfgang Polak, QUANTUM COMPUTING A Gentle Introduction, 2011
5. Nielsen M. A., Quantum Computation and Quantum Information, Cambridge UniversityPress.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

CS4307	FORMAL MODELS OF SOFTWARE SYSTEMS	L T P C 3 0 0 3

COURSE OBJECTIVES:

- To understand the goals, complexity of software systems, the role of Specification activitiesand qualities to control complexity.
- To understand the fundamentals of abstraction and formal systems
- To learn fundamentals of logic reasoning- Propositional Logic, temporal logic and apply to models systems
- To understand formal specification models based on set theory, calculus and algebra and apply to a case study
- 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**

Propositional Logic - Reasoning Based on Adopting a Premise, Inference Based on NaturalDeduction. 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 SetTheory, 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.

COURSE OUTCOMES:

CO1: Understand the complexity of software systems, the need for formal specifications activitiesand qualities to control complexity.

CO2: Gain knowledge on fundamentals of abstraction and formal systems

CO3: Learn the fundamentals of logic reasoning- Propositional Logic, temporal logic and apply to models systems

CO4: Develop formal specification models based on set theory, calculus and algebra and apply toa typical case study

CO5: Have working knowledge on Z, Object Z and B Specification languages with case studies.

TOTAL: 45 PERIODS

REFERENCES

1. Mathematical Logic for computer science ,second edition, M.Ben-Ari ,Springer,2012.
2. Logic in Computer Science- modeling and reasoning about systems, 2 nd Edition,Cambridge University Press, 2004.
3. Specification of Software Systems, V.S. Alagar, K. Periyasamy, David Grises and Fred B Schneider, Springer –Verlag London, 2011
4. The ways Z: Practical programming with formal methods, Jonathan Jacky, CambridgeUniversity Press,1996.
5. Using Z-Specification Refinement and Proof,Jim Woodcock and Jim Devies Prentice Hall, 1996
6. 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

CS4308	ROBOTICS	L T P C 3 0 0 3

COURSE OBJECTIVES:

- To Introduce the concepts of Robotic systems
- To understand the concepts of Instrumentation and control related to Robotics
- To understand the kinematics and dynamics of robotics
- To explore robotics in Industrial applications

UNIT I	INTRODUCTION TO ROBOTICS	9

Robotics -History - Classification and Structure of Robotic Systems - Basic components -Degreesof freedom - Robot joints coordinates- Reference frames - workspace- Robot languages- Robotic sensors- proximity and range sensors, ultrasonic sensor, touch and slip sensor.

UNIT II	ROBOT KINEMATICS AND DYNAMICS	9

Kinematic Modelling: Translation and Rotation Representation, Coordinate transformation, DH parameters, Forward and inverse kinematics, Jacobian, Dynamic Modelling: Forward and inverse dynamics, Equations of motion using Euler-Lagrange formulation, Newton Euler formulation.

UNIT III	ROBOT KINEMATICS AND DYNAMICS	9

Propositional Logic - Reasoning Based on Adopting a Premise, Inference Based on NaturalDeduction. 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	ROBOT INTELLIGENCE AND TASK PLANNING	9

Artificial Intelligence - techniques - search problem reduction - predicate logic means and end analysis - problem solving -robot learning - task planning - basic problems in task planning - AI in robotics and Knowledge Based Expert System in robotics

UNIT V	INDUSTRIAL ROBOTICS	9

Robot cell design and control - cell layouts - multiple robots and machine interference - work cell design - work cell control - interlocks – error detection deduction and recovery - work cell controller - robot cycle time analysis. Safety in robotics, Applications of robot and future scope.

COURSE OUTCOMES:

At the end of the course the student will be able to

CO1: Describe the fundamentals of robotics

CO2: Understand the concept of kinematics and dynamics in robotics.

CO3: Discuss the robot control techniques

CO4: Explain the basis of intelligence in robotics and task planning

CO5: Discuss the industrial applications of robotics.

TOTAL:45 PERIODS

REFERENCE:

1. John J. Craig, 'Introduction to Robotics (Mechanics and Control)', Addison-Wesley, 2nd Edition, 2004.
2. Richard D. Klafter, Thomas A. Chmielewski, Michael Negin, 'Robotics Engineering: AnIntegrated Approach', PHI Learning, New Delhi, 2009.
3. K.S.Fu, R.C.Gonzalez and C.S.G.Lee, 'Robotics Control, Sensing, Vision and Intelligence', Tata McGraw Hill, 2nd Reprint,2008.
4. Reza N.Jazar, 'Theory of Applied Robotics Kinematics, Dynamics and Control', Springer, 1st Indian Reprint, 2010.
5. Mikell. P. Groover, Michell Weis, Roger. N. Nagel, Nicolous G.Odrey, 'Industrial Robotics Technology, Programming and Applications ', McGraw Hill, Int 2012.

CS4309	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
- To explore semantics of words and semantic role labeling of sentences
- To understand discourse analysis, question answering and chatbots

UNIT I	INTRODUCTION	9
Natural Language Processing – Components - Basics of Linguistics and Probability andStatistics – Words-Tokenization-Morphology-Finite State Automata		
UNIT II	**STATISTICAL NLP AND SEQUENCE LABELING**	**9**
N-grams and Language models –Smoothing -Text classification- Naïve Bayes classifier – Evaluation - Vector Semantics – TF-IDF - Word2Vec- Evaluating Vector Models -Sequence Labeling **–** Part of Speech – Part of Speech Tagging -Named Entities **–**Named Entity Tagging		
UNIT III	**CONTEXTUAL EMBEDDING**	**9**
Constituency –Context Free Grammar –Lexicalized Grammars- CKY Parsing – Earley's algorithm- Evaluating Parsers -Partial Parsing – Dependency Relations- Dependency Parsing - Transition Based - Graph Based		
UNIT IV	**COMPUTATIONAL SEMANTICS**	**9**
Word Senses and WordNet – Word Sense Disambiguation – Semantic Role Labeling –Proposition Bank- FrameNet- Selectional Restrictions - Information Extraction - Template Filling		
UNIT V	**DISCOURSE ANALYSIS AND SPEECH PROCESSING**	**9**
Discourse Coherence – Discourse Structure Parsing – Centering and Entity Based Coherence – Question Answering –Factoid Question Answering – Classical QA Models – Chatbots and Dialogue systems – Frame-based Dialogue Systems – Dialogue–State Architecture		

COURSE OUTCOMES:

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 searchingsystem using the concepts of NLP

CO5: Implement a simple chatbot using dialogue system concepts

TOTAL : 45 PERIODS

REFERENCES

1. Daniel Jurafsky and James H.Martin, "Speech and Language Processing: An Introductionto 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 Pythonand NLTK, 2019
4. Christopher Manning, "Foundations of Statistical Natural Language Processing", MITPress, 2009.
5. Nitin Indurkhya,Fred J. Damerau, "Handbook of Natural Language Processing", Secondedition, 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 LifeSciences, 2015

CS4310	GPU COMPUTING	L T P C 3 0 0 3

COURSE OBJECTIVES:

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

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.

COURSE OUTCOMES:

CO1: Describe GPU Architecture

CO2: Write programs using CUDA, identify issues and debug them

CO3: Implement efficient algorithms in GPUs for common application kernels, such asmatrix multiplication

CO4: Write simple programs using OpenCL

CO5: Identify efficient parallel programming patterns to solve problems

TOTAL: 45 PERIODS

REFERENCES

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

CS4311	DEVOPS AND MICROSERVICES(Lab Integrated)	L T P C 3 0 2 4

COURSE OBJECTIVES:

- To learn the basic concepts and terminology of DevOps
- To gain knowledge on Devops platform
- To understand building and deployment of code
- To be familiar with DevOps automation tools
- To learn basics of MLOps

UNIT I	INTRODUCTION	9

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

UNIT II	DEVOPS PLATFORM AND SERVICES	9

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	9

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	9

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

UNIT V	MLOPS	9

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

SUGGESTED ACTIVITIES:

1. Creating a new Git repository, cloning existing repository, Checking changes into a Git repository, Pushing changes to a Git remote, Creating a Git branch
2. Installing Docker container on windows/Linux, issuing docker commands
3. Building Docker Images for Python Application
4. Setting up Docker and Maven in Jenkins and First Pipeline Run
5. Running Unit Tests and Integration Tests in Jenkins Pipelines

COURSE OUTCOMES:

CO1: Implement modern software Engineering process

CO2: work with DevOps platform

CO3: build, test and deploy code

CO4: Explore DevOps tools

CO5: Correlate MLOps concepts with real time examples

	THEORY 45 PERIODS **PRACTICALS 30 PERIODS** **TOTAL:75 PERIODS**
REFERENCES	
1. Len Bass, Ingo Weber and Liming Zhu, —"DevOps: A Software Architect's Perspective", Pearson Education, 2016 2. Joakim Verona - "Practical DevOps" - Packet Publishing , 2016 3. Viktor Farcic -"The DevOps 2.1 Toolkit: Docker Swarm" - Packet Publishing, 2017 4. Mark Treveil, and the Dataiku Team-"Introducing MLOps" - O'Reilly Media- 2020	

CS4312	**MOBILE APPLICATION DEVELOPMENT(Lab Integrated)**	**L T P C** **3 0 2 4**
COURSE OBJECTIVES: • To facilitate students to understand android SDK • To help students to gain basic understanding of Android application development		
• To understand how to work with various mobile application development frameworks • To inculcate working knowledge of Android Studio development tool • To learn the basic and important design concepts and issues of development ofmobile applications		
UNIT I	**MOBILE PLATFORM AND APPLICATIONS**	**9**
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**	**9**
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**	**9**
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**	**9**
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**	**9**

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.

LIST OF EXPERIMENTS:

1. Develop an application that uses GUI components, Font, Layout Managers andevent listeners.
2. Develop an application that makes use of databases
3. Develop a native application that uses GPS location information
4. Implement an application that creates an alert upon receiving a message
5. Develop an application that makes use of RSS Feed.
6. Create an application using Sensor Manager
7. Create an android application that converts the user input text to voice.
8. Develop a Mobile application for simple and day to day needs (Mini Project)

COURSE OUTCOMES:

CO1: Identify various concepts of mobile programming that make it unique from programming forother platforms

CO2: Create, 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: Create interactive applications in android using databases with multiple activities includingaudio, video and notifications and deploy them in marketplace

THEORY 45 PERIODS
PRACTICALS 30 PERIODS
TOTAL:75 PERIODS

REFERENCES

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

CS4313	DEEP LEARNING(Lab Integrated)	L T P C 3 0 2 4

COURSE OBJECTIVES:

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

UNIT I	DEEP LEARNING CONCEPTS	9

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	9

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

UNIT III	CONVOLUTIONAL NEURAL NETWORK	9

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

UNIT VI	NATURAL LANGUAGE PROCESSING USING RNN	9

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). Gatedrecurrent unit GRU.

UNIT V	DEEP REINFORCEMENT & UNSUPERVISED LEARNING	9

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

LIST OF EXPERIMENTS:

1. Feature Selection from Video and Image Data
2. Image and video recognition
3. Image Colorization
4. Aspect Oriented Topic Detection & Sentiment Analysis
5. Object Detection using Autoencoder

COURSE OUTCOMES:

CO1: Feature Extraction from Image and Video Data

CO2: Implement Image Segmentation and Instance Segmentation in Images

CO3: Implement image recognition and image classification using a pretrained network (Transfer Learning)

CO4: Traffic Information analysis using Twitter Data

CO5: Autoencoder for Classification & Feature Extraction

THEORY 45 PERIODS
PRACTICALS 30 PERIODS
TOTAL:75 PERIODS

REFERENCES

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

CS4314	**BLOCKCHAIN TECHNOLOGIES(Lab Integrated)**	**L T P C 3 0 2 4**

COURSE OBJECTIVES:

- This course is intended to study the basics of Blockchain technology.
- During this course the learner will explore various aspects of Blockchain technology likeapplication in various domains.
- By implementing, learners will have idea about private and public Blockchain, and smartcontract.

UNIT I	**INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN**	**9**

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

UNIT II	**BITCOIN AND CRYPTOCURRENCY**	**9**

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, Blockchain and Digital Currency, Transactional Blocks, Impact of Blockchain Technology on Cryptocurrency

UNIT III	**INTRODUCTION TO ETHEREUM**	**9**

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

UNIT IV	INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING	9

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	9

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

LIST OF EXPERIMENTS:

1. Create a Simple Blockchain in any suitable programming language.
2. Use Geth to Implement Private Ethereum Block Chain.
3. Build Hyperledger Fabric Client Application.
4. Build Hyperledger Fabric with Smart Contract.
5. Create Case study of Block Chain being used in illegal activities in real world.
6. Using Python Libraries to develop Block Chain Application.

SUPPLEMENTARY RESOURCES

- NPTEL online course : https://nptel.ac.in/courses/106/104/106104220/#
- Udemy: https://www.udemy.com/course/build-your-blockchain-az/
- EDUXLABS Online training :https://eduxlabs.com/courses/blockchain-technology- training/?tab=tab-curriculum

COURSE OUTCOMES:

After the completion of this course, student will be able to

CO1: Understand and explore the working of Blockchain technology

CO2: Analyze the working of Smart Contracts

CO3: Understand and analyze the working of Hyperledger

CO4: Apply the learning of solidity to build de-centralized apps on Ethereum

CO5: Develop applications on Blockchain

THEORY 45 PERIODS
PRACTICALS 30 PERIODS
TOTAL:75 PERIODS

REFERENCE:

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

CS4315	EMBEDDED SOFTWARE DEVELOPMENT	L T P C 3 0 2 4

COURSE OBJECTIVES:

- To understand the architecture of embedded processor, microcontroller, and peripheral devices.
- To interface memory and peripherals with embedded systems.
- To study the embedded network environment.
- To understand challenges in Real time operating systems.
- To study, analyse 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.

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.

SUGGESTED ACTIVITIES:

1. Study of ARM evaluation system
2. Interfacing ADC and DAC.
3. Interfacing LED and PWM.
4. Interfacing real time clock and serial port.
5. Interfacing keyboard and LCD.
6. Interfacing EPROM and interrupt.
7. Principles of Mailbox.
8. Interrupt performance characteristics of ARM and FPGA.
9. Flashing of LEDS.

Interfacing stepper motor and temperature sensor.

COURSE OUTCOMES:

CO1: Understand different architectures of embedded processor, microcontroller and peripheral devices. Interface memory and peripherals with embedded systems.
CO2: Interface memory and peripherals with embedded systems.
CO3: Work with embedded network environment.
CO4: Understand challenges in Real time operating systems.
CO5: Design and 85nalyse applications on embedded systems.

THEORY 45 PERIODS
PRACTICALS 30 PERIODS
TOTAL:75 PERIODS

REFERENCES

1. Adrian McEwen, Hakim Cassimally, "Designing the Internet of Things" Wiley Publication,First edition, 2013
2. Andrew N Sloss, D. Symes, C. Wright, Arm system developers guide, Morgan Kauffman/Elsevier, 2006.
3. ArshdeepBahga, Vijay Madisetti, " Internet of Things: A Hands-on-Approach" VPT First Edition, 2014
4. C. M. Krishna and K. G. Shin, “Real-Time Systems , McGraw-Hill, 1997
5. Frank Vahid and Tony Givargis, “Embedded System Design: A Unified Hardware/Software Introduction, John Wiley & Sons.1999
6. Jane.W.S. Liu, “Real-Time systems, Pearson Education Asia,2000
7. Michael J. Pont, “Embedded C, Pearson Education, 2007.
8. Muhammad Ali Mazidi , SarmadNaimi , SepehrNaimi, "The AVR Microcontroller and Embedded Systems: Using Assembly and C" Pearson Education, First edition, 2014
9. Steve Heath, “Embedded System Design, Elsevier, 2005
10. Wayne Wolf, “Computers as Components:Principles of Embedded Computer System Design, Elsevier, 2006.

CS4316	FULL STACK WEB APPLICATION DEVELOPMENT(Lab Integrated)	L T P C 3 0 2 4

COURSE OBJECTIVES:

- Develop TypeScript Application
- Develop Single Page Application (SPA)
- Able to communicate with a server over the HTTP protocol
- Learning all the tools need to start building applications with Node.js
- 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. 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.

LIST OF EXPERIMENTS

1. Accessing the Weather API from Angular
2. Accessing the Stock Market API from Angular
3. Call the Web Services of Express.js From Angular
4. Read the data in Node.js from MongoDB
5. CRUD operation in MongoDB using Angular

COURSE OUTCOMES:

CO1: Develop basic programming skills using Javascript
CO2: Implement a front-end web application using Angular.
CO3: Will be able to create modules to organise 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

THEORY 45 PERIODS
PRACTICALS 30 PERIODS
TOTAL:75 PERIODS

REFERENCES

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
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

CS4317	BIO INFORMATICS(Lab Integrated)	L T P C 3 0 2 4

COURSE OBJECTIVES:

- Exposed to the need for Bioinformatics technologies
- Be familiar with the modeling techniques
- Learn microarray analysis
- Exposed to Pattern Matching and Visualization
- To know about Microarray Analysis

UNIT I	INTRODUCTION	9

Need for Bioinformatics technologies – Overview of Bioinformatics technologies Structural bioinformatics – Data format and processing – Secondary resources and applications – Role of Structural bioinformatics – Biological Data Integration System.

UNIT II	DATAWAREHOUSING AND DATAMINING IN BIOINFORMATICS	9

Bioinformatics data – Data warehousing architecture – data quality – Biomedical data analysis – DNA data analysis – Protein data analysis – Machine learning – Neural network architectureand applications in bioinformatics.

UNIT III	MODELING FOR BIOINFORMATICS	9

Hidden Markov modeling for biological data analysis – Sequence identification –Sequence classification – multiple alignment generation – Comparative modeling –Protein modeling – genomic modeling – Probabilistic modeling – Bayesian networks – Boolean networks – Molecular modeling – Computer programs for molecular modeling.

UNIT IV	PATTERN MATCHING AND VISUALIZATION	9

Gene regulation – motif recognition – motif detection – strategies for motif detection – Visualization – Fractal analysis – DNA walk models – one dimension – two dimension – higher dimension – Game representation of biological sequences – DNA, Protein, Amino acid sequences.

UNIT V	MICROARRAY ANALYSIS	9

Microarray technology for genome expression study – image analysis for data extraction – preprocessing – segmentation – gridding – spot extraction – normalization, filtering – cluster analysis – gene network analysis – Compared Evaluation of Scientific Data Management Systems
– Cost Matrix – Evaluation model – Benchmark – Tradeoffs.

LIST OF EXPERIMENTS:

1. Manipulating DNA strings
2. Use Protein Data Bank to visualize and Analyze the Proteins from protein database
3. Explore the Human Genome with the SciPy Stack
4. Hidden Markov Model for Biological Sequence
5. Molecular Modeling using MMTK package
6. Sequence Alignment using Biopython, Pairwise and multiple sequence alignment using ClustalW and BLAST
7. Simple generation and manipulation of genome graphs
8. DNA data handling using Biopython
9. Chaos Game Representation of a genetic sequence
10. Visualize the microarray data using Heatmap

COURSE OUTCOMES:

CO1: Understand the different Data formats

CO2: Develop machine learning algorithms.

CO3: Develop models for biological data.

CO4: Apply pattern matching techniques to bioinformatics data – protein data genomic data.

CO5: Apply micro array technology for genomic expression study.

THEORY 45 PERIODS
PRACTICALS 30 PERIODS
TOTAL:75 PERIODS

REFERENCES

1. Yi-Ping Phoebe Chen (Ed), "BioInformatics Technologies", First Indian Reprint, Springer Verlag, 2007.
2. Bryan Bergeron, "Bio Informatics Computing", Second Edition, Pearson Education, 2015.
3. Arthur M Lesk, "Introduction to Bioinformatics", Second Edition, Oxford University Press, 2019

CS4318	CYBER PHYSICAL SYSTEMS	L T P C 3 0 2 4

COURSE OBJECTIVES:

- To learn about the principles of cyber-physical systems
- To familiarize with the basic requirements of CPS.
- To know about CPS models
- To facilitate the students to understand the CPS foundations
- To make the students explore the applications and platforms.
- To provide introduction to practical aspects of cyber physical systems.
- To equip students with essential tools to implement CPS.

UNIT I	INTRODUCTION TO CYBER-PHYSICAL SYSTEMS	9

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**	**9**

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

UNIT III	**CPS MODELS**	**9**

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**	**9**

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

UNIT V	**APPLICATIONS AND PLATFORMS**	**9**

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

LIST OF EXPERIMENTS

1. Installation of Xilinx SDK, LABVIEW, MatLab and Cybersim
2. Installation of, myRIO iRobot Create Wiring, Kobuki Wiring
3. CPS DEsign with the iRobot Create
4. CPS Design with the Kobuki.
5. Write a program in MATLAB to implement open loop system stability.
6. Write a program in MATLAB to implement timed automation.

COURSE OUTCOMES:

CO1: Explain the core principles behind CPS

CO2: Discuss the requirements of CPS.

CO3: Explain the various models of CPS.

CO4: Describe the foundations of CPS.

CO5: Use the various platforms to implement the CPS.

THEORY 45 PERIODS

PRACTICALS 30 PERIODS

TOTAL:75 PERIODS

REFERENCES

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

CS4319	MIXED REALITY(Lab Integrated)	L T P C 3 0 2 4

COURSE OBJECTIVES:

- To study about Fundamental Concept and Components of Virtual Reality
- To study about Interactive Techniques in Virtual Reality
- To study about Visual Computation in Virtual Reality
- To study about Augmented and Mixed Reality and Its Applications
- To know about I/O Interfaces and its functions.

UNIT I	INTRODUCTION TO VIRTUAL REALITY	9

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

UNIT II	INTERACTIVE TECHNIQUES IN VIRTUAL REALITY	9

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	9

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.

UNIT IV	AUGMENTED AND MIXED REALITY	9

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	9

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, Modeling virtual world, Physical simulation, VR toolkits, Introduction to VRML, Input -- Tracker, Sensor, Digitalglobe, 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: 45 PERIODS

PRACTICALS:

1. Study of tools like Unity, Maya, 3DS MAX, AR toolkit, Vuforia and Blender.
2. Use the primitive objects and apply various projection methods by handling the camera.
3. Download objects from asset stores and apply various lighting and shading effects.
4. Model three dimensional objects using various modeling techniques and apply textures over them.
5. Create three dimensional realistic scenes and develop simple virtual reality enabled mobile applications which have limited interactivity.
6. Add audio and text special effects to the developed application.
7. Develop VR enabled applications using motion trackers and sensors incorporating full haptic interactivity.
8. Develop AR enabled applications with interactivity like E learning environment, Virtual walkthroughs and visualization of historic places.
9. Develop MR enabled simple applications like human anatomy visualization, DNA/RNA structure visualization and surgery simulation.
10. Develop simple MR enabled gaming applications.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

CO1: Understand the Fundamental Concept and Components of Virtual Reality

CO2: Able to know the Interactive Techniques in Virtual Reality

CO3: Can know about Visual Computation in Virtual Reality

CO4: Able to know the concepts of Augmented and Mixed Reality and Its Applications

CO5: Know about I/O Interfaces and its functions.

THEORY 45 PERIODS
PRACTICALS 30 PERIODS
TOTAL:75 PERIODS

REFERENCES

1. Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition. Wiley-IEEE Press, 2003/2006.
2. Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann,First Edition 2013.
3. Alan Craig, William Sherman and Jeffrey Will, Developing Virtual Reality Applications, Foundations of Effective Design, Morgan Kaufmann, 2009.
4. John Vince, "Virtual Reality Systems ", Pearson Education Asia, 2007.
5. Adams, "Visualizations of Virtual Reality", Tata McGraw Hill, 2000.
6. Grigore C. Burdea, Philippe Coiffet , "Virtual Reality Technology", Wiley Inter Science, 2nd

OC4301	MACHINE LEARNING AND DEEP LEARNING	L T P C 3 0 0 3

COURSE OBJECTIVES:

The course is aimed at

- Understanding about the learning problem and algorithms
- Providing insight about neural networks
- Introducing the machine learning fundamentals and significance
- Enabling the students to acquire knowledge about pattern recognition.
- 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.

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

COURSE OUTCOMES (CO):

At the end of the course the student will be able to

CO1 : Illustrate the categorization of machine learning algorithms.

CO2: Compare and contrast the types of neural network architectures, activation functions

CO3: Acquaint with the pattern association using neural networks

CO4: Elaborate various terminologies related with pattern recognition and architectures ofconvolutional neural networks

CO5: Construct different feature selection and classification techniques and advanced neuralnetwork architectures such as RNN, Autoencoders, and GANs.

REFERENCES:

1. J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A ComputationalApproach 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.

OC4302	BIG DATA ANALYTICS	L T P C 3 0 0 3

COURSE OBJECTIVES:

- To understand the basics of big data analytics
- To understand the search methods and visualization
- To learn mining data streams
- To learn frameworks
- To gain knowledge on R language

UNIT I	INTRODUCTION TO BIG DATA	9

Introduction to Big Data Platform – Challenges of Conventional Systems - Intelligent data analysis –Nature of Data - Analytic Processes and Tools - Analysis Vs Reporting - Modern Data Analytic Tools- Statistical Concepts: Sampling Distributions - Re-Sampling - Statistical Inference - Prediction Error.

UNIT II	SEARCH METHODS AND VISUALIZATION	9

Search by simulated Annealing – Stochastic, Adaptive search by Evaluation – Evaluation Strategies – Genetic Algorithm – Genetic Programming – Visualization – Classification of Visual Data Analysis Techniques – Data Types – Visualization Techniques – Interaction techniques – Specific Visual data analysis Techniques

UNIT III	MINING DATA STREAMS	9

Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window - Real time Analytics Platform(RTAP) Applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions

UNIT IV	FRAMEWORKS	9

MapReduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases - S3 - Hadoop Distributed FileSystems – Case Study- Preventing Private Information Inference Attacks on Social Networks- Grand Challenge: Applying Regulatory Science and Big Data to Improve Medical Device Innovation

UNIT V	R LANGUAGE	9

Overview, Programming structures: Control statements -Operators -Functions -Environment and scope issues -Recursion -Replacement functions, R data structures: Vectors -Matrices and arrays -Lists -Data frames -Classes, Input/output, String manipulations

COURSE OUTCOMES:

CO1:understand the basics of big data analytics

CO2: Ability to use Hadoop, Map Reduce Framework.

CO3: Ability to identify the areas for applying big data analytics for increasing the businessoutcome.

CO4:gain knowledge on R language

CO5: Contextually integrate and correlate large amounts of information to gain faster insights.

TOTAL:45 PERIODS

REFERENCE:

1. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.
2. Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, CambridgeUniversity Press, 3rd edition 2020.
3. Norman Matloff, The Art of R Programming: A Tour of Statistical Software Design,No Starch Press, USA, 2011.
4. Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge DataStreams with Advanced Analytics, John Wiley & sons, 2012.
5. Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007.

AC4001	ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES:

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

UNIT I	INTRODUCTION TO RESEARCH PAPER WRITING	6

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

UNIT II	PRESENTATION SKILLS	6

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

UNIT III	TITLE WRITING SKILLS	6

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

UNIT IV	RESULT WRITING SKILLS	6

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

UNIT V	VERIFICATION SKILLS	6

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

		45 PERIODS

COURSE OUTCOMES:

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

REFERENCES

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's 5. book 1998

AC4002	DISASTER MANAGEMENT	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES:

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

UNIT I	INTRODUCTION	6

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

UNIT II	REPERCUSSIONS OF DISASTERS AND HAZARDS	6

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

UNIT III	DISASTER PRONE AREAS IN INDIA	6

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

UNIT IV	DISASTER PREPAREDNESS AND MANAGEMENT	6

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

UNIT V	RISK ASSESSMENT	6

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

		45 PERIODS

COURSE OUTCOMES:

CO1 - Ability to summarize basics of disaster

CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO5: Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCES

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

AC4003	CONSTITUTION OF INDIA	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES:

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

UNIT I	HISTORY OF MAKING OF THE INDIAN CONSTITUTION	6

History, Drafting Committee, (Composition & Working)

UNIT II	PHILOSOPHY OF THE INDIAN CONSTITUTION	6

Preamble, Salient Features

UNIT III	CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES	6

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

UNIT IV	ORGANS OF GOVERNANCE	6

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

UNIT V	LOCAL ADMINISTRATION	6

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

UNIT VI	ELECTION COMMISSION	6

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

		30 PERIODS

COURSE OUTCOMES:

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

SUGGESTED READING

1. The Constitution of India,1950(Bare Act), Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edn., LexisNexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, LexisNexis, 2015.

AC4004	நற்றமிழ் இலக்கியம்	L	T	P	C
		2	0	0	0
UNIT I	சங்க இலக்கியம் 1. தமிழின் Fவக்க நூல் ததொல்கொப்பியம் எழுத்F, ,தசொல், தபொருள் 2. அகநொனூறு (82) இயற்கக இன் னிகச அரங் கம் 3. குறிஞ்சிப் பொட்டின் மலரக் கொட்சி 4. புறநொனூறு (95,195) – பபொகர நிறுத்திய ஔகவயொர்				6
UNIT II	அறதநறித்தமிழ் 1. அறதநறி வகுத்த திருவள்ளுவர் - அறம் வலியுறுத்தல், அன் புகடகம,ஒப்புறவு அறிதல், ஈகக, புகழ் 2. பிற அறநூல் கள் - இலக்கிய மருந்F – ஏலொதி, சிறுபஞ்ச மூலம், திரிகடுகம், ஆசொரக்பகொகவ (தூய் கமகய வலியுறுத்Fம் நூல்)				6
UNIT III	இரட்கடக்கொப்பியங் கள் 1. கண் ணகியின் புரட்சி - சிலப்பதி கொர வழக்குகர கொகத 2. சமூக பசகவ இலக்கியம் மணிபமகல - சிகரபகொட்டம் அறக்கபகொட்டமொகிய கொகத				6
UNIT IV	அருள் தநறித்தமிழ் 1. சிறுபொணொற்றுப்பகட – பொரி முல் கலக்குத் பதர்தகொடுத்தF, பபகன் மயிலுக்குப் பபொரக் வ தகொடுத்தF, அதியமொன் ஔகவக்கு தநல் லிக்கனி தகொடுத்தF, அரசர் பண் புகள் 2. நற்றிகண - அன் கனக்குரிய புன் கன சிறப்பு 3. திருமந்திரம் (617, 618) - இயமம் நியமம் விதிகள் 4. தர்மசொகலகய நிறுவிய வள்ளலொர் 5. புறநொனூறு - சிறுவபன வள்ளலொனொன் 6. அகநொனூறு (4) - வண் டு நற்றிகண (11) - நண் டு கலித்ததொகக (11) – யொகன, புறொ ஐந்திகண 50 (27) - மொன் ஆகியகவ பற்றி தசய் திகள்				6
UNIT V	நவீன தமிழ் இலக்கியம் 1.உகர நகடத்தமிழ். தமிழின் முதல் புதினம், தமிழின் முதல் சிறுககத				6

	கட்டுகர இலக்கியம், பயண இலக்கியம் நொடகம், 2. நொட்டு விடுதகல பபொரொட்டமும் தமிழ் இலக்கியமும், 3. சமதொய விடுதகலயும் தமிழ் இலக்கியமும், 4. தபண் விடுதகலயும் விளிம்பு நிகலயினரின் பமம்பட்டில் தமிழ் இலக்கியமும், 5. அறிவியல் தமிழ், 6. இகணயத்தில் தமிழ் 7. சுற்று சூழல் பமம்பொட்டில் தமிழ் இலக்கியம்	

30 PERIODS

தமிழ் இலக்கிய தவளியீடுகள் / புத்தகங்கள்

1.தமிழ் இகணய கல்விக்கழகம் (Tamil Virtual University)
- www.tamilvu.org
2. தமிழ் விக்கிப்பீடியொ (Tamil Wikipedia)
-https://ta.wikipedia.org
3. தர்மபுர ஆதீன தவளியீடு
4. வொழ்வியல் களஞ்சியம்
- தமிழ்ப் பல்ககலக்கழகம், தஞ்சொவூர்
5. தமிழ்கககலக்களஞ்சியம்
- தமிழ் வளர்ச்சி த் Fகற (thamilvalarchithurai.com)
6. அறிவியல் களஞ்சியம்
- தமிழ்ப் பல்ககலக்கழகம், தஞ்சொவூர்

SS4211 **SOFTWARE DEFINED NETWORKS** **L T P C**
3 0 0 3

OBJECTIVES:

- To understand the concepts of software defined networks
- To learn the interface between networking devices and the software controlling them
- To learn network virtualization and tools
- To explore modern approaches like VMware, open flow, open stack

UNIT I SOFTWARE DEFINED NETWORK (SDN) **9**

Introduction – Centralized and Distributed Control and Data Planes – Open Flow – SDN Controllers – General Concepts – VLANs – NVGRE – Open Flow – Network Overlays – Types – Virtualization – Data Plane – I/O – Design of SDN Framework

UNIT II VIRTUALIZATION BASICS **9**

Primer on Virtualization, Benefits of virtual machines, Hypervisors, Managing Virtual resources, Virtualized cloud/data center

UNIT III NETWORK FUNCTIONS VIRTUALIZED **9**

Virtualize a Network, virtualizing appliances, virtualizing core networking functions, scalability and performance

UNIT IV MODERN NETWORKING APPROACHES **9**

Open flow, VMware NSX, Open Day Light project-ODL architecture & controller platform, control network, Business case for SDN

UNIT V SECURITY & VISIBILITY **9**

Security-Preventing Data leakage, Logging and auditing, Encryption in Virtual Networks Visibility-Overlay networks, Network management tools, Monitoring Traffic

TOTAL: 45 PERIODS

OUTCOMES:

Upon successful completion of this course, a student will be able to:

- To identify/design software defined network for the required application/platform
- To deploy network virtualization tool & design
- To equip in various network security measures and tackle

REFERENCES:

1. Jim Doherty,"SDN and NFV Simplified", Addison Wesley, 2016
2. SiamakAzodoimolky, "Software Defined Networking with Open Flow", Packt Publishing Limited, 2013 3. Thomas D.Nadeau and Ken Gray, ―SDN – Software Defined Networks‖, O‟Reilly Publishers, 2013

SS4212 SOFTWARE SECURITY L T PC
3 0 0 3

UNIT I LOW-LEVEL ATTACKS 9

Need for Software Security – Memory-Based Attacks – Low-Level Attacks Against Heap And Stack - Stack Smashing – Buffer Overflow – Code Injection - Format String Attacks – ROP (Return Oriented Programming) – Defense a gainst Memory-Based Attacks – Stack Canaries – Non- Executable Data - Address Space Layout Randomization (ASLR)- Memory-Safety Enforcement - Control-Flow Integrity (CFI) – Randomization

UNIT II WEB SECURITY AND SECURE DESIGN 9

SQL Injection - Session Hijacking – Cross-Site Scripting (XSS), Cross-Site Forgery (CSRF) – Database Security – File Security - Secure Design - Threat Modeling and Security Design Principles - Good and Bad Software Design

UNIT III SECURITY RISK MANAGEMENT 9

Risk Management Life Cycle – Risk Profiling – Risk Exposure Factors – Risk Evaluation and Mitigation – Risk Assessment Techniques – Threat and Vulnerability Management

UNIT IV SECURITY TESTING 9

Traditional Software Testing – Comparison - Secure Software Development Life Cycle - Risk Based Security Testing – Prioritizing Security Testing with Threat Modeling – Shades of Analysis: White, Grey, and Black Box Testing.

UNIT V PENETRATION TESTING 9

Advanced Penetration Testing – Planning And Scoping – DNS Groper – DIG (Domain Information Graph) – Enumeration – Remote Exploitation – Web Application Exploitation - Exploits And Client Side Attacks – Post Exploitation – Bypassing Firewalls and Avoiding Detection - Tools for Penetration Testing

TOTAL: 45 PERIODS

REFERENCES

1. Robert C. Seacord, “Secure Coding in C and C++ (SEI Series in Software Engineering)”, Addison-Wesley Professional, 2005.

2. Jon Erickson , “Hacking: The Art of Exploitation”, 2nd Edition, No Starch Press, 2008.

3. Mike Shema, “Hacking Web Apps: Detecting and Preventing Web Application Security Problems”, First edition, Syngress Publishing, 2012

4. Bryan Sullivan and Vincent Liu, “Web Application Security, A Beginner's Guide”, Kindle Edition, McGraw Hill, 2012

5. Evan Wheeler, “Security Risk Management: Building an Information Security Risk Management Program from the Ground Up”, First edition, Syngress Publishing, 2011

6. Chris Wysopal, Lucas Nelson, Dino Dai Zovi, and Elfriede Dustin, “The Art of Software Security Testing: Identifying Software Security Flaws (Symantec Press)”, Addison-Wesley Professional, 2006

7. Lee Allen, “Advanced Penetration Testing for Highly-Secured Environments: The Ultimate Security Guide (Open Source: Community Experience Distilled)”, Kindle Edition, Packt Publishing, 2012.

COURSE OUTCOMES:

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

CO1:Identify various vulnerabilities related to memory attacks.

CO2:Apply security principles in software development.

CO3:Evaluate the extent of security risks

CO4:Involve selection of testing techniques related to software security in the testing phase of software development.

CO5:Use tools for securing software.

SS4213 SOFTWARE RELIABILITY METRICS AND MODELS L T P C
3 0 0 3

UNIT I INTRODUCTION TO SOFTWARE TESTING 9

Background on Software Testing – Manual Testing –Automated Testing–Automated Test Life Cycle Methodology (ATLM) – Test Maturity Model – Test Automation Development – Overcoming False Expectations of Automated Testing – benefits – Test tool proposal.

UNIT II SOFTWARE RELIABILITY CONCEPTS 9

Basic Ideas of Software Reliability, Hardware reliability vs. Software reliability, Reliability metrics, Failure and Faults – Prevention, Removal, Tolerance, Forecast, Dependability Concept – Failure Behaviour, Characteristics, Maintenance Policy, Reliability and Availability Modeling, Reliability Evaluation Testing methods, Limits, Starvation, Coverage, Filtering, Microscopic Model of Software Risk.

UNIT III COMPUTATIONAL SOFTWARE RELIABILITY 9

Computation of software reliability, Functional and Operational Profile, Operational Profiles – Difficulties, Customer Type, User Type, System Mode, Test Selection - Selecting Operations, Regression Test.

UNIT IV RELIABILITY MODELING 9

Classes of software reliability Models, Time Dependent Software Reliability Models: Time between failure reliability Models, Fault Counting Reliability Models. Time Independent Software Reliability Models: Fault injection model of Software Reliability, Input Domain Reliability Model, Orthogonal defect classification, Software availability Models. Software Reliability Modeling: A general procedure for reliability modeling.

UNIT V RELIABILITY METRICS 9

Short and Long Term Prediction, Model Accuracy, Analysing Predictive Accuracy – Outcomes, PLR, U and Y Plot, Errors and Inaccuracy, Recalibration – Detecting Bias, Different Techniques, Power of Recalibration, Limitations in Present Techniques, Improvements.

TOTAL: 45 PERIODS

REFERENCES

1. John D. Musa, Software Reliability Engineering: More Reliable Software and Cheaper, AuthorHouse, 2nd Edition, 2004.
2. Hoan g Pham, Software Reliability, Springer Verlag, New York , 2000.
3. Michael R. Lyu,Software Reliability Engineering, IEEE Computer Society Press (Digital Version), 2011.
4. Michael R. Lyu, Software Fault Tolerance, Wiley (Digital Version), 2007.
5. Patric D. T.O Connor, Andre Kleyner: Practical Reliability Engineering, 5th Edition, John Wesley & Sons , 2012
6. D. Reled, Software Reliability Methods, Springer Verlag, New York , 2001

COURSE OUTCOMES:

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

CO1:Identify and apply various software metrics, which determine the quality level of software.
CO2:Identify and evaluate the reliability of any given software product.
CO3:Understand the fault handling and failure forecasting techniques in software systems.
CO4:Understand and Comprehend different time-dependent and time-independent software reliability models.
CO5:Design reliability models for evaluating the quality level of software systems based on the requirement.

SS4214 SOCIAL NETWORK ANALYSIS L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Introduction to Semantic Web: Limitations of current Web - Development of Semantic Web - Emergence of the Social Web - Social Network analysis: Development of Social Network Analysis - Key concepts and measures in network analysis - Applications of Social Network Analysis- Graph Essentials –Graph Basics – Graph Representation- Types of Graphs – Connectivity in Graphs – Special Graphs – Graph Algorithms.

UNIT II MODELLING, AGGREGATING AND KNOWLEDGE REPRESENTATION 9

Ontology and their role in the Semantic Web: Ontology-based knowledge Representation - Ontology languages for the Semantic Web: Resource Description Framework - Web Ontology Language - Modelling and aggregating social network data: State-of-the-art in network data representation - Ontological representation of social individuals - Ontological representation of social relationships - Aggregating and reasoning with social network data - Advanced representations.

UNIT III DETECTING AND MINING COMMUNITIES 9

Detecting communities in social networks - Definition of community - Evaluating communities - Methods for community detection and mining - Applications of community mining algorithms - Tools for detecting communities social network infrastructures and communities- Strategic network formation: game theoretic models for network creation/ user behaviour in social networks - Information diffusion in Social Media- Herd Behaviour -Information Cascades-Diffusion of Innovations-Epidemics

UNIT IV VISUALIZATION OF SOCIAL NETWORKS 9

Social Networks as Graphs- Random graph models/ graph generators- Graph theory - Centrality - Clustering - Node-Edge Diagrams - Matrix representation - Visualizing online social networks, Visualizing social networks with matrix-based representations - Matrix and Node-Link Diagrams - Hybrid representations - Applications - Cover networks - Community welfare - Collaboration networks - Co-Citation networks.

UNIT V APPLICATIONS 9

Classical Recommendation Algorithms- Recommendation Using Social Context-Evaluating Recommendations Behavior Analytics: Individual Behavior- Collective Behavior- Hacking on Twitter Data-Twitter: Friends, Followers, and Set wise Operations-Analyzing Tweets-Visualizing tons of tweets.

TOTAL: 45 PERIODS

REFERENCES

1. R. Zafarani, M. Abbasi, and H. Liu,"Social Media Mining: An Introduction", Cambridge University Press, 2014.
2. Peter Mika, "Social Networks and the Semantic Web", First Edition, Springer 2007.
3. Borko Furht, "Handbook of Social Network Technologies and Applications", 1st Edition, Springer, 2010.
4. Guandong Xu ,Yanchun Zhang and Lin Li, "Web Mining and Social Networking – Techniques and applications", First Edition, Springer, 2011.
5. Dion Goh and Schubert Foo, "Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively", IGI Global Snippet, 2008.
6. Matthew A. Russell, "Mining the Social Web", O"Reilly Media,2nd edition, 2013.
7. Colleen McCue, "Data Mining and Predictive Analysis: Intelligence Gathering and Crime Analysis", Elsevier,2nd edition, 2015.

COURSE OUTCOMES:

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

CO1: Develop semantic web related applications.
CO2: Represent knowledge using ontology.
CO3: Predict human behaviour in social web and related communities.
CO4: Visualize social networks
CO5: Apply social network analysis techniques in real-life applications

SS4215	SEMANTIC WEB	L T P C
		3 0 0 3

UNIT I THE QUEST FOR SEMANTICS **9**

Building Models – Calculating with Knowledge – Exchanging Information – Semantic Web Technologies – Layers – Architecture – Components – Types – Ontological Commitments – Ontological Categories – Philosophical Background – Sample Knowledge Representation Ontologies – Top Level Ontologies – Linguistic Ontologies – Domain Ontologies – Semantic Web – Need – Foundation.

UNIT II LANGUAGES FOR SEMANTIC WEB AND ONTOLOGIES **9**

Web Documents in XML – RDF – Schema – Web Resource Description using RDF – RDF Properties – Topic Maps and RDF – Overview – Syntax Structure – Semantics – Pragmatics – Traditional Ontology Languages – LOOM – OKBC – OCML – Flogic Ontology Markup Languages – SHOE – OIL – DAML+OIL – OWL.

UNIT III ONTOLOGY LEARNING FOR SEMANTIC WEB **9**

Taxonomy for Ontology Learning – Layered Approach – Phases of Ontology Learning –Importing and Processing Ontologies and Documents – Ontology Learning Algorithms –Methods for evaluating Ontologies

UNIT IV ONTOLOGY MANAGEMENT AND TOOL **9**

Overview – Need for management – Development process – Target Ontology – Ontology mapping – Skills management system – Ontological class – Constraints – Issues – Evolution –Development of Tools and Tool Suites – Ontology Merge Tools – Ontology based Annotation Tools.

UNIT V APPLICATIONS **9**

Web Services – Semantic Web Services – Case Study for specific domain – Security issues – Web Data Exchange and Syndication – Semantic Wikis – Semantic Portals – Semantic Metadata in Data Formats – Semantic Web in Life Sciences – Ontologies for Standardizations – Rule Interchange Format.

TOTAL: 45 PERIODS

REFERENCES

1. Pascal Hitzler, Markus Krötzsch, Sebastian Rudolph, “Foundations of Semantic Web Technologies”, Chapman & Hall/CRC, 2009.

2. Asuncion Gomez-Perez, Oscar Corcho, Mariano Fernandez-Lopez, “Ontological Engineering: with Examples from the Areas of Knowledge Management, e-Commerce and the Semantic Web”, Springer, 2004.

3. Grigoris Antoniou, Frank van Harmelen, “A Semantic Web Primer (Cooperative Information Systems)”, MIT Press, 2004.

4. Alexander Maedche, “Ontology Learning for the Semantic Web”, First Edition, Springer. 2002.

5. John Davies, Dieter Fensel, Frank Van Harmelen, “Towards the Semantic Web: Ontology Driven Knowledge Management”, John Wiley, 2003.

6. John Davies, Rudi Studer, Paul Warren, (Editor), “Semantic Web Technologies: Trends and Research in Ontology-Based Systems”, Wiley, 2006.

COURSE OUTCOMES:

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

CO1:Create ontology for a given domain.
CO2:Develop an application using ontology languages and tools.
CO3:Understand the concepts of semantic Web.
CO4:Use ontology related tools and technologies for application creation.
CO5:Design and develop applications using semantic web.
CO6:Understand the standards related to semantic web.