

**ANNA UNIVERSITY  
CENTRE FOR DISTANCE EDUCATION  
MASTER OF COMPUTER APPLICATIONS  
REGULATIONS - 2023  
SEMESTER I**

Course Title	Credits*	Marks
Matrices, Probability and Statistics	4	100
Data Structures and Algorithms	4	100
Database Technology	3	100
Object Oriented Software Engineering	3	100
Python Programming	3	100
Research Methodology and Intellectual Property Rights	2	100
Database Technology Laboratory	2	100
Data Structures and Python Programming Laboratory	2	100
Communication Skills Enhancement - I	2	100
<b>TOTAL</b>	<b>25</b>	<b>900</b>

**SEMESTER II**

Course Title	Credits*	Marks
Internet Programming	4	100
Cloud Computing Technologies	3	100
Artificial Intelligence and Machine Learning	4	100
Mobile Application Development	3	100
Cyber Security	3	100
Professional Elective I	3	100
Internet Programming Laboratory	2	100
Artificial Intelligence and Machine Learning Laboratory	2	100
Communication Skills Enhancement - II	2	100
<b>TOTAL</b>	<b>26</b>	<b>900</b>

**SEMESTER III**

Course Title	Credits*	Marks
Data Science	4	100
Multimedia Systems and Applications	3	100
Accounting and Financial Management for Application Development	4	100
Professional Elective II	3	100
Professional Elective III	3	100
Professional Elective IV	3	100
Professional Elective V	3	100
Data Science Laboratory	2	100
Multimedia Systems and Applications Laboratory	2	100
<b>TOTAL</b>	<b>27</b>	<b>900</b>

**SEMESTER IV**

Course Title	Credits*	Marks
Project Work	12	400
<b>TOTAL</b>	<b>12</b>	<b>400</b>
<b>Total No. of Credits and Marks</b>	<b>90</b>	<b>3100</b>

\*Each credit is equivalent to 30 hours of student study comprising of all learning activities.

**PROFESSIONAL ELECTIVES  
ELECTIVE I - SEMESTER II**

Course Title	Credits*	Marks
Software Project Management	3	100
Agile Methodologies	3	100
E-Learning	3	100
Software Testing and Quality Assurance	3	100
Advanced Operating Systems	3	100
Web Content Design and Management	3	100

**ELECTIVE II - SEMESTER III**

Course Title	Credits*	Marks
Software Security	3	100
Next Generation Wireless Networks	3	100
Wireless Sensor Networks And Protocols	3	100
Semantic Web	3	100
Network Programming And Security	3	100
Service Oriented Architecture	3	100

**ELECTIVE III - SEMESTER III**

Course Title	Credits*	Marks
Social Network Analytics	3	100
Mixed Reality	3	100
Information Retrieval Techniques	3	100
Software Architecture	3	100
Ethical Hacking & Cyber Forensics	3	100
Data Warehousing and Data Mining	3	100

**ELECTIVE IV - SEMESTER III**

Course Title	Credits*	Marks
Data Visualization Techniques	3	100
Operations Research	3	100
Professional Ethics in Information Technology	3	100
Marketing Management	3	100
Organizational Behavior	3	100
Business Data Analytics	3	100

**ELECTIVE V - SEMESTER III**

Course Title	Credits*	Marks
Blockchain Technologies	3	100
User Interface Design	3	100
Soft Computing Techniques	3	100
Deep Learning	3	100
Big Data Processing	3	100
Natural Language Processing	3	100

## ANNEXURE - I

ANNA UNIVERSITY  
CENTRE FOR DISTANCE EDUCATION  
MASTER OF COMPUTER APPLICATIONS  
REGULATIONS - 2023  
SEMESTER I to IV

### MATRICES, PROBABILITY AND STATISTICS

CREDIT: 4

#### OBJECTIVES:

- Provide methods for understanding the consistency and solving the equation as well as for finding the Eigenvalues and Eigenvectors of square matrix.
- Present foundation on Applied Probability
- Introduce the concepts of correlation and regression of random variables
- Use various statistical techniques in Application problems
- Understand the concept of Design of Experiments for data analysis

#### UNIT - I MATRICES AND EIGENVALUE PROBLEMS

Matrices - Rank of a Matrix - Consistency of a system of linear equations - Solution of the matrix equation  $Ax = b$  - Row - reduced Echelon Form - Eigenvalues and Eigenvectors - Properties - Cayley - Hamilton Theorem - Inverse of a matrix.

#### UNIT - II PROBABILITY AND RANDOM VARIABLES

Probability - Axioms of Probability - Conditional Probability - Addition and multiplication laws of Probability - Baye's theorem - Random Variables - Discrete and continuous random variables - Probability mass function and Probability density functions - Cumulative distribution function - Moments and variance of random variables - Properties - Binomial, Poisson, Geometric, Uniform, Exponential, Normal distributions and their properties.

#### UNIT - III TWO-DIMENSIONAL RANDOM VARIABLES

Joint probability distributions - Marginal and conditional probability distributions - Covariance - Correlation - Linear regression lines - Regression curves - Transform of random variables - Central limit theorem (for independent identically random variables).

#### UNIT - IV TESTING OF HYPOTHESIS

Sampling distributions - Tests based on small and large samples - Normal, Student's t, Chi-square and F distributions for testing of mean, variance and proportion and testing of difference of means variances and proportions - Tests for independence of attributes and goodness of fit.

#### UNIT - V DESIGN OF EXPERIMENTS

Analysis of variance - Completely randomized design - Random block design (One-way and Two-way classifications) - Latin square design -  $2^2$  Factorial design.

#### OUTCOMES:

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

- Test the consistency and solve system of linear equations as well as find the Eigenvalues and Eigenvector.
- Apply the Probability axioms as well as rules and the distribution of discrete and continuous ideas in solving real world problems.
- Apply the concepts of correlation and regression of random variables in solving application problems.
- Use statistical techniques in testing hypothesis on data analysis.
- Use the appropriate statistical technique of design of experiments in data analysis.

**REFERENCE BOOKS:**

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 43rd Edition, New Delhi, 2015.
2. R.K. Jain and S.R.K Iyenger, Advanced Engineering Mathematics, Narosa Publishing House, New Delhi, 2002.
3. Devore, J.L, Probability and Statistics for Engineering and Sciences, Cengage Learning, 8th Edition, New Delhi, 2014.
4. Miller and M. Miller, Mathematical Statistics, Pearson Education Inc., Asia 7th Edition, New Delhi, 2011.
5. Richard Johnson, Miller and Freund's Probability and Statistics for Engineer, Prentice Hall of India Private Ltd., 8th Edition, New Delhi, 2011.

**OBJECTIVES:**

Understand and apply linear data structures-List, Stack and Queue

- Understand the graph algorithms.
- Learn different algorithm analysis techniques.
- Apply data structures and algorithms in real time applications
- Understand the principles of algorithm Design.
- Analyze the efficiency of an algorithm

**UNIT I LINEAR DATA STRUCTURES**

Introduction - Abstract Data Types (ADT) - Stack - Queue - Circular Queue - Double Ended Queue - Applications of stack - Evaluating Arithmetic Expressions - Other Applications - Applications of Queue - Linked Lists - Singly Linked List - Circularly Linked List - Doubly Linked lists - Applications of linked list - Polynomial Manipulation.

**UNIT II NON-LINEAR DATA STRUCTURES**

Binary Tree - expression trees - Binary tree traversals - applications of trees - Huffman Algorithm - Binary search tree - Balanced Trees - AVL Tree - B-Tree - Splay Trees.

**UNIT III GRAPHS**

Representation of graph - Graph Traversals - Depth-first and breadth-first traversal - Applications of graphs - Topological sort - shortest - path algorithms - Dijkstra's algorithm - Bellman - Floyd's Algorithm - minimum spanning tree - Prim's and Kruskal's algorithms.

**UNIT IV ALGORITHM DESIGN**

Divide and Conquer - Merge Sort - Quick Sort - Binary Search - Greedy Algorithms - Knapsack Problem - Dynamic Programming - Greedy Algorithms - Backtracking - Local Search Algorithms.

**UNIT V ALGORITHM ANALYSIS**

Algorithm Analysis - Asymptotic Notations - Efficiency of Algorithms - Analysis of Recursive programs - Solving Recurrence Equations - A General Solution for a Large Class of recurrences.

**OUTCOMES:**

- Implement a program using stack, queue, linked list data structures
- Design and Implement Tree data structures and Sets
- Apply the Graph Data structure and to find shortest path among the several possibilities
- Perform analysis of various algorithms
- Analyze and design algorithms to appreciate the impact of algorithm design in practice.

**REFERENCES:**

1. Anany Levitin "Introduction to the Design and Analysis of Algorithms" 3rd Edition Pearson

Education, 2015.

2. Jean Paul Tremblay and Paul G. Sorensen. "An Introduction to Data Structures with Applications", 2nd Edition, Tata McGraw Hill, New Delhi, 2017
3. Peter Drake, "Data Structures and Algorithms in Java", 4th Edition, Pearson Education 2014
4. T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein, "Introduction to algorithms", 3rd Edition, PHI Learning Private Ltd, 2012
5. V. Aho, J. E. Hopcroft, and J. D. Ullman, "Data Structures and Algorithms", 1st Edition, Pearson Education, 1983.
6. Michael T. Goodrich, "Algorithm Design: Foundations, Analysis and Internet Examples", 2nd Edition, Wiley India Pvt. Ltd, 2006.

**COURSE OBJECTIVES**

- Understand the importance of Modeling an Entity Relationship Diagram, Map the Entity Relationship Diagram to Relations and Database Normalization.
- Gain Knowledge on Designing Parallel Databases and Distributed Databases.
- Understand the Basics of XML Databases, Web Databases, Active Databases and Temporal Databases.
- Gain Basic Knowledge on Mongo DB No SQL Database.
- Understand the Basics of Data Warehousing and Data Mining

**UNIT I RELATIONAL MODEL**

Entity Relationship Model - Relational Data Model - Mapping Entity Relationship Model to Relational Model - Relational Algebra - Structured Query Language - Database Normalization - First Normal Form - Second Normal Form - Third Normal Form - Boyce Codd Normal Form - Fourth Normal Form - Fifth Normal Form.

**UNIT II PARALLEL AND DISTRIBUTED DATABASES**

Parallel Databases - I/O Parallelism - Inter-Query and Intra-Query Parallelism - Inter-Operation and Intra-Operation Parallelism - Distributed Database Architecture - Distributed Data Storage - Distributed Transactions - Distributed Query Processing - Distributed Transaction Management - ACID Properties - Concurrency Control.

**UNIT III XML DATABASES, WEB DATABASES, ACTIVE DATABASES AND TEMPORAL DATABASES**

XML Data Model - DTD - XML Schema - XML Querying - Web Databases - Open Database Connectivity - Java Database Connectivity - Accessing Relational Database using PHP - Event Condition Action Model - Design and Implementation Issues for Active Databases - Temporal Databases - Interpreting Time in Relational Databases.

**UNIT IV NoSQL DATABASES**

NoSQL Database vs. SQL Databases- CAP Theorem - Migrating from RDBMS to NOSQL - MongoDB - CRUD Operations- MongoDB Sharding - MongoDB Replication - Web Application Development using MongoDB with PHP and Java.

**UNIT V DATA WAREHOUSING AND DATA MINING**

Data Warehouse - Characteristics - Three Tier Architecture - Data Cube - Online Analytical Processing vs. Online Transaction Processing - Online Analytical Processing Operations - Star Schema - Snow Flake Schema - Fact Constellation Schema - Data Mart - Data Mining - Apriori Algorithm for Association Rule Mining - Decision Tree Induction using Information Gain for Classification - k-Means Clustering.

**COURSE OUTCOMES:**

- On completion of the course, the student will be able to:
- Design a Relational Database for an Enterprise.
- Design a Parallel Database and Distributed Database for an Enterprise.
- Apply Knowledge of XML Database, Web Database, Active Database and Temporal Database for Maintaining Data of an Enterprise.
- Model a Data Warehouse and Integration of a Data Mining System with A Data Warehouse

**References**

1. Ramez Elmasri, Shamkant B. Navathe, Fundamentals of Database Systems, Seventh Edition, Pearson Education, 2016.
2. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, Database System Concepts, Seventh Edition, McGraw Hill Education 2020.
3. Brad Dayley, "Teach Yourself NoSQL with MongoDB in 24 Hours", Sams Publishing, 2014
4. Jiawei Han, Jian Pei and Hanghang Tong, Data Mining Concepts and Techniques, Fourth Edition, Morgan Kaufmann Publishers, 2022.



**OBJECTIVES:**

- Be aware of the phases in object oriented software development
- Gain fundamental concepts of requirements engineering and analysis.
- Know about the different approach for object oriented design and its methods
- Understand how to perform object oriented testing and how to maintain software
- Provide various quality metrics and to ensure risk management.

**UNIT I SOFTWARE DEVELOPMENT LIFE CYCLE**

Introduction - Object Orientation - Object Oriented Methodologies - Terminologies - Software Development Life Cycle - Conventional Software Life Cycle Models - Build and Fix Model - Waterfall Model - Prototyping Model - Iterative Enhancement Model - Spiral Model - Extreme Programming - Object Oriented Software Life Cycle Models - Selection of Software Development Life Cycle Models.

**UNIT II OBJECT ORIENTED REQUIREMENTS ELICITATION & ANALYSIS**

Software Requirement - Requirements Elicitation Techniques - Initial Requirements Document - Use Case Approach - Characteristics of a Good Requirement - SRS Document - Requirements Change Management - Object Oriented Analysis : Identification of Classes and Relationships, Identifying State and Behavior - Case Study LMS - Managing Object Oriented Software Engineering: Projection Selection and Preparation - Product Development Organization - Project Organization and Management - Project Staffing.

**UNIT III OBJECT ORIENTED SOFTWARE DESIGN**

Object Oriented Design - Interaction Diagrams - Sequence Diagram - Collaboration Diagrams - Refinement of Use Case Description - Refinement of Classes and Relationships - Construction of Detailed Class Diagram - Development of Detailed Design & Creation of Software Design Document - Object Oriented Methods : Object Oriented Analysis (OOA / Coad-Yourdon), Object Oriented Design (OOD/Booch) , Hierarchical Object Oriented Design (HOOD), Object Modeling Technique (OMT), Responsibility - Driven Design Case Studies : Warehouse Management System, Telecom.

**UNIT IV OBJECT ORIENTED TESTING AND MAINTENANCE**

Software testing: Software Verification Techniques - Object Oriented Checklist - Functional Testing - Structural Testing - Class Testing - Mutation Testing - Levels of Testing - Static and Dynamic Testing Tools - Software Maintenance - Categories - Challenges of Software Maintenance - Maintenance of Object Oriented Software - Regression Testing.

**UNIT V SOFTWARE QUALITY & METRICS**

Need of Object Oriented Software Estimation - Lorenz and Kidd Estimation - Use Case Points Method - Class Point Method - Object Oriented Function Point - Risk Management - Software Quality Models - Analyzing the Metric Data - Metrics for Measuring Size and Structure - Measuring Software Quality - Object Oriented Metrics.

**OUTCOMES:**

- Able to identify the appropriate process model to develop the object oriented software
- Gain knowledge about requirement elicitation and analyzing techniques
- Able to choose and design suitable UML diagrams and methods
- Able to apply correct testing methods and maintain software systems.
- Able to estimate the object oriented application by applying metric data.

**REFERENCES:**

1. Yogesh Singh, Ruchika Malhotra, "Object - Oriented Software Engineering", PHI Learning Private Limited, First edition, 2012
2. Ivar Jacobson, Magnus Christerson, Patrik Jonsson, Gunnar Overgaard, "Object Oriented Software Engineering, A Use Case Driven Approach", Pearson Education, Seventh Impression, 2009
3. Craig Larman, "Applying UML and Patterns, an Introduction to Object-Oriented Analysis and Design and Iterative Development", Pearson Education, Third Edition, 2008.
4. Grady Booch, Robert A. Maksimchuk, Michael W. Engle, Bobbi J. Young, Jim Conallen, Kelli A. Houston, "Object Oriented Analysis & Design with Applications, Third Edition, Pearson Education, 2010
5. Roger S. Pressman, "Software Engineering: A Practitioner's Approach, Tata McGraw-Hill Education, 8th Edition, 2015.
6. Timothy C. Lethbridge and Robert Laganieri, "Object - Oriented Software Engineering, Practical Software Development using UML and Java", Tata McGraw Hill Publishing Company Limited, Second Edition, 2004.

**OBJECTIVES:**

- Learn and develop Python programs with conditionals and loops.
- Understand the concepts of Python functions and use function calls.
- Design and Implement Python data structures - lists, tuples, dictionaries.
- Be familiar with input/output files in Python.
- Understand oops concepts in python.

**UNIT I PYTHON BASICS**

Introduction to Python Programming - Python Interpreter and Interactive Mode- Variables and Identifiers - Arithmetic Operators - Values and Types - Statements. Operators - Boolean Values - Operator Precedence - Expression - Conditionals: If-Else Constructs - Loop Structures/Iterative Statements - While Loop - For Loop - Break Statement-Continue statement - Function Call and Returning Values - Parameter Passing - Local and Global Scope - Recursive Functions.

**UNIT II DATA TYPES IN PYTHON**

Lists, Tuples, Sets, Strings, Dictionary, Modules: Module Loading and Execution - Packages - Making Your Own Module - The Python Standard Libraries.

**UNIT III FILE HANDLING AND EXCEPTION HANDLING**

Files: Introduction - File Path - Opening and Closing Files - Reading and Writing Files -File Position - Exception: Errors and Exceptions, Exception Handling, Multiple Exceptions.

**UNIT IV MODULES, PACKAGES**

Modules: Introduction - Module Loading and Execution - Packages - Making Your Own Module - The Python Libraries for data processing, data mining and visualization- NUMPY, Pandas, Matplotlib, Plotly.

**UNIT V OBJECT ORIENTED PROGRAMMING IN PYTHON**

Creating a Class, Class methods, Class Inheritance, Encapsulation, Polymorphism, class method vs. static methods, Python object persistence.

**OUTCOMES:**

Upon completion of the course, students will be able to

- Develop algorithmic solutions to simple computational problems
- Structure simple Python programs for solving problems.
- Read and write data from/to files in Python Programs.
- Represent compound data using Python lists, tuples, dictionaries.
- Decompose a Python program into functions.

## REFERENCES:

1. Reema Thareja, “Python Programming using Problem Solving Approach”, Oxford University Press, First edition, 2017.
2. Allen B. Downey, “Think Python: How to Think Like a Computer Scientist”, Second Edition, Shroff, O’Reilly Publishers, 2016(<http://greenteapress.com/wp/thinkpython/>).
3. Guido van Rossum, Fred L. Drake Jr., “An Introduction to Python - Revised and Updated for Python 3.2, Network Theory Ltd., First edition, 2011.
4. John V Guttag, “Introduction to Computation and Programming Using Python”, Revised and Expanded Edition, MIT Press, 2013.
5. Charles Dierbach, “Introduction to Computer Science using Python”, Wiley India Edition, First Edition, 2016.
6. Timothy A. Budd, “Exploring Python”, Mc-Grew Hill Education (India) Private Ltd., First edition, 2011.
7. Kenneth A. Lambert, “Fundamentals of Python: First Programs”, Cengage Learning, second edition, 2012.

**COURSE OBJECTIVES:**

The course should enable the students to:

- Identify an appropriate research problem in their interesting domain.
- Understand ethical issues; understand the Preparation of a research project thesis report.
- Understand the Preparation of a research project thesis report
- Understand the law of patent and copyrights.
- Acquire adequate knowledge of IPR.

**UNIT I RESEARCH METHODOLOGY**

Research Methodology - An Introduction, Objectives, Types of research, Research approaches, Significance, Research methods versus Methodology, Research and Scientific method, Importance, Research process, Criteria, Problems encountered by researchers. Defining the research problem - Research problem, Selecting the problem, Necessity, Technique involved, An illustration. Reviewing the Literature - The place of the literature review in research, How to review the Literature, Writing about the literature reviewed.

**UNIT II RESEARCH DESIGN**

Research Design - Meaning, Need, Features, Different research design, Basic principles of experimental designs, Important experimental designs. Measurement & Scaling techniques - Sampling Design, Measurement in research, Measurement scales, Error, Measurement tools, Scaling, Meaning, Scale classification, Scale construction techniques. Data Collection - Collection of primary data, Collection of secondary data, Selection of appropriate method for data collection.

**UNIT III RESEARCH TECHNIQUE AND TOOLS**

Testing of Hypothesis - Basic concepts, Procedure, Test of Hypothesis, Important parametric Tests, Hypothesis Testing unifications. Interpretation & Report writing - Meaning, techniques, Precaution in Interpretation, Significance of Report writing, steps, Layout, types, mechanics, precautions. Use of Tools/ Techniques for research - Use of Encyclopedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline, Use of tools / techniques for Research methods to search required information effectively, Reference Management Software like Zotero / Mendeley, Software for paper formatting like LaTeX / MS Office, Software for detection of Plagiarism.

**UNIT IV INTELLECTUAL PROPERTY RIGHTS**

Intellectual Property - The concept, intellectual property rights (IPS) in India, development, Trade secrets, utility Models, IPR & Bio diversity, CBD, WIPO, WTO, Right of Property, Common rules, PCT, Features of Agreement, Trademark, UNESCO.

## **UNIT V PATENTS**

Patents - Learning objectives, Concept, features, Novelty, Inventive step, Specification, Types of patent application, E-filing, Examination, Grant of patent, Revocation, Equitable Assignments, Licences, Licencing of related patents, patent agents, Registration of patent agents.

### **OUTCOMES:**

On completion of the course the student would be able to:

- Understand the research problem and Literature review.
- Understand the various research designs and their characteristics.
- Prepare a well-structured research paper and scientific presentations.
- Explore on various IPR Components and process of filing.
- Develop awareness the patent law and procedural mechanism in obtaining a patent.

### **REFERENCE BOOKS:**

1. Research Methodology: Methods and Techniques by C.R.Kothari, GauravGarg, New Age International 4th Edition 2018 (UNIT I to UNIT III)
2. Research Methodology a step-by-step guide for beginners by Ranjit Kumar, SAGE publications Ltd 3rd Edition 2011 (For the topic Reviewing the Literature under Unit I)
3. Stuart Melville and Wayne Goddard, "Research Methodology: An Introduction for Science & engineering students. Juta and Co., Limited, 1996, First edition
4. Research methods: The concise knowledge base-Trochim, Atomic Dog publishing, First edition, 2005.
5. John W. Best & James V. Khan, "Research in Education", Pearson 8th Edition 'year.
6. Professional Programme Intellectual Property Rights, Law and practice, The Institute of Company Secretaries of India, Statutory body under an Act of parliament, September 2013 (UNIT IV & UNIT V)

**COURSE OBJECTIVES**

- Gain Knowledge on Data Definition Language, Data Manipulation Language and Transaction Control Language.
- Understand the Types of Joins, Aggregate Functions, Nested Queries, Creating Views and Creating Stored Procedures.
- Gain Basic Knowledge on Implementing Distributed, XML and Temporal Databases.
- Gain Basic Knowledge on Accessing and Updating a Relational Database using PHP and Java.
- Gain Basic Knowledge on Accessing and Updating a MongoDB NoSQL Database using PHP.

**LIST OF EXERCISES**

1. Data Definition Language - Create - Alter - Drop - Enforcing Primary Key and Foreign Key Constraints - Data Manipulation Language - Insert - Delete - Update - Transaction Control Language - Commit - Rollback - Save Points.
2. Cartesian Product - Equi Join - Left Outer Join - Right Outer Join - Full Outer Join.
3. Set Operations - Creating Views - Creating Sequence - Indexing-Aggregate Functions - AnalyticFunctions - Nested Queries.
4. Creating Triggers and Stored Procedures.
5. Distributed Database Implementation.
6. XML Database Implementation.
7. Temporal Database Implementation.
8. Accessing and Updating a Relational Database using PHP.
9. Accessing and Updating a Relational Database using JDBC.
10. MongoDB - CRUD Operations
11. Accessing and Updating MongoDB using PHP.

**Exercises 1 to 9 should be implemented using a Relational Database (Oracle / MySQL / PostgreSQL). Exercises 10 and 11 should be implemented using MongoDB NoSQL Database.**

**COURSE OUTCOMES:**

On completion of the course, the student will be able to:

- Create a Relational Database Enforcing Integrity Constraints and perform Data Manipulation Language Operations.
- Create Views and Stored Procedures.
- Implement Distributed, XML and Temporal Databases.
- Access and Update a Relational Database using PHP and Java.
- Access and Update a MongoDB NoSQL Database using PHP.

**OBJECTIVES:**

- Learn the basic programming constructs in Python.
- Implement Recursive programming in Python
- Implement Divide and Conquer algorithmic technique in Python
- Implement Tree Data structures in Python
- Implement Graphs in Python
- Deploy the standard libraries in Python

**EXPERIMENTS:**

1. Towers of Hanoi using Recursion
2. To implement Binary Search
3. Merge Sort
4. To implement AVL Trees using Python
5. To implement Splay Trees using Python
6. To implement Red black Trees using Python
7. To implement Graphs using Python
8. Implementing programs using written modules and Python Standard Libraries.
9. Implementing real-time/technical applications using Files and Exception handling.

**OUTCOMES:**

On completion of the course, students will be able to:

- Develop algorithmic solutions to simple computational problems
- Develop and execute Python programs.
- Decompose a Python program into functions.
- Represent compound data using Python data structures.
- Apply Python features in developing software applications.



**OBJECTIVES:**

- Provide opportunities to learners to practice English and thereby make them proficient users of the language.
- Enable learners to fine-tune their linguistic skills (LSRW) with the help of Technology.
- Enhance the performance of students listening, speaking, reading and writing and thereby develop their career opportunities.

**LIST OF ACTIVITIES:**

**Listening:**

- Listening and practicing neutral accents
- Listening to short talks and lectures and completing listening comprehension exercises
- Listening to TED Talks

**Speaking:**

- Giving one minute talks
- Participating in small Group Discussions
- Making Presentations

**Reading:**

- Reading Comprehension
- Reading subject specific material
- Technical Vocabulary

**Writing:**

- Formal vs Informal Writing
- Paragraph Writing
- Essay Writing
- Email Writing

**REFERENCES / MANUALS / SOFTWARE:** Open Sources / websites

**OUTCOMES:**

On completion of the course the students will be able to:

- Listen and comprehend Lectures in English
- Articulate well and give presentations clearly
- Participate in Group Discussions successfully

- Communicate effectively in formal and informal writing
- Write proficient essays and emails

**COURSE OBJECTIVES:**

- Understand the fundamentals of web programming and client side scripting.
- Design and Implement the server side development using servlets, web socket.
- Learn the Spring framework and build applications using Spring.
- Learn and implement the concept of Java Persistence API.
- Study the advanced client side scripting and framework.

**UNIT I INTRODUCTION TO WEB & CLIENT SIDE PROGRAMMING**

Introduction to Web: Server - Client - Communication Protocol (HTTP), JavaScript: Data Types and Variables - Expressions - Operators and Statements - Objects and Arrays - Functions - Classes - Modules - DOM - Events - Storage: Local Storage, Cookies, Indexed DB, JSON, AJAX.

**UNIT II SERVER SIDE PROGRAMMING**

Web Server: Web Containers - Web Components, Servlet: Lifecycle - Request - Servlet Context - Response - Filter - Session - Dispatching Requests, Web Socket, Logging - Log4j2, Build tool - Gradle. Introduction to Spring: IoC Container and Dependency Injection (DI).

**UNIT III SPRING**

Spring Configuration and Spring Boot, Spring MVC: DispatcherServlet and Configuration - Interceptors - Controllers - Views - Input Validation - File Upload, Building RESTful Web Services, Spring Security Architecture, Spring Cache.

**UNIT IV JAVA PERSISTENCE API AND HIBERNATE**

Entity: Basic, Embeddable and Collection Types - Identifiers - Entity Relationship - Inheritance, Persistence Context and Entity Manager, JPQL, Criteria API, Spring Data JPA - Specification and Projection.

**UNIT V ADVANCED CLIENT SIDE PROGRAMMING**

Asynchronous JavaScript: Callbacks - Promises - async and await, React JS: ReactDOM - JSX - Components - Properties - State and Lifecycle - Events - Lifting State Up - Composition and Inheritance - Higher Order Components.

**COURSE OUTCOMES:**

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

- Able to write client side scripting.
- Implement the server side of the web application.
- Develop Web Application using Spring.
- Implement a Java application using Java Persistence API.
- Design and implement a full-stack Single Page Application using React, Spring and JPA.

## REFERENCE BOOKS

1. David Flanagan, "Java Script: The Definitive Guide", O'Reilly Media, Inc, 7th Edition, 2020
2. Matt Frisbie, "Professional JavaScript for Web Developers", Wiley Publishing, Inc, 4th Edition, ISBN: 978-1-119-36656-0, 2019
3. Alex Banks, Eve Porcello, "Learning React", O'Reilly Media, Inc, 2nd Edition, 2020
4. <https://reactjs.org/docs>
5. David R. Heffel finger, "Java EE 8 Application Development", Packt Publishing, First edition2017
6. Benjamin Muschko, "Gradle in Action", Manning Publications, First edition2014
7. Iuliana Cosmina, Rob Harrop, Chris Schaefer, Clarence Ho, "Pro Spring 5: An In-Depth Guide to the Spring Framework and Its Tools", Apress, Fifth edition2017
8. Christian Bauer, Gavin King, and Gary Gregory, "Java Persistence with Hibernate", Manning Publications, \r, 2nd Edition, 2015.

**OBJECTIVES:**

- Understand the basic concepts of Distributed systems
- Learn about the current trend and basics of Cloud computing
- Be familiar with various Cloud concepts
- Expose with the Server, Network and storage virtualization
- Be aware of Micro services

**UNIT I DISTRIBUTED SYSTEMS**

Introduction to Distributed Systems - Characterization of Distributed Systems - Distributed Architectural Models - Remote Invocation - Request-Reply Protocols - Remote Procedure Call - Remote Method Invocation - Group Communication - Coordination in Group Communication - Ordered Multicast - Time Ordering - Physical Clock Synchronization - Logical Time and Logical Clocks.

**UNIT II INTRODUCTION TO CLOUD COMPUTING**

Cloud Computing Basics - Desired features of Cloud Computing - Elasticity in Cloud - On demand provisioning - Applications - Benefits - Cloud Components: Clients, Datacenters & Distributed Servers - Characterization of Distributed Systems - Distributed Architectural Models - Principles of Parallel and Distributed computing - Applications of Cloud computing - Benefits - Cloud services - Open source Cloud Software: Eucalyptus, Open Nebula, Open stack, Aneka, Cloudsim.

**UNIT III CLOUD INFRASTRUCTURE**

Cloud Architecture and Design - Architectural design challenges - Technologies for Network based system - NIST Cloud computing Reference Architecture - Public, Private and Hybrid clouds - Cloud Models : IaaS, PaaS and SaaS - Cloud storage providers.

**UNIT IV CLOUD ENABLING TECHNOLOGIES**

Service Oriented Architecture - Web Services - Basics of Virtualization - Emulation - Types of Virtualization - Implementation levels of Virtualization - Virtualization structures - Tools & Mechanisms - Virtualization of CPU, Memory & I/O Devices - Desktop Virtualization - Server Virtualization - Google App Engine - Amazon AWS - Federation in the Cloud.

**UNIT V MICROSERVICES**

Defining Micro services - Emergence of Micro service Architecture - Design patterns of Micro services - The Mini web service architecture - Micro service dependency tree - Challenges with Micro services - SOA vs Micro service - Micro service and API - Deploying and maintaining Micro services.

**OUTCOMES:**

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

- Use Distributed systems in Cloud Environment
- Articulate the main concepts, key technologies, strengths and limitations of Cloud computing
- Identify the Architecture, Infrastructure and delivery models of Cloud computing
- Install, choose and use the appropriate current technology for the implementation of Cloud
- Adopt Micro services in Cloud environment

#### **REFERENCES:**

1. Kai Hwang, Geoffrey C. Fox & Jack G. Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, First Edition, 2012
2. Andrew S. Tanenbaum & Maarten Van Steen, "Distributed Systems - Principles and Paradigms", Second Edition, Pearson Prentice Hall, 2006
3. Thomas Erl, Zaigham Mahood & Ricardo Puttini, "Cloud Computing, Concept, Technology & Architecture", Prentice Hall, SecondEdition,2013
4. Richard Rodger, "The Tao of Microservices", ISBN 9781617293146, Manning Publications, First Edition, December 2017.
5. Magnus Larsson, "Hands-On Microservices with Spring Boot and Spring Cloud: Build and deploy microservices using spring cloud, Istio and kubernetes", Packt Publishing Ltd, FirstEdition, September 2019.
6. Jim Lewis, "DEVOPS: A complete beginner's guide to DevOps best practices", ISBN- 13:978-1673259148, ISBN-10: 1673259146, First Edition, 2019.

**OBJECTIVES:**

- Familiarize with the principles of Artificial intelligence like problem solving, inference, perception, knowledge representation, and learning.
- Understand the various characteristics of Intelligent agents
- Design and implement the machine learning techniques for real world problems
- Gain experience in doing research using Artificial intelligence and Machine learning techniques.

**UNIT I ARTIFICIAL INTELLIGENCE**

Foundation of AI-History of AI-State of Art.-Intelligent Agents: Agents and Environments-Concepts of Rationality-Nature of Environments-Structure of Agents. Problem Solving: Problem Solving by Search: Problem Solving Agents-Searching for Solutions-Uniform Search Strategies-Heuristic Search Strategies- local Search Algorithms and Optimization Problems.

**UNIT II KNOWLEDGE AND REASONING**

Logical Agents: Knowledge Based Agents-Logic-Propositional Logic-Propositional Theorem Proving-Model Checking-Agent based on Propositional Logic. First-Order Logic: Syntax and Semantics- Using First-Order Logic-Knowledge Engineering. Inference in First-Order Logic: Propositional Vs. First-Order Inference-Unification and Lifting-Forward Chaining-Backward Chaining -Resolution.

**UNIT III BAYESIAN LEARNING**

Basic Probability Notation- Inference - Independence - Bayes' Rule. Bayesian Learning: Maximum Likelihood and Least Squared error hypothesis-Maximum Likelihood hypotheses for predicting probabilities- Minimum description Length principle -Bayes optimal classifier - Naïve Bayes classifier - Bayesian Belief networks -EM algorithm.

**UNIT IV PARAMETRIC MACHINE LEARNING**

Logistic Regression: Classification and representation - Cost function - Gradient descent - Advanced optimization - Regularization - Solving the problems on overfitting. Perceptron - Neural Networks - Multi - class Classification - Backpropagation - Non-linearity with activation functions (Tanh, Sigmoid, Relu, PRelu) - Dropout as regularization.

**UNIT V NON PARAMETRIC MACHINE LEARNING**

k- Nearest Neighbors- Decision Trees - Branching - Greedy Algorithm - Multiple Branches - Continuous attributes - Pruning. Random Forests: ensemble learning. Boosting - Adaboost algorithm. Support Vector Machines - Large Margin Intuition - Loss Function - Hinge Loss - SVM Kernels.

**OUTCOMES:**

- Apply the techniques of Problem Solving in Artificial Intelligence.
- Implement Knowledge and Reasoning for real world problems.

- Model the various Learning features of Artificial Intelligence
- Analyze the working model and features of Decision tree
- Apply k-nearest algorithm for appropriate research problem.

**REFERENCES:**

1. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach" , Third Edition Pearson Education Limited, 2015
2. CalumChace , "Surviving AI: The Promise and Peril of Artificial Intelligence", Three CS publication, Second Edition, 2015.
3. Christopher M Bishop, "Pattern Recognition and Machine Learning", Spring 2011 Edition.
4. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning: Data Mining, Inference and Prediction", Springer 2nd Edition
5. EthemAlpaydin, "Introduction to Machine Learning", Second Edition, MIT Press, 2010.
6. Tom M. Mitchell, "Machine Learning", India Edition, 1st Edition, McGraw-Hill Education Private Limited, 2013
7. Elaine Rich, Kevin Knight, Shivashankar B. Nair, "Artificial Intelligence", Third Edition, Tata McGraw-Hill Education, 2012
8. Elaine Rich, Kevin Knight, Shivashankar B. Nair, "Artificial Intelligence", Third Edition, Tata McGraw-Hill Education, 2012



**OBJECTIVES:**

- Understand the need and characteristics of mobile applications.
- Design the right user interface for mobile application.
- Understand the design issues in the development of mobile applications.
- Learn the development procedure for mobile application.
- Develop mobile applications using various tools and platforms.

**UNIT I INTRODUCTION**

Mobile Application Model - Infrastructure and Managing Resources - Mobile Device Profiles - Frameworks and Tools.

**UNIT II USER INTERFACE**

Generic UI Development - Multimodal and Multichannel UI -Gesture Based UI - Screen Elements and Layouts - Voice XML.

**UNIT III APPLICATION DESIGN**

Memory Management - Design Patterns for Limited Memory - Work Flow for Application development - Java API - Dynamic Linking - Plugins and rule of thumb for using DLLs - Concurrency and Resource Management..

**UNIT IV MOBILE OS**

Mobile OS: Android, iOS - Android Application Architecture - Android basic components -Intents and Services - Storing and Retrieving data - Packaging and Deployment - Security and Hacking.

**UNIT V APPLICATION DEVELOPMENT**

Communication via the Web - Notification and Alarms - Graphics and Multimedia: Layer Animation, Event handling and Graphics services - Telephony - Location based services.

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**OUTCOMES**

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

- Understand the basics of mobile application development frameworks and tools
- Be able to develop a UI for mobile application
- Design mobile applications that manages memory dynamically
- Build applications based on mobile OS like Android, iOS

- Build location based services

**REFERENCES:**

1. Reto Meier, "Professional Android 4 Application Development", Wiley, First Edition, 2012
2. ZigurdMednieks, LairdDornin, G. Blake Meike, Masumi Nakamura, "ProgrammingAndroid", O'Reilly, 2ndEdition, 2012.
3. Alasdair Allan, "iPhone Programming", O'Reilly, First Edition, 2010.

**OBJECTIVES**

- Study the principles of cyber security and to identify threats and risks.
- Gain knowledge of how to secure physical assets and develop system security controls.
- Understand how to apply security for Business applications and Network Communications.
- Learn the technical means to achieve security.
- Learn to monitor and audit security measures.

**UNIT I PLANNING FOR CYBER SECURITY**

Best Practices-Standards and a plan of Action-Security Governance Principles, components and Approach-Information Risk Management-Asset Identification-Threat Identification-Vulnerability Identification-Risk Assessment Approaches-Likelihood and Impact Assessment-Risk Determination, Evaluation and Treatment-Security Management Function-Security Policy-Acceptable Use Policy-Security Management Best Practices.

**UNIT II SECURITY CONTROLS**

People Management-Human Resource Security-Security Awareness and Education-Information Management- Information Classification and handling-Privacy-Documents and Record Management-Physical Asset Management-Office Equipment-Industrial Control Systems-Mobile Device Security- System Development-Incorporating Security into SDLC- Case study on information security policies.

**UNIT III CYBER SECURITY FOR BUSINESS APPLICATIONS AND NETWORKS**

Business Application Management-Corporate Business Application Security-End user Developed Applications-System Access- Authentication Mechanisms-Access Control-System Management-Virtual Servers-Network Storage Systems-Network Management Concepts-Firewall-IP Security-Electronic Communications - Case study on OWASP vulnerabilities using OWASP ZAP tool.

**UNIT IV TECHNICAL SECURITY**

Supply Chain Management-Cloud Security-Security Architecture-Malware Protection-Intrusion Detection-Digital Rights Management-Cryptographic Techniques-Threat and Incident Management-Vulnerability Management-Security Event Management-Forensic Investigations-Local Environment Management-Business Continuity. - Case study on cloud and cryptographic vulnerabilities.

**UNIT V SECURITY ASSESSMENT**

Security Monitoring and Improvement-Security Audit-Security Performance-Information Risk Reporting-Information Security Compliance Monitoring-Security Monitoring and Improvement Best Practices. - Case study on vulnerability assessment using ACUNETIX.

**OUTCOMES**

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

- Develop a set of risk and security requirements to ensure that there are no gaps in an organization's security practices.

- Achieve management, operational and technical means for effective cyber security.
- Audit and monitor the performance of cyber security controls.
- Spot gaps in the system and devise improvements.
- Identify and report vulnerabilities in the system

**REFERENCES:**

1. William Stallings, “Effective Cyber Security- A guide to using Best Practices and Standards”, Addison-Wesley Professional, First Edition,2018.
2. Adam Shostack, “Threat Modelling- Designing for Security”, Wiley Publications ,First Edition,2014.
3. Gregory J. Touhill and C. Joseph Touhill, “Cyber Security for Executives- A Practical guide”, Wiley Publications, First Edition,2014.
4. Raef Meeuwisse, “Cyber Security for Beginners”, Second Edition, Cyber Simplicity Ltd, 2017.
5. Patrick Engebretson, “The Basics of Hacking and Penetration Testing: Ethical Hacking and Penetration Testing Made Easy”, 2nd Edition, Syngress, 2013.

**COURSE OBJECTIVES:**

- Implement the client side of the web application using javascript.
- Implement the server side of the web application using Servlets and WebSockets.
- Develop a web application using Spring.
- Implement a Persistence layer using Hibernate and Spring Data JPA.
- Develop a full stack single page application using React, Spring and Hibernate.

**LIST OF EXERCISES**

1. Create an event registration application using javascript. It should implement different widgets for registration form and registered records view using tabs. It should perform the form validation.
2. Create a javascript application in an Object Oriented way using Classes and Modules. It should also use browser storage for persistence.
3. Build a web application using Gradle. The server side of the application should implement RESTful APIs using Servlet and do necessary logging. The client side of the application should be a single page application which consumes the RESTful APIs through AJAX.
4. Build a chat application using WebSocket.
5. Create a Spring MVC application. The application should handle form validation, file upload, session tracking.
6. Implement a RESTful Spring Boot application using Spring REST, Spring Security and Spring Cache.
7. Design a complex system using JPA and Hibernate. The system should have multiple entities and relationships between the entities. The database schema should be generated through Hibernate. Provide RESTful endpoints for CRUD operations for the defined entities. Also, support pagination and searching using JPA's JPQL and Criteria API.
8. Create a Spring RESTful Application with Spring Data JPA. Support pagination and searching using Specifications.
9. Create a React application with different components and interactions between the components.
10. Develop a full-stack application using React and Spring. Make use of Spring REST, Spring Security, Spring Data JPA, Hibernate, Spring Boot, Gradle and React's higher order component.

**COURSE OUTCOMES:**

- Implement client and server side of the web application.
- Implement a real time application using Web Socket.
- Use Spring framework in web development.
- Implement applications using Java Persistence API.
- Implement applications using the JavaScript framework React.

**ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING  
LABORATORY**

**CREDIT: 2**

**OBJECTIVES:**

- Familiarize with the machine learning algorithms and implement in practical situations.
- Involve the students to practice AI algorithms and techniques.
- Learn to use different algorithms for real time data sets.

**List of Experiments:**

1. Write a program to illustrate problem solving as a search.
2. Write a program to illustrate local search algorithms.
3. Write a program to demonstrate logical agents.
4. Evaluate forward chainer and rule base on at least four different databases. Try to create at least one database that demonstrates an interesting feature of the domain, or an interesting feature of forward chaining in general.
5. Demonstrate agent based on propositional logic.
6. Write a program to implement the naïve Bayesian classifier for a sample training data set. Compute the accuracy of the classifier, considering few test data sets.
7. Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set.
8. Apply EM algorithm to cluster a set of data stored in a .CSV file.
9. Write a program to implement k-Nearest Neighbor algorithm to classify the data set.
10. Apply the technique of pruning for a noisy data monk2 data, and derive the decision tree from this data. Analyze the results by comparing the structure of pruned and unpruned tree.
11. Build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets
12. Implement Support Vector Classification for linear kernel.
13. Implement Logistic Regression to classify the problems such as spam detection. Diabetes predictions so on.

**OUTCOMES:**

- Apply the techniques of Problem Solving in Artificial Intelligence.
- Implement Knowledge and Reasoning for real world problems.
- Model the various Learning features of Artificial Intelligence

- Analyze the working model and features of Decision tree
- Apply k-nearest algorithm for appropriate research problem.



**OBJECTIVES:**

- Provide opportunities to learners to practice their communication skills to make them become proficient users of English.
- Enable learners to fine-tune their linguistic skills (LSRW) with the help of Technology to communicate globally.
- Enhance the performance of learners at placement interviews and group discussions and other recruitment procedures

**1. SOFT SKILLS**

People skills  
Interpersonal skills  
Team building skills  
Leadership skills  
Problem solving skills

**2. PRESENTATION SKILLS**

Preparing slides with animation related to the topic  
Introducing oneself to the audience  
Introducing the topic  
Presenting the visuals effectively - 5 minute presentation

**3. GROUP DISCUSSION**

**SKILLS** Participating in group discussions  
Brainstorming the topic  
Activities to improve GD skills.

**4. INTERVIEW SKILLS**

Interview etiquette - dress code - body language  
Attending job interviews  
Answering questions confidently  
Technical interview - telephone/Skype interview  
Emotional and cultural intelligence  
Stress Interview

**REFERENCES / MANUALS / SOFTWARE:** Open Sources / websites

**OUTCOMES:**

- Upon Completion of the course, the students will be able to:
- Students will be able to make presentations and participate in Group discussions with confidence.
- Students will be able to perform well in the interviews.
- Students will make effective presentations.

**OBJECTIVES:**

- Know the fundamental concepts of data science and analytics.
- Learn fundamental data analysis using R.
- Understand various data modeling techniques.
- Learn the basic and advanced features of open source big data tools and frameworks.
- Study various analytics on stream data.

**UNIT I INTRODUCTION TO DATA SCIENCE AND BIG DATA**

Introduction to Data Science - Data Science Process - Exploratory Data analysis - Big data: Definition, Risks of Big Data, Structure of Big Data - Web Data: The Original Big Data - Evolution Of Analytic Scalability - Analytic Processes and Tools - Analysis versus Reporting - Core Analytics versus Advanced Analytics- Modern Data Analytic Tools - Statistical Concepts: Sampling Distributions - Re-Sampling - Statistical Inference - Introduction to Data Visualization.

**UNIT II DATA ANALYSIS USING R**

Univariate Analysis: Frequency, Mean, Median, Mode, Variance, Standard Deviation, Skewness and Kurtosis - Bivariate Analysis: Correlation - Regression Modeling: Linear and Logistic Regression - Multivariate Analysis - Graphical representation of Univariate, Bivariate and Multivariate Analysis in R: Bar Plot, Histogram, Box Plot, Line Plot, Scatter Plot, Lattice Plot, Regression Line, Two-Way cross Tabulation.

**UNIT III DATA MODELING**

Bayesian Modeling - Support Vector and Kernel Methods - Principal Component Analysis - Introduction to NoSQL: CAP Theorem, MongoDB: RDBMS VsMongoDB, Mongo DB Database Model, Data Types and Sharding - Data Modeling in HBase: Defining Schema - CRUD Operations

**UNIT IV DATA ANALYTICAL FRAMEWORKS**

Introduction to Hadoop: Hadoop Overview - RDBMS versus Hadoop - HDFS (Hadoop Distributed File System): Components and Block Replication - Introduction to MapReduce - Running Algorithms Using MapReduce - Introduction to HBase: HBase Architecture, HLog and HFile, Data Replication - Introduction to Hive, Spark and Apache Sqoop.

**UNIT V STREAM ANALYTICS**

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.

**OUTCOMES:**

On completion of the course, the students will be able to:

- Convert real world problems to hypothesis and perform statistical testing.
- Perform data analysis using R.

- Design efficient modeling of very large data and work with big data plat forms.
- Implement suitable data analysis for stream data.
- Write efficient Map Reduce programs for small problem solving methods.

**REFERENCES:**

1. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley & sons, First Edition,2013.
2. Umesh R Hodeg hatta, Umesha Nayak, "Business Analytics Using R - A Practical Approach", Apress, First Edition,2017.
3. J. Leskowec, Anand Rajaraman, Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, Second Edition,2014.
4. NishantGarg, "HBase Essentials", Packt, First Edition, 2014.
5. Rachel Schutt, Cathy O'Neil, "Doing Data Science", O'Reilly, First Edition,2013
6. Foster Provost, Tom Fawcet, "Data Science for Business", O'Reilly, First Edition,2013.
7. Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley, First Edition, 2014.

**OBJECTIVES:**

Upon Completion of the course, the students should be able to:

- Enrich student learning in Multimedia systems basics
- Train the students to acquire knowledge in multimedia Tools and authoring
- Acquire knowledge about multimedia data compression techniques
- Acquire knowledge in the area of multimedia communication systems
- Know about popular multimedia application areas.

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

**UNIT II MULTIMEDIA TOOLS and AUTHORING:** Hardware - Display Devices, wearables, Graphics cards, I/O devices, software - Editing tools for Text, Image, Audio, Video and animation. Authoring tools, Authoring Multimedia presentations, Authoring Metaphors.

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

**UNIT IV MULTIMEDIA COMMUNICATION SYSTEMS:** Multimedia Communication Standards, Transport Protocols, streaming protocols, Internet Protocols Wireless multimedia communications, synchronization and QOS, security, Entertainment networks, Collaborative multimedia support, Real-time distributed multimedia networks, Hypertext, Hypermedia.

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

**OUTCOMES:**

On completion of the course, the students will be able to:

- Handle the multimedia elements effectively
- Use Multimedia Hardware and Software for Editing and Authoring multimedia applications
- Implement Compression algorithms for various multimedia applications
- Develop effective strategies to deliver Quality-of-Experience in networked Multimedia applications
- Design and develop multimedia applications in various domains.

## REFERENCES:

1. Ze-Nian Li, Mark S. Drew, Jiangchuan Liu, "Fundamentals of Multimedia", Second Edition, Springer Nature (Texts in Computer Science), 2014.
2. Prabhat K. Andleigh, Kiran Thakrar, "Multimedia Systems Design", Pearson Education India, 1st Edition, 2015.
3. Ralf Steinmetz and KlaraNahrstedt, "Multimedia computing, communications, and applications", Pearson India, Pearson, 2002.
4. Fred Halsall, "Multimedia Communications: Applications, Networks, Protocols and Standards", Pearson Education, 2002.
5. Khalid Sayood, "Introduction to Data Compression", 4th Edition, Morgan Kauffman, 2012.
6. K.R. Rao, Zoran S. Bojkovic, Bojan M. Bakmaz, "Wireless Multimedia Communication systems: Design, Analysis and Implementation", CRC press, 2017.
7. V.S. Subrahmanian, "Principles of Multimedia Database Systems", Elsevier / Morgan Kauffmann, 2008.

**ACCOUNTING AND FINANCIAL MANAGEMENT FOR APPLICATION  
DEVELOPMENT**

**CREDIT: 4**

**OBJECTIVES:**

- Understand the basic principles of Double entry system and preparation of cash book.
- Learn how to prepare final accounts and balance sheet.
- Acquire knowledge about partnership accounts
- Understand the process of estimating the depreciation of a particular asset.
- Learn single and double entry accounting.

**UNIT I INTRODUCTION TO ACCOUNTING**

Meaning and scope of Accounting, Basic Accounting Concepts and Conventions - Objectives of Accounting - Accounting Transactions - Double Entry Book Keeping - Journal, Ledger, Preparation of Trial Balance - Preparation of Cash Book.

**UNIT II FINAL ACCOUNTS**

Preparation of Final Accounts of a Sole Trading Concern - Adjustments Receipts and Payments Account, Income & Expenditure Account and Balance Sheet of Non Trading Organizations.

**UNIT III PARTNERSHIP ACCOUNTS**

Partnership Accounts-Final accounts of partnership firms - Basic concepts of admission, retirement and death of a partner including treatment of goodwill - rearrangement of capitals. (Simple problems on Partnership Accounts).

**UNIT IV DEPRECIATION**

Depreciation - Meaning, Causes, Types - Straight Line Method - Written Down Value Method, Insurance Policy Method, Sinking Fund Method & Annuity Method. Insurance claims - Average Clause (Loss of stock & Loss of Profit)

**UNIT V SINGLE ENTRY ACCOUNTING**

Single Entry - Meaning, Features, Defects, Differences between Single Entry and Double Entry System - Statement of Affairs Method - Conversion Method

**OUTCOMES:**

- Able to understand the basics of accounting
- Able to understand balance sheet preparation and do analysis
- Able to understand the partnership accounts
- Able to appreciate and depreciate the assets of an organization in accounting
- Able to understand Single Entry Accounting

**REFERENCES:**

1. R.L.Gupta & V. K.Gupta, Advanced Accounting - Sultan Chand& Sons - New Delhi. Fourteenth Revised and Enlarged Edition, 2019.
2. Jain & Narang, Financial Accounting - Kalyani Publishers - New Delhi, Twelfth edition -2014.

3. T.S. Reddy & A. Murthy, Financial Accounting - Margham Publications - Chennai-17. 6th Edition, 2012.
4. Shukla & Grewal, Advanced Accounting - S Chand - New Delhi, 19th Edition, 2017.
5. Nirmal Gupta, Financial Accounting - Ane Books India - New Delhi. Fifth Edition, 2012.

**OBJECTIVES:**

- Provide hands-on cloud and data analytics frameworks and tools.
- Use the Python/R packages for performing analytics.
- Learn using analytical tools for real world problems.
- Familiarize the usage of distributed frameworks for handling voluminous data.
- Write and deploy analytical algorithms as Map Reduce tasks.

**EXPERIMENTS:****Do the following experiments use R/Python:**

1. Download, install and explore the features of R/Python for data analytics.
2. Use the Diabetes data set from UCI and Pima Indians Diabetes data set for performing the following:
  - a. Univariate Analysis: Frequency, Mean, Median, Mode, Variance, Standard Deviation, Skewness and Kurtosis.
  - b. Bivariate Analysis: Linear and logistic regression modeling.
  - c. Multiple Regression Analysis
  - d. Also compare the results of the above analysis for the two data sets.
3. Apply Bayesian and SVM techniques on Iris and Diabetes data set.
4. Apply and explore various plotting functions on UCI data sets.

**Implement the following using Hadoop, Map Reduce, HDFS, Hive:**

1. Perform setting up and Installing Hadoop in its two operating modes: pseudo-distributed and fully distributed.
2. Implement the following file management tasks in Hadoop: adding files and directories, retrieving files and Deleting files
3. Performing a Map Reduce Job for word search count (look for specific keywords in a file).  
Implement stop word elimination problem: Input a large textual file containing one sentence per line and a small file containing a set of stop words (one stop word per line) and save the results in an output textual file containing the same sentences of the large input file without the words appearing in the small file.
4. Implement a Map Reduce program that processes a weather data set to:
  - (i) Find average, max and min temperature for each year in National Climate Data Centre data set.
  - (ii) Filter the readings of a set based on value of the measurement. The program must save the line of input files associated with a temperature value greater than 30.0 and store it in a separate file.
5. Install, deploy & configure Apache Spark cluster. Run Apache Spark applications using Scala.



6. Install and run Hive then use Hive to create, alter, and drop databases, tables, views, functions, and indexes.
7. Mini projects on the following:
  - (i) Simulate a simple recommender system with Amazon product dataset, Social tweet data set etc. on Hadoop.
  - (ii) Perform a very large text classification run on Hadoop.

**OUTCOMES:**

On completion of the course, the students will be able to:

- Install analytical tools and configure distributed file system.
- Have skills in developing and executing analytical procedures in various distributed frameworks and databases.
- Develop, implement and deploy simple applications on very large datasets.
- Implement simple to complex data modeling in NoSQL databases.
- Develop and deploy simple applications in cloud.

**OBJECTIVES:**

- Learn tools relevant to multimedia systems.
- Implement animations on multimedia dataset.
- Design and develop games using multimedia tools.

**EXPERIMENTS:**

1. Editing various images (Image restoration, Changing colour image to Grey scale and vice versa) and adding special effects to images using tools like Photoshop, Gimp and flash.
2. Creating and Editing various video clippings and adding special effects using tools like Adobe Premier Pro.
3. Creating and Editing various audio files and adding special effects using tools like Sound Forge and Audacity.
4. Creating three dimensional models and animations using tools like Blender, 3DS Max, Unity.
5. Working on Text compression algorithms like Run length and Huffman.
6. Implementation of transformations like DCT and FFT Designing User Interfaces and developing simple games using multimedia tools.
7. Creating simple multimedia applications using any popular Authoring tools.

**OUTCOMES:**

On completion of the course, the students will be able to:

- Create 3D models and animations on datasets.
- Develop multimedia applications using authoring tools.
- Design and develop models of text compression.

**OBJECTIVES:**

- Know of how to do project planning for the software process.
- Learn the cost estimation techniques during the analysis of the project.
- Understand the quality concepts for ensuring the functionality of the software.
- Learn risk management concepts.
- Explore globalization issues and its impacts.

**UNIT I SOFTWARE PROJECT MANAGEMENT CONCEPTS**

Introduction to Software Project Management: An Overview of Project Planning: Select Project, Identifying Project scope and objectives, infrastructure, project products and Characteristics. Estimate efforts, Identify activity risks, and allocate resources- TQM, Six Sigma, Software Quality: defining software quality, ISO9126, External Standards.

**UNIT II SOFTWARE EVALUATION AND COSTING**

Project Evaluation: Strategic Assessment, Technical Assessment, cost-benefit analysis, Cash flow forecasting, cost-benefit evaluation techniques, Risk Evaluation. Selection of Appropriate Project approach: Choosing technologies, choice of process models, structured methods.

**UNIT III SOFTWARE ESTIMATION TECHNIQUES**

Software Effort Estimation: Problems with over and under estimations, Basis of software Estimation, Software estimation techniques, expert Judgment, Estimating by analogy. Activity Planning: Project schedules, projects and activities, sequencing and scheduling Activities, networks planning models, formulating a network model.

**UNIT IV RISK MANAGEMENT**

Risk Management: Nature of Risk, Managing Risk, Risk Identification and Analysis, Reducing the Risk. Resource Allocation: Scheduling resources, Critical Paths, Cost scheduling, Monitoring and Control: Creating Framework, cost monitoring, prioritizing monitoring.

**UNIT V GLOBALIZATION ISSUES IN PROJECT MANAGEMENT**

Globalization issues in project management: Evolution of globalization- challenges in building global teams-models for the execution of some effective management techniques for managing global teams. Impact of the internet on project management: Introduction - the effect of internet on project management - managing projects for the internet - effect on project management activities. Comparison of project management software's: dot Project, Launch pad, open Proj. Case study: PRINCE2.

**OUTCOMES:**

- Understand the activities during the project scheduling of any software application.
- Learn the risk management activities and the resource allocation for the projects.
- Can apply the software estimation and recent quality standards for evaluation of the software projects
- Acquire knowledge and skills needed for the construction of highly reliable software project
- Able to create reliable, replicable cost estimation that links to the requirements of project planning and managing.

**REFERENCES:**

1. Bob Hughes & Mike Cotterell, "Software Project Management", Tata McGraw- Hill Publications, Fifth Edition 2012.
2. Futrell , "Quality Software Project Management", Pearson Education India, 2008.
3. Gobalswamy Ramesh, "Managing Global Software Projects", Tata McGraw Hill Publishing Company, 2003.
4. Richard H. Thayer "Software Engineering Project Management", IEEE Computer Society
5. S. A. Kelkar, " Software Project Management" PHI, New Delhi, Third Edition, 2013.

**OBJECTIVES:**

- Provide students with a theoretical as well as practical understanding of agile software development practices and how small teams can apply them to create high-quality software.
- Provide a good understanding of software design and a set of software technologies and APIs.
- Do a detailed examination and demonstration of Agile development and testing techniques.
- Know the benefits and pitfalls of working in an Agile team.
- Be aware of Agile development and testing

**UNIT I                   AGILE METHODOLOGY**

Theories for Agile Management - Agile Software Development - Traditional Model vs. Agile Model - Classification of Agile Methods - Agile Manifesto and Principles - Agile Project Management - Agile Team Interactions - Ethics in Agile Teams - Agility in Design, Testing - Agile Documentations - Agile Drivers, Capabilities and Values

**UNIT II                   AGILE PROCESSES**

Lean Production - SCRUM, Crystal, Feature Driven Development- Adaptive Software Development - Extreme Programming: Method Overview - Lifecycle - Work Products, Roles and Practices

**UNIT III                   AGILITY AND KNOWLEDGE MANAGEMENT**

Agile Information Systems - Agile Decision Making - Earl's Schools of KM - Institutional Knowledge Evolution Cycle - Development, Acquisition, Refinement, Distribution, Deployment, Leveraging - KM in Software Engineering - Managing Software Knowledge - Challenges of Migrating to Agile Methodologies - Agile Knowledge Sharing - Role of Story-Cards - Story-Card Maturity Model (SMM)

**UNIT IV                   AGILITY AND REQUIREMENTS ENGINEERING**

Impact of Agile Processes in RE-Current Agile Practices - Variance - Overview of RE Using Agile - Managing Unstable Requirements - Requirements Elicitation - Agile Requirements Abstraction Model - Requirements Management in Agile Environment, Agile Requirements Prioritization - Agile Requirements Modeling and Generation - Concurrency in Agile Requirements Generation

**UNIT V                   AGILITY AND QUALITY ASSURANCE**

Agile Product Development - Agile Metrics - Feature Driven Development (FDD) - Financial and Production Metrics in FDD - Agile Approach to Quality Assurance - Test Driven Development - Agile Approach in Global Software Development - Agile Scrum - Scrum Master - Scaling Projects using Scrum

**OUTCOMES:**

- Realize the importance of interacting with business stakeholders in determining the requirements for a software system

- Perform iterative software development processes: how to plan them, how to execute them.
- Point out the impact of social aspects on software development success.
- Develop techniques and tools for improving team collaboration and software quality.
- Show how agile approaches can be scaled up to the enterprise level

## REFERENCES

1. David J. Anderson and Eli Schragenheim,, “Agile Management for Software Engineering: Applying the Theory of Constraints for Business Results”, Illustrated Edition, Prentice Hall PTR, 2004
2. Orit Hazza and Yaepl Dubinsky, “Agile Software Engineering: Undergraduate Topics in Computer Science, Springer Verlag, First Edition,2009
3. Craig Larman, “Agile and Iterative Development: A Manager’s Guide”, Pearson Education, Second Impression, 2007
4. Kevin C. Desouza, “Agile Information Systems: Conceptualization, Construction, and Management”, Elsevier, Butterworth-Heinemann, FirstEdition,2007
5. Ken Schwaber, “Agile Project Management with Scrum”, Illustrated, Revised Edition Microsoft Press, 2004
6. KonnorCluster, “Agile Project Management: Learn How To Manage a Project With Agile Methods, Scrum, Kanban and Extreme Programming”, Independently Published, First Edition, 2019.

**OBJECTIVES:**

- Learn the various E-learning approaches and Components.
- Explore Design Thinking.
- Understand the types of design models of E-learning.
- Learn about E-learning Authoring tools.
- Know about evaluation and management of E-learning solutions

**UNIT I INTRODUCTION**

Need for E-Learning - Approaches of E-Learning - Components of E-Learning -synchronous and Asynchronous Modes of Learning - Quality of E-Learning - Blended Learning: Activities, Team and Technology - Work Flow to Produce and Deliver E-Learning Content - Design Thinking: Introduction - Actionable Strategy - Act to Learn - Leading Teams to Win.

**UNIT II DESIGNING E-LEARNING COURSE CONTENT**

Design Models of E-Learning - Identifying and Organizing E-Learning Course Content: Needs Analysis - Analyzing the Target Audience - Identifying Course Content - Defining Learning Objectives - Defining the Course Sequence - Defining Instructional Methods - Defining Evaluation and Delivery Strategies - Case Study.

**UNIT III CREATING INTERACTIVE CONTENT**

Preparing Content: Tips for Content Development and Language Style - Creating Storyboards: Structure of an Interactive E-Lesson - Techniques for Presenting Content - Adding Examples - Integrating Multimedia Elements - Adding Examples - Developing Practice and Assessment Tests- Adding Additional Resources-Courseware Development Authoring Tools - Types of Authoring Tools - Selecting an Authoring Tool.

**UNIT IV LEARNING PLATFORMS**

Types of Learning Platforms - Proprietary vs. Open - Source LMS - LMS Vs LCMS - Internally Handled and Hosted LMS - LMS Solutions - Functional Areas of LMS.

**UNIT V COURSE DELIVERYAND EVALUATION**

Components of an Instructor-Led or Facilitated Course - Planning and Documenting Activities - Facilitating Learners Activities - E-Learning Methods and Delivery Formats - Using Communication Tools for E-Learning - Course Evaluation.

**OUTCOMES:**

On completion of course, the students will be able to:

- Distinguish the phases of activities in models of E-learning.
- Identify appropriate instructional methods and delivery strategies.
- Choose appropriate E-learning Authoring tools.
- Create interactive E-learning courseware.

- Evaluate the E-learning courseware.

**REFERENCE BOOKS:**

1. Clark, R. C., Mayer, R. E., “E-Learning and the Science of Instruction”. Third Edition, 2011.
2. Crews, T. B., Sheth, S. N., Horne, T. M., “Understanding the Learning Personalities of Successful Online Students”, 1st Edition, Educause Review, 2014.
3. Johnny Schneider, “Understanding Design Thinking, Lean and Agile”, 1st Edition, O'Reilly Media, 2017.
4. Madhuri Dubey, “Effective E-learning Design, Development and Delivery”, 1st Edition, University Press, 2011.



**OBJECTIVES:**

- Understand software quality assurance and the usage of different types of softwares.
- Know the Quality Metrics of various Software.
- Know the methodologies used in developing software.
- Learn test automation tools.
- Test the product finally to check the product Quality.

**UNIT I INTRODUCTION:** Introduction to Software Quality - Challenges - Objectives - Quality Factors - Components of SQA - Contract Review - Development and Quality Plans - SQA Components in Project Life Cycle - SQA Defect Removal Policies - Reviews.

**UNIT II TESTING METHODOLOGIES:** Basics of Software Testing - Test Generation from Requirements - Finite State Models - Combinatorial Designs - Test Selection, Minimization and Prioritization for Regression Testing - Test Adequacy, Assessment and Enhancement.

**UNIT III TEST STRATEGIES:** Testing Strategies - White Box and Black Box Approach - Integration Testing - System and Acceptance Testing - Performance Testing - Regression Testing - Internationalization Testing - Ad-hoc Testing - Website Testing - Usability Testing - Accessibility Testing.

**UNIT IV TEST AUTOMATION AND MANAGEMENT:** Test plan - Management - Execution and Reporting - Software Test Automation - Automated Testing tools - Hierarchical Models of Software Quality - Configuration Management - Documentation Control.

**UNIT V SQA IN PROJECT MANAGEMENT:** Project progress control - costs - quality management standards - project process standards - management and its role in SQA - SQA unit.

**OUTCOMES:**

Up on completion of the course the students will be able to

- Develop Quality plans and use SQA components in project life cycle.
- Analyze the product Quality.
- Judge the use of infrastructure components and use configuration items for Quality control.
- Use various testing methods and verify.
- Assess Quality standards of various software products.

**REFERENCE BOOKS:**

1. Daniel Galin, "Software Quality Assurance - from Theory to Implementation" Pearson Education, 2009.
2. Yogesh Singh, "Software Testing", Cambridge University Press, 2012.

3. Aditya Mathur, "Foundations of Software Testing", Pearson Education, 2008.
4. Ron Patton, "Software Testing" , Second Edition, Pearson Education, 2007.
5. Srinivasan Desikan, Gopaldaswamy Ramesh, "Software Testing - Principles and Practices", Pearson Education, 2006.
6. Alan C Gillies, "Software Quality Theory and Management", Cengage Learning, Second Edition, 2003.
7. Robert Furtell, Donald Shafer, and Linda Shafer, "Quality Software Project Management", Pearson Education Asia, 2002.

**OBJECTIVES:**

- Understand the concepts of distributed systems.
- Get an insight into the various issues and solutions in distributed operating systems.
- Learn about real-time operating systems.
- Gain knowledge on the design concepts of mobile operating systems.
- Understand cloud operating systems.

**UNIT I INTRODUCTION:** Distributed Operating Systems - Issues - Communication Primitives - Limitations of a Distributed System - Lamport's Logical Clocks - Vector Clocks - Causal Ordering of Messages.

**UNIT II DISTRIBUTED OPERATING SYSTEMS:** Distributed Mutual Exclusion Algorithms - Classification - Preliminaries - Simple Solution - Lamport's Algorithm - Ricart - Agrawala Algorithm - Suzuki - Kasami's Broadcast Algorithm - Raymond's Tree-Based Algorithm - Distributed Deadlock Detection - Preliminaries - Centralized Deadlock Detection Algorithms - Distributed Deadlock Detection Algorithms - Path Pushing Algorithm - Edge Chasing Algorithm.

**UNIT III DISTRIBUTED RESOURCE MANAGEMENT:** Distributed File Systems - Design Issues - Google File System - Hadoop Distributed File System - Distributed Shared Memory - Algorithms for Implementing Distributed Shared Memory - Load Distributing Algorithms - Synchronous and Asynchronous Check Pointing and Recovery - Fault Tolerance - Two-Phase Commit Protocol - Non blocking Commit Protocol.

**UNIT IV REAL TIME OPERATING SYSTEMS:** Basic Model of Real Time Systems - Characteristics - Application of Real Time Systems - Real Time Task Scheduling - Handling Resource Sharing.

**UNIT V MOBILE AND CLOUD OPERATING SYSTEMS:** Android - Overall Architecture - Linux Kernel -Hardware Support - Native User-Space - Dalvik and Android's Java - System Services - Introduction to Cloud Operating Systems.

**OUTCOMES:**

Upon Completion of the course, the students should be able to:

- Identify the features of distributed operating systems.
- Demonstrate the various protocols of distributed operating systems.
- Identify the different features of real time operating systems.
- Discuss the features of mobile operating systems.
- Discuss the features of cloud operating systems.

**REFERENCES:**

1. MukeshSinghal and Niranjan G. Shivaratri, "Advanced Concepts in Operating Systems - Distributed, Database and Multiprocessor Operating Systems", Tata Mc Graw-Hill, 2001.
2. Rajib Mall, "Real-Time Systems: Theory and Practice", Pearson Education India, 2006.
3. KarimYaghmour, "Embedded Android", O'Reilly, First Edition, 2013.
4. NikolayElenkov, "Android Security Internals: An In-Depth Guide to Android's Security Architecture", No Starch Press, 2014.

**OBJECTIVES:**

- Explore the detailed design practices, standards.
- Gain an insight into Content Management System for content design.
- Use any Content Management System tool for better content management.
- Get familiarized with Web Analytics for better management.

**UNIT I PRINCIPLES OF WEB DESIGN:** User Centered Design, Web Medium, Information Architectures, Site Types and Architectures, Page Structure, Site Maps, Navigation, Search, Web Design Process, Designing for Multiple Screen Resolutions, Creating A Unified Site Design, Evaluating Web Sites.

**UNIT II ELEMENTS OF PAGE DESIGN:** Elements Of Page Design, Adding Styles With CSS, Pages And Layout, Typography, Color, Images, GUI Widgets and Forms, Responsive Web Designs, User Input Forms, Working With Data Tables, Web Standards And Styles.

**UNIT III WEB CONTENT DESIGN:** Features - Automated Templates - Template Processor -Front Controller Pattern - Content Modeling - Content Aggregation - Plug-Ins - Search Engine Optimization - Recommended Usage Of Tools - WORDPRESS.

**UNIT IV WEB CONTENT MANAGEMENT:** Work Flow Management - Document Management - Collaboration - Versioning - Recommended Usage of Tools - WORDPRESS.

**UNIT V WEB ANALYTICS:** Web Analytics Process - Data Collection - Qualitative Analysis - Log File Analysis - Page Tagging - Hybrid Methods - Click Analytics - Onsite And Offsite Analytics - Web Analytics Methods.

**OUTCOMES:**

Up on completion of the course, the students will be able to

- Design web pages that follow standards and are usable.
- Design web sites that are appealing.
- Be able to use Content management System for designing web Content.
- Take advantage of Content Management System tools for managing content for large web sites.
- Be able to use analytics tools for better management.

**REFERENCES:**

1. Patrich J. Lynch, Sarah Horton, “Web Style Guide-Foundations of User Experience Design”, Yale University Press, 4th Edition, 2016.
2. Thomas A. Powell, “The Complete Reference- Web Design”, Tata McGraw Hill, Second

Edition, 2003.

3. Joel Sklar, "Principles of Web Design, Cengage Learning", Web Warrior Series, 6th Edition, 2015.
4. Deane Barker, "Web Content management-Systems, Features and Best Practices", O'reilly Media, 1st Edition, 2016.
5. Brian Clifton, "Advanced web Metrics with Google Analytics", Third Edition, Sybex Publishers, 2012.
6. Avinash Kaushik, "Web Analytics 2.0: The Art of Online Accountability and Science of Customer Centricity", 1st edition, Sybex publishers, 2009.

**OBJECTIVES:**

- Know the importance and need of software security.
- Know about various attacks.
- Learn about secure software design.
- Understand risk management in secure software development.
- Know the working of tools related to software security.

**UNIT I LOW LEVEL ATTACKS:** Need For Software Security - Memory Based Attacks - Low Level Attacks Against Heap and Stack - Stack Smashing - Format String Attacks - Stale Memory Access Attacks - ROP (Return Oriented Programming) - Malicious Computation Without Code Injection. Defense Against Memory Based Attacks - Stack Canaries - Non-Executable Data - Address Space Layout Randomization (ASLR), Memory-Safety Enforcement, Control-Flow Integrity (CFI) - Randomization.

**UNIT II SECURE DESIGN:** Isolating The Effects of Untrusted Executable Content - Stack Inspection - Policy Specification Languages - Vulnerability Trends - Buffer Overflow - Code Injection - Generic Network Fault Injection- Local Fault Injection - SQL Injection - Session Hijacking. Secure Design - Threat Modeling and Security Design Principles - Good and Bad Software Design - Web Security.

**UNIT III SECURITY RISK MANAGEMENT:** Risk Management Life Cycle - Risk Profiling - Risk Exposure Factors - Risk Evaluation and Mitigation - Risk Assessment Techniques - Threat and Vulnerability Management.

**UNIT IV SECURITY TESTING:** 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:** 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.

**OUTCOMES:**

On completion of the course the students should be able to:

- Identify various vulnerabilities related to memory attack.
- Apply security principles in software development.
- Evaluate the extent of risks.
- Involve selection of testing techniques related to software security in testing phase of software development.

- Use tools for securing software.

#### **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.



**OBJECTIVES:**

- Learn the fundamentals of 5G internet.
- Understand the concept of small cells in 5G mobile networks.
- Learn the mobile clouds in 5G network context.
- Understand the role of cognitive radios in 5G networks.
- Learn the security issues in 5G networks.

**UNIT I PERVASIVE CONNECTED WORLD AND 5G INTERNET:** Historical Trend of Wireless Communications - Evolution of LTE Technology to Beyond 4G - 5G Roadmap - Ten Pillars of 5G - Internet of Things and Context Awareness - Networking Reconfiguration and Virtualization Support - Mobility - Quality of Service Control.

**UNIT II SMALL CELLS FOR 5G MOBILE NETWORKS:** Introduction to Small Cells - Capacity Limits and Achievable Gains with Densification - Mobile Data Demand - Demand vs. Capacity - Small Cell Challenges.

**UNIT III COOPERATION FOR NEXT GENERATION WIRELESS NETWORKS:** Introduction - Cooperative Diversity and Relaying Strategies: Cooperation and Network Coding, Cooperative ARQ MAC Protocols - PHY Layer Impact on MAC Protocol Analysis: Impact of Fast Fading and Shadowing on Packet Reception for QoS Guarantee, Impact of Shadowing Spatial Correlation- Study: NCCARQ, PHY Layer Impact.

**UNIT IV MOBILE CLOUDS AND COGNITIVE RADIO:** Introduction - The Mobile Cloud - Mobile Cloud Enablers - Network Coding - Overview of Cognitive Radio Technology in 5G Wireless - Spectrum Optimization using Cognitive Radio - Relevant Spectrum Optimization Literature in 5G - Cognitive Radio and Carrier Aggregation.

**UNIT V SECURITY:** Overview of Potential 5G Communications System Architecture - Security Issues and Challenges in 5G Communications Systems.

**OUTCOMES:**

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

- Compare the 5G network with older generations of networks.
- Identify suitable small cells for different applications in 5G networks.
- Simulate 5G network scenarios.
- Connect applications to mobile cloud.
- Design applications with 5G network support.
- Analyze the security risks in 5G networks.

**REFERENCES:**

1. Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", Wiley, 2015.
2. Yin Zhang, Min Chen, "Cloud Based 5G Wireless Networks", SpringerBriefs in Computer Science, Springer, 2016.
3. Athanasios G. Kanatas, Konstantina S. Nikita, Panagiotis Takis Mathiopoulos, "New Directions in Wireless Communications Systems: From Mobile to 5G", CRC Press, 2017.

**OBJECTIVES:**

The student should be made:

- Learn about the physical layer and MAC layer of WSNs.
- Understand the data centric computing to be followed in WSNs.
- Study about the routing protocols followed in WSNs.
- Study about data aggregation and in-network processing.
- Explore various motes, sensor network operating systems, databases and development platforms.

**UNIT I FUNDAMENTALS OF WSN:** Wireless Adhoc Networks - Distributed Sensing - Sensors and Transducers - Types of Sensors - Accuracy, Resolution and Hysteresis - Architecture of a Sensor Node and WSN - Sensor Network Design Considerations - Energy Efficient Design Principles for WSNs - Applications of WSNs.

**UNIT II MAC LAYER OF WSN AND ZIGBEE STANDARD:** Energy issues in Transceiver Design and Channel Access - PHY Frame Structure - Roles of Nodes - End device, Router and Coordinator - Full Function Device and Reduced Function Device - Star, Mesh and Tree topology - Medium Access Control - Duty cycle S - MAC protocol - IEEE 802.15.4 standard and ZigBee.

**UNIT III DATA CENTRIC COMPUTING IN WSN:** Data Gathering and Dissemination-Broadcasting and Geocasting from Sink - Data Aggregation - LMST based Aggregation - Power Efficient Data gathering and Aggregation (PEDAP) - In-Network Processing - Aggregate Queries - Routing Challenges and Strategies in WSNs - SPIN, Directed Diffusion, Rumour Routing, Energy Aware Routing, Gradient based Routing.

**UNIT IV SYNCHRONIZATION, LOCALIZATION AND TRACKING IN WSNs:** Sensor Management - Topology Control Protocols and Sensing Mode Selection Protocols - Time Synchronization - Localization and Positioning - Ranging techniques - Range based localization algorithms - Location services - Scene analysis, GPS and RFID.

**UNIT V SENSOR NETWORK PLATFORMS AND TOOLS:** Sensor Network Hardware - Berkeley Motes - Arduino IDE - Node Level Software Platforms - Tiny OS - Imperative Language - nesC - Simulators - ns-3, Contiki OS and COOJA IDE, TOSSIM - State Centric Programming - PIECES - A State Centric Framework - Google for Physical World - Role of WSN in IoT.

**OUTCOMES:**

Outcomes to be changed with respect to contents

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

- Understand different types of sensors, their actuators and the architecture of motes.
- Design the topology of WSNs using different types of ZigBee devices and understanding their roles.

- Understand apply data centric computing in wireless sensor networks.
- Apply appropriate localization techniques for different scenarios.
- Manage sensor networks by synchronizing the time, locating and tracking objects.
- Carry out experiments in simulators and real sensors.

**REFERENCES:**

1. Mohammed A. Matin, “Wireless Sensor Networks: Technology and Protocols”, InTech, 2012.
2. Holger Karl, Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks”, John Wiley, 2005.
3. Robert Faludi, “Building Wireless Sensor Networks”, O’Reilly Media, 2011.
4. Feng Zhao, Leonidas Guibas, “Wireless Sensor Networks”, Morgan Kaufmann, 2004.
5. Bob Tucker, “Wireless Sensor Networks: Signals and Communication Technology”, NY Research Press, 2015.

**OBJECTIVES:**

Upon Completion of the course, the students should be able to:

- Learn the fundamentals of semantic web and to conceptualize and depict Ontology for semantic web.
- Understand the languages for semantic web.
- Learn about the ontology learning algorithms and to utilize in the development of an application.
- Know the fundamental concepts of ontology management.
- Learn the applications related to semantic web.

**UNIT I THE QUEST FOR SEMANTICS:** 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:** 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:** 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 TOOLS:** 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.

**UNIT V APPLICATIONS:** 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.

**OUTCOMES:**

- Create ontology for a given domain.
- Develop an application using ontology languages and tools.
- Understand the concepts of semantic Web.
- Use ontology related tools and technologies for application creation.

- Design and develop applications using semantic web.
- Understand the standards related to semantic web.

#### **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.

**OBJECTIVES:**

- Understand the basics of Network Programming
- Be familiar with building network applications
- Design and implement client server Applications using TCP and UDP Sockets
- Expose with various socket options
- Get aware of Network security for Network Programming

**UNIT I INTRODUCTION**

TCP/IP Layer Model - Multicast, broadcast and Any cast - Socket address Structures - Byte ordering functions - address conversion functions - Elementary TCP Sockets - socket, connect, bind, listen, accept, read, write, close functions - Iterative Server - Concurrent Server

**UNIT II ELEMENTARY TCP SOCKETS**

TCP Echo Server - TCP Echo Client - Posix Signal handling - Server with multiple clients - boundary conditions: Server process Crashes, Server host Crashes, Server Crashes and reboots, Server Shutdown

**UNIT III SOCKET OPTIONS AND MULTIPLEXING**

Socket options - getsockopt and setsockopt functions - generic socket options - IP socket options - ICMP socket options - TCP socket options I/O multiplexing - I/O Models - select function - shutdown function - TCP echo Server (with multiplexing) - poll function - TCP echo Client (with Multiplexing)

**UNIT IV ELEMENTARY UDP SOCKETS**

UDP echo Server - UDP echo Client - Multiplexing TCP and UDP sockets - Domain name system - get host by name function - Ipv6 support in DNS - get host by adr function - getservbyname and getservbyport functions.

**UNIT V NETWORK SECURITY**

SSL - SSL Architecture, SSL Protocols, SSL Message, Secure Electronic Transaction (SET). TLS -TLS Protocols, DTLS Protocols, PKI - Fundamentals, Standards and Applications

**OUTCOMES:**

- Upon completion of the course, the student will be able to
- Design and implement the client/server programs using variety of protocols
- Understand the key protocols which support Internet
- Demonstrate advanced knowledge of programming interfaces for network communication
- Use the basic tools for design and testing of network programs in Unix environment.
- Identify some of the factors driving the need for network security

## REFERENCE BOOKS:

1. W. Richard Stevens, Bill Fenner, Andrew M. Rudoff,” Unix Network Programming, Volume 1: The Sockets Networking API”, Third Edition, ISBN:0-13-141155-1, Addison Wesley Pearson Education,2004
2. Behrouz A Forouzan, Debdeep Mukhopadhyay “Cryptography and Network Security”, Second Edition, ISBN -13:978-0-07–070208-0 Tata McGraw Hill Education Private Limited 2010
3. William Stallings, “Cryptographic and network security Principles and Practices”, Fourth Edition, Publisher Prentice Hall, November 2005
4. Andre Perez,” Network Security”, First Edition, Publisher John Wiley & Sons, 2014
5. Gary R. Wright, W. Richard Stevens,” TCP/IP Illustrated: The Implementation”, ISBN 0-201-63354-X, Vol. 2, 1st Edition, Addison Wesley Professional, January 2008
6. Michael J. Donahoo, Kenneth L. Calvert “TCP/IP Sockets in C: Practical Guide for Programmers “, Morgan Kaufmann Publishers 2ndEdition. 2009
7. Lewis Van Winkle,” Hands-On Network Programming with C: Learn socket programming in C and write secure and optimized network code”, ISBN -978-1-78934-986-3, Packt Publishing 2019 First Edition.



**OBJECTIVES:**

- Understand the basic principles of service orientation.
- Analyze various software architectures.
- Introduce service oriented and micro services architecture.
- Analyze and implement a web service based applications.
- Understand the technology underlying service design and micro services applications.

**UNIT I SOFTWARE ENGINEERING PRACTICES:** Software Engineering Principles - SDLC - Agile Development Methodologies - Emergence of Devops Architecture - Need for Software Architecture - Types of IT Architecture - Pattern & Style - Architecting Process for Software Applications - High Level Architecture - Solution Architecture - Software Platforms - Enterprise Applications - Custom Software Applications - Cloud Computing Platforms.

**UNIT II SOA AND MICROSERVICE ARCHITECTURE BASICS:** SOA and MSA - Basics - Evolution of SOA & MSA - Drivers for SOA - Dimensions, Standards and Guidelines for SOA - Emergence of MSA - Enterprise-wide SOA - Strawman and SOA Reference Architecture - OOAD Process & SOAD Process.

**UNIT III WEB SERVICES:** XML - DOM and SAX Processors - SOAP - WSDL - UDDI - JSON - WS - Security - Web Services Standards - Java, .NET, Python Web Services - RESTful Web Services - Middleware Services for IoT - Mobile Services.

**UNIT IV SERVICE ORIENTED ANALYSIS AND DESIGN:** Principles of Service Design - Design of Activity, Data, Client, Business Process Services - Resilience Services -Technologies for SOA - Service Enablement - Integration - Orchestration - SOA Governance - Design Time and Run Time Governance - SOA Best Practices - EA and SOA for IT Alignment.

**UNIT V MICROSERVICE BASED APPLICATIONS:** Implementing Microservices with Python - Microservice Discovery Framework - Coding, Testing & Documenting Microservices - Interacting with Other Services - Monitoring and Securing the Services - Containerized Services - Deploying on Cloud.

**OUTCOMES:**

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

- Analyze and design SOA based solutions.
- Understand the basic principles of service orientation.
- Analyze and implement a web service based applications.
- Understand the technology underlying service design.
- Implement SOA with Micro services applications.
- Classify and make reasonable decision on the adoption of different SOA platforms.

## REFERENCES:

1. Shankar Kambhampaty, "Service-Oriented Architecture and Microservice Architecture: For Enterprise, Cloud, Big Data and Mobile", Third Edition, Wiley, 2018.
2. Tarek Ziadé , "Python Microservices Development", O'REILLY publication,2017.
3. Thomas Erl, "Service Oriented Architecture: Concepts, Technology, and Design", Pearson Education, 2005.
4. Ron Schmelzer et.al, "XML and Web Services", Pearson Education, 2002.
5. Leonard Richardson, Sam Ruby, "RESTful Web Services", O'REILLY publication, 2007.
6. Nicolai M. Josuttis, "SOA in Design - The Art of Distributed System Design", O'REILLY publication, 2007.
7. Raj Balasubramanian, Benjamin Carlyle, Thomas Erl, Cesare Pautasso, "SOA with REST - Principles, Patterns & Constraints for Building Enterprise Solutions with REST", Prentice Hall, 2013.

**OBJECTIVES:**

- Gain knowledge about social networks, its structure and their data sources.
- Study about the knowledge representation technologies for social network analysis.
- Analyze the data left behind in social networks.
- Gain knowledge about the community maintained social media resources.
- Learn about the visualization of social networks.

**UNIT I INTRODUCTION TO SEMANTIC WEB**

The development of Semantic Web - Emergence of the Social Web - The Development of Social Network Analysis - Basic Graph Theoretical Concepts of Social Network Analysis - Electronic Sources for Network Analysis - Electronic Discussion Networks, Blogs and Online Communities, Web-based Networks.

**UNIT II KNOWLEDGE REPRESENTATION ON THE SEMANTIC WEB**

Ontology-based knowledge Representation - Ontology languages for the Semantic Web: RDF and OWL-Modeling Social Network Data - Network Data Representation, Ontological Representation of Social Individuals and Relationships -Aggregating and Reasoning with Social Network Data.

**UNIT III SOCIAL NETWORK MINING**

Detecting Communities in Social Network - Evaluating Communities -Methods for Community Detection - Applications of Community Mining Algorithms - Tools for detecting communities - Application: Analyzing social graph connections, Analyze images on social media.

**UNIT IV COMMUNITY MAINTAINED SOCIAL MEDIA RESOURCES**

Community Maintained Resources - Supporting technologies for community maintained resources- User motivations-Location based social interaction - location technology- mobile location sharing - Social Information Sharing and social filtering - Automated recommender system.

**UNIT V VISUALIZATION OF SOCIAL NETWORKS**

Visualization of Social Networks - Node-Edge Diagrams - Random Layout - Force-Directed Layout - Tree Layout - Matrix Representations -Matrix and Node-Link Diagrams - Hybrid Representations - Visualizing Online Social Networks.

**OUTCOMES:**

Up on completion of the course, the students will be able to:

- Explain the basic principles behind network analysis algorithms.
- Model and represent knowledge for social semantic Web.
- Use extraction and mining tools for analyzing Social networks.
- Discuss about community maintained social media resources.

- Develop personalized visualization for Social networks.

**REFERENCES:**

1. Matthew A. Russell, "Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Google+, Github and more", O'REILLY, Third Edition, 2018.
2. Charu Aggarwal, "Social Network Data Analytics," Springer, First Edition, 2014.
3. Jennifer Golbeck, "Analyzing the social web", Waltham, MA: Morgan Kaufmann (Elsevier), First Edition, 2013.
4. Borko Furht, "Handbook of Social Network Technologies and Applications", Springer, First Edition, 2010
5. Peter Mika, "Social Networks and the Semantic Web", Springer, First Edition, 2007
6. Stanley Wasserman and Katherine Faust, "Social network analysis: methods and applications", Cambridge University Press, First Edition, 1999.

**OBJECTIVES:**

- Impart the fundamental aspects and principles of mixed reality technologies.
- Know the internals of the hardware and software components involved in the development of mixed reality enabled applications.
- Learn about the graphical processing units and their architectures.
- Gain knowledge about mixed reality application development.
- Know the technologies involved in the development of mixed reality based applications.

**UNIT I INTRODUCTION:** Introduction to Virtual Reality and Mixed Reality - Definition - Introduction to Trajectories and Hybrid Space - Three I'S of Virtual Reality - Virtual Reality vs 3D Computer Graphics - Benefits of Virtual Reality - Components of VR System - Introduction to AR-AR Technologies - Input Devices - 3D Position Trackers - Performance Parameters - Gesture Interfaces - Types of Gesture Input Devices. Output Devices - Graphics Display - Human Visual System - Personal Graphics Displays - Sound Displays - Human Auditory System.

**UNIT II MR COMPUTING ARCHITECTURE:** Computing Architectures of VR - Rendering Principle - Graphics and Haptics Rendering - PC Graphics Architecture - Graphics Accelerators - Graphics Benchmarks - Workstation Based Architectures - SGI Infinite Reality Architecture - Distributed VR Architectures - Multipipeline Synchronization - Collocated Rendering Pipelines - Distributed Virtual Environments - MR architecture.

**UNIT III MR MODELING:** Modeling - Geometric Modeling - Virtual Object Shape - Object Visual Appearance - Kinematics Modeling - Transformation Matrices - Object Position - Transformation Invariants - Object Hierarchies - Viewing the 3D World - Physical Modeling - Collision Detection - Surface Deformation - Force Computation - Force Smoothing and Mapping - Behavior Modeling - Model Management.

**UNIT IV PROGRAMMING AND APPLICATIONS:** VR Programming - Toolkits and Scene Graphs - World Tool Kit - Java 3D - Comparison of World Tool Kit and Java 3D - GHOST - People Shop - Human Factors in VR - Methodology and Terminology - VR Health and Safety Issues - VR and Society - Applications of VR.

**UNIT V MIXED REALITY TECHNOLOGIES:** Synchronizing Time - Tangible & Ubiquitous - Vision Based Tracking - Sensing Technologies - Seamless Design - Assembling Interaction - Trajectories through Mixed Reality Performance - Mobile Interface Design - Wearable Computing - Games.

**OUTCOMES:**

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

- Familiarize with the basic concepts of mixed reality.
- Understand the tools and technologies related to Mixed Reality.
- Know the working principle of mixed reality related Sensor devices.

- Develop the Virtual Reality applications in different domains.
- Design of various models using modeling techniques.
- Expose the concept of Virtual Reality and Mixed reality Programming with toolkits.

**REFERENCES:**

1. Charles Palmer, John Williamson, “Virtual Reality Blueprints: Create Compelling VR Experiences for Mobile”, Packt Publisher, 2018
2. John Vince, “Introduction to Virtual Reality”, Springer-Verlag, 2004.
3. William R. Sherman, Alan B. Craig, “Understanding Virtual Reality - Interface, Application, Design”, Morgan Kaufmann, 2003.

**OBJECTIVES:**

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

**UNIT I INTRODUCTION: MOTIVATION**

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**

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**

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 CLASSIFICATION AND CLUSTERING**

Text Classification and Naïve Bayes - Vector Space Classification - Support vector machines and Machine learning on documents. Flat Clustering - Hierarchical Clustering - Matrix decompositions and latent semantic indexing - Fusion and Meta learning

**UNIT V SEARCHING THE WEB**

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

**OUTCOMES:**

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

- Build an Information Retrieval system using the available tools.
- Identify and design the various components of an Information Retrieval system.
- Model an information retrieval system
- Apply machine learning techniques to text classification and clustering which is used for efficient Information Retrieval.

- Design an efficient search engine and analyze the Web content structure.

**REFERENCES:**

1. Implementing and Evaluating Search Engines, The MIT Press, Cambridge, Massachusetts  
London, England, First Edition 2010
2. Ricardo Baeza - Yates, Berthier Ribeiro - Neto, –Modern Information Retrieval: The concepts  
and Technology behind SearchI (ACM Press Books), Second Edition, 2011.
3. Stefan Buttcher, Charles L. A. Clarke, Gordon V. Cormack, –Information Retrieval First  
Edition 2010
4. Manning Christopher D., Raghavan Prabhakar & Schutze Hinrich, “Introduction to Information  
Retrieval”, Cambridge University Press, Online Edition, 2009.



**OBJECTIVES:**

- Understand software architectural requirements and drivers
- Be exposed to architectural styles and views
- Be familiar with architectures for emerging technologies

**UNIT I INTRODUCTION AND ARCHITECTURAL DRIVERS**

Introduction - Software architecture - Architectural structures - Influence of software architecture on organization - both business and technical - Architecture Business Cycle- Functional requirements - Technical constraints - Quality Attributes.

**UNIT II QUALITY ATTRIBUTE WORKSHOP**

Quality Attribute Workshop - Documenting Quality Attributes - Six part scenarios - Case studies.

**UNIT III ARCHITECTURAL VIEWS**

Introduction - Standard Definitions for views - Structures and views - Representing views- available notations - Standard views - 4+1 view of RUP, Siemens 4 views, SEI's perspectives and views - Case studies

**UNIT IV ARCHITECTURAL STYLES**

Introduction - Data flow styles - Call-return styles - Shared Information styles - Event styles - Case studies for each style.

**UNIT V DOCUMENTING THE ARCHITECTURE**

Good practices - Documenting the Views using UML - Merits and Demerits of using visual languages - Need for formal languages - Architectural Description Languages - ACME - Case studies. Special topics: SOA and Web services - Cloud Computing - Adaptive structures

**OUTCOMES:**

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

- Explain influence of software architecture on business and technical activities
- Summarize quality attribute workshop
- Identify key architectural structures
- Use styles and views to specify architecture
- Design document for a given architecture

**REFERENCES:**

1. Len Bass, Paul Clements, and Rick Kazman, "Software Architectures Principles and Practices", 2n Edition, Addison-Wesley, 2003.
2. Anthony J Lattanze, "Architecting Software Intensive System. A Practitioner's Guide", 1st Edition, Auerbach Publications, 2010.

3. Paul Clements, Felix Bachmann, Len Bass, David Garlan, James Ivers, Reed Little, Paulo Merson, Robert Nord, and Judith Stafford, "Documenting Software Architectures. Views and Beyond", 2nd Edition, Addison-Wesley, 2010
4. Paul Clements, Rick Kazman, and Mark Klein, "Evaluating software architectures: Methods and case studies.", 1st Edition, Addison-Wesley, 2001.
5. Mark Hansen, "SOA Using Java Web Services", 1st Edition, Prentice Hall, 2007
6. David Garlan, Bradley Schmerl, and Shang-Wen Cheng, "Software Architecture-Based Self-Adaptation," 31-56. Mieso K Denko, Laurence Tianruo Yang, and Yan Zang (eds.), "Autonomic Computing and Networking". 1st Edition, Springer Verlag 2009.

**OBJECTIVES:**

- Understand the hacking techniques of computer forensics.
- Learn about data recovery methods.
- Identify the threats in computer forensics.

**UNIT I ETHICAL HACKING:** Foundation for Ethical Hacking-Ethical Hacking in Motion-Hacking Network Hosts-Hacking Operating Systems-Hacking Applications.

**UNIT II TYPES OF COMPUTER FORENSICS:** Computer Forensics Fundamentals - Types of Computer Forensics Technology - Types of Vendor and Computer Forensics Services.

**UNIT III DATA RECOVERY:** Data Recovery - Evidence Collection and Data Seizure - Duplication and Preservation of Digital Evidence - Computer Image Verification and Authentication.

**UNIT IV ELECTRONIC EVIDENCE:** - Discover of Electronic Evidence - Identification of Data - Reconstructing Past Events - Networks.

**UNIT V THREATS:** Fighting against Macro Threats - Information Warfare Arsenal - Tactics of the Military - Tactics of Terrorist and Rogues - Tactics of Private Companies.

**OUTCOME:**

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

- Distinguish between hackers and normal users.
- Apply the principles of computer forensics for security.
- Implement the data recovery methods.
- Manage threats and the tactics.

**REFERENCES:**

1. John R. Vacca, –Computer ForensicsI, Firewall Media, 2004.
2. Kevin Beaver, –Hacking For DummiesI, John Wiley & Sons,2012.
3. Chad Steel, –Windows ForensicsI, Wiley India, 2006.
4. Majid Yar, –Cybercrime and SocietyI, Sage Publications, 2006.
5. Robert M Slade, –Software ForensicsI, Tata McGrawHill, 2004.

**OBJECTIVES:**

Upon Completion of the course, the students should be able to:

- Expose the students to the concepts of Data warehousing Architecture and Implementation.
- Understand Data mining principles and pre-process techniques.
- Expose the students to the concepts of Association Rule Mining Techniques.
- Study the overview of classification and predictions in data mining.
- Identify the major categorization of clustering techniques in Data mining.

**UNIT I DATA WAREHOUSE:** Data Warehousing - Operational Database Systems vs Data Warehouses - Multidimensional Data Model - Schemas for Multidimensional Databases - OLAP operations - Data Warehouse Architecture - Indexing - OLAP queries & Tools.

**UNIT II DATA MINING & DATA PREPROCESSING:** Introduction to KDD process - Knowledge Discovery from Databases - Need for Data Preprocessing - Data Cleaning - Data Integration and Transformation - Data Reduction - Data Discretization and Concept Hierarchy Generation.

**UNIT III ASSOCIATION RULE MINING:** Introduction - Data Mining Functionalities - Association Rule Mining - Mining Frequent Itemsets with and without Candidate Generation - Mining Various Kinds of Association Rules - Constraint-Based Association Mining.

**UNIT IV CLASSIFICATION & PREDICTION:** Classification vs Prediction - Data preparation for Classification and Prediction - Classification by Decision Tree Introduction - Bayesian Classification - Rule Based Classification - Classification by Back propagation - Support Vector Machines - Associative Classification - Lazy Learners - Other Classification Methods - Prediction - Accuracy and Error Measures - Evaluating the Accuracy of a Classifier or Predictor - Ensemble Methods - Model Selection.

**UNIT V CLUSTERING:** Cluster Analysis: - Types of Data in Cluster Analysis - A Categorization of Major Clustering Methods - Partitioning Methods - Hierarchical methods - Density-Based Methods - Grid-Based Methods - Model-Based Clustering Methods - Clustering HighDimensional Data - Constraint-Based Cluster Analysis - Outlier Analysis.

**OUTCOMES:**

On completion of the course, the students will be able to:

- Able to construct the multidimensional data modeling.
- Evolve the importance of data preprocessing.
- Discover the knowledge imbibed in the high dimensional system.
- Experiment Ensemble Methods of various classification algorithms.
- Evaluate various mining techniques on complex data objects.

**REFERENCES:**

1. Jiawei Han and Micheline Kamber “Data Mining Concepts and Techniques” Second Edition, Elsevier, Reprinted 2011.
2. K.P. Soman, Shyam Diwakar and V. Ajay “Insight into Data mining Theory and Practice”, Easter Economy Edition, Prentice Hall of India, 2006.
3. G. K. Gupta “Introduction to Data Mining with Case Studies”, Easter Economy Edition, Prentice Hall of India, 2006.
4. Pang-Ning Tan, Michael Steinbach and Vipin Kumar “Introduction to Data Mining”, Pearson Education, 2007.

**OBJECTIVES:**

- Understand the categories of data quality principles.
- Describe data through visual representation.
- Provide basic knowledge about how large datasets are represented into visual graphics
- Easily understand about the complex relationships within the data.
- Design effective visualization techniques for any different problems.

**UNIT I INTRODUCTION**

Visualization - visualization process - role of cognition - Pseudocode conventions - Scatter plot - Data foundation : Types of data - Structure within and between records - Data preprocessing - Human perceptions and information processing.

**UNIT II VISUALIZATION FOUNDATIONS**

Semiology of graphical Symbols - Eight Visual Variables - Historical Perspective- Visualization Techniques for spatial data - One-dimensional data- two dimensional data - Three dimensional data- dynamic data - combining techniques- Visualization of Geospatial data - Visualization of Point, line, area data.

**UNIT III DESIGNING EFFECTIVE VISUALIZATION**

Steps in Designing Visualization - problems in Designing Effective Visualization - Comparing and evaluating visualization techniques - Visualization Systems.

**UNIT IV INFORMATION DASHBOARD DESIGN**

Characteristics of dashboards - Key goals in visual design process - Dashboard display media - Designing dashboards for usability - Meaningful organization - Maintaining consistency - Aesthetics of dashboards - Testing for usability - Case Studies: Sales dashboard, Marketing analysis dashboard.

**UNIT V VISUALIZATION SYSTEMS**

Systems based on Data type-systems based on Analysis type - Text analysis and visualization - Modern integrated visualization systems - toolkit-Research directions in visualization - issues of cognition, perception and reasoning -issues of evaluation - issues of Hardware.

**OUTCOME:**

On completion of the course the student should be able to:

- Describe principles of visual perception
- Apply visualization techniques for various data analysis tasks - numerical data
- Apply visualization techniques for various data analysis tasks - Non numerical data
- Design effective visualization techniques for different problems
- Design information dashboard.

**REFERENCES:**

1. Matthew O. Ward, Georges Grinstein, Daniel Keim “Interactive Data Visualization:

Foundations, Techniques, and Applications”, CRC Press; 2nd edition, 2015

2. Stephen Few, "Now you see it: Simple Visualization Techniques for Quantitative Analysis", 1st Edition, Analytics Press, 2009.
3. Stephen Few, "Information Dashboard Design: The Effective Visual Communication of Data", 1st Edition, O'Reilly, 2006.
4. Ben Fry, "Visualizing data: Exploring and explaining data with the processing environment", 1st Edition, O'Reilly, 2008.

**OBJECTIVES:**

- Provide the concept and an understanding of basic concepts in Operations Research techniques for Analysis and Modeling in Computer Applications.
- Understand, develop and solve mathematical model of linear programming problems
- Understand, develop and solve mathematical model of Transport and assignment problems
- Know network modeling for planning and scheduling the project activities
- Learn methods of game theory.

**UNIT I LINEAR PROGRAMMING MODELS**

Formulation of LPP, Graphical solution of LPP. Simplex Method, Artificial variables: big-M method, degeneracy and unbound solutions.

**UNIT II TRANSPORTATION AND ASSIGNMENT MODELS**

Formulation - Methods for finding basic Feasible Solution - Optimality Test - MODI method - Degeneracy in Transportation Problem -Unbalanced Transportation Problem. Assignment Method:Mathematical formulation of assignment models - Hungarian Algorithm - Variants of the Assignment problem

**UNIT III SCHEDULING BY PERT AND CPM**

Introduction - Rules to frame a Network - Fulkerson's Rule to numbering of events - Activity, Times - Critical Path Computation - Slack and Float - PERT- Steps and computing variance, Merits and demerits of PERT, CPM- Time estimating & Limitations, Comparison between PERT & CPM.

**UNIT IV QUEUEING MODELS**

Characteristics of Queueing Models-Poisson Queues-(M / M / 1): (FIFO /  $\infty$  /  $\infty$ ), (M / M / 1) : (FIFO / N /  $\infty$ ), (M / M / C) : (FIFO /  $\infty$  /  $\infty$ ), (M / M / C) : (FIFO / N /  $\infty$ ) models.

**UNIT V GAME THEORY**

Competitive game, rectangular game, saddle point, minimax (maxmini) method of optimal strategies- value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point - mixed strategy for 2 X 2 games.

**OUTCOMES:**

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

- Understand and apply linear programming to solve operational problem with constraints
- Apply transportation and assignment models to find optimal solution
- Prepare project scheduling using PERT and CPM
- Identify and analyze appropriate queueing model to reduce the waiting time in queue.
- Choose the best strategy using decision making methods under game theory.

**REFERENCES:**

1. Taha H.A., "Operations Research: An Introduction", 10th Edition, Prentice Hall of India, New



Delhi, 2017

2. KantiSwarup, P.K. Gupta, Man Mohan, "Operations Research", 15th Revised Edition, S. Chand& Sons Education Publications, New Delhi, 2017
3. Ronald L Rardin, Optimization In Operations Research, 2nd Edition, Pearson Education, India, 2018
4. Jatinder Kumar, Optimization Techniques in Operations Research, LAP LAMBERT Academic Publishing, 2015
5. D.S.Hira and P.K.Gupta, Operations Research, 5th Edition, S.Chand& Sons, 2015.
6. Frederick S. Hillier, Gerald J. Lieberman, "Introduction to Operations Research", Mc Graw Hill Higher Education, 9th Edition, 2010.

**OBJECTIVES:**

- Understand the concepts of computer ethics in work environment.
- Enhance the threats in computing environment
- Gain Knowledge about the intricacies of accessibility issues
- Ensure safe exits when designing the software projects

**UNIT I INTRODUCTION TO ETHICS**

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

**UNIT II ETHICS IN INFORMATION TECHNOLOGY**

IT Professionals - Are IT Workers Professionals- Professional Relationships That Must Be Managed -Professional Codes of Ethics - Professional Organizations - Certification - IT Professional Ethics, Three Codes of Ethics, Management Conflicts.

**UNIT III FREEDOM OF EXPRESSION, PRIVACY**

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

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

Intellectual Property Rights-Copyrights-Copyright Term - Eligible Works -Fair Use Doctrine - Software Copyright Protection -Copyright Laws and the internet-Copyright and Piracy-Patents- Software Patents -Cross-Licensing Agreements.

**UNIT V SOCIAL NETWORKING ETHICS AND ETIQUETTES**

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

**OUTCOMES:**

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

- Helps to examine situations and to internalize the need for applying ethical principles, values to tackle with various situations.
- Develop a responsible attitude towards the use of computer as well as the technology.
- Able to envision the societal impact on the products/ projects they develop in their career
- Understanding the code of ethics and standards of computer professionals.
- Analyze the professional responsibility and empowering access to information in the work place.

**REFERENCES:**

1. Caroline Whitback,” Ethics in Engineering Practice and Research “, Cambridge University Press, 2ndEdition2011.
2. George Reynolds, “Ethics in Information Technology”, Cengage Learning, 6thEdition2018.
3. Barger, Robert. (2008). Computer ethics: A case-based approach. Cambridge University Press 1stEdition.
4. John Weckert and Douglas Adeney, Computer and Information Ethics, Greenwood Press, First Edition1997.
5. Penny Duquenoy, Simon Jones and Barry G Blundell, “Ethical, legal and professional issues in computing”, Middlesex University Press, First Edition2008.
6. Sara Baase, “A Gift of Fire: Social, Legal, and Ethical Issues for Computing and the Internet”, 3rd Edition, Prentice Hall, 2008.

**OBJECTIVE:**

- Provide basic knowledge of concepts, principles, tools and techniques of Marketing.
- Provide an exposure to the students pertaining to marketing strategies, which they are expected to possess when they enter the industry as practitioners.
- Give them an understanding of the various marketing Strategies used in consumer and industrial marketing.

**UNIT I INTRODUCTION TO MARKETING MANAGEMENT**

Introduction - Market and Marketing - the Exchange Process- Core Concepts of Marketing - Functions of Marketing - Importance of Marketing - Marketing Orientations -Marketing Mix-The Traditional 4Ps - The Modern Components of the Mix - The Additional 3Ps - Developing an Effective Marketing Mix.

**UNIT II MARKETING ENVIRONMENT**

Introduction - Environmental Scanning - Analysing the Organization's Micro Environment - Company's Macro Environment, Differences between Micro and Macro Environment - Techniques of Environment Scanning - Marketing organization - Marketing Research and the Marketing Information System, Types and Components.

**UNIT III CONSUMER AND BUSINESS BUYER BEHAVIOUR**

Introduction - Characteristics - Types of Buying Decision Behaviour - Consumer Buying Decision Process - - Buying Motives - Buyer Behaviour Models - Characteristics of Business Markets - Differences between Consumer and Business Buyer Behaviour - Buying Situations in Industrial/Business Market - Buying Roles in Industrial Marketing - Factors that Influence Business Buyers - Steps in Business Buying Process

**UNIT IV SEGMENTATION, TARGETING AND POSITIONING**

Introduction - Concept of Market Segmentation - Benefits of Market Segmentation - Requisites of Effective Market Segmentation - The Process of Market Segmentation - Bases for Segmenting Consumer Markets - Targeting (T) - Market Positioning (P)

**UNIT V INTERNATIONAL MARKETING MANAGEMENT & RECENT TRENDS**

Introduction - Nature of International Marketing - International Marketing Concept - International Market Entry Strategies - Approaches to International Marketing - Cause related marketing - Ethics in marketing -Online marketing trends.

**OUTCOMES:**

- Knowledge of basic understanding in solving marketing related problems.
- Awareness of marketing management process, strategies and the marketing mix elements.
- Clear understanding of functional area of marketing
- Demonstrating conceptual knowledge and analytical skills in analyzing the marketing

environment.

- Develop skills in recent trends in global marketing.

#### REFERENCES:

1. Sherlekar, "Marketing Management ", S.A, Himalaya Publishing House, Thirteenth Edition 2016.
2. Philip Kotler and Kevin Lane Keller, ". Marketing Management ", PHI 15th Edition, 2015
3. S.H.H. Kazmi, ". Marketing Management," , Excel Books India, 2nd Edition, 2013
4. C. B Gupta & N Rajan Nair, "Marketing Management text and Case " 17th Edition 2016
5. KS Chandrasekar, "Marketing management-Text and Cases", Tata McGraw Hill, First edition, 2010.
6. V S Ramaswamy & S Namkumari, "Marketing management Global Perspective, Indian Context" , Macmillan Publishers India, 5th Edition, 2015

**OBJECTIVE:**

- The objective is to enable the students to understand the Organizational Behavior, and Organizational Change and dynamic of groups.
- Learn process, learning theories.
- Understand leadership and power centers.
- Know organizational dynamics concepts.

**UNIT I ORGANISATIONAL BEHAVIOUR**

Organization Behaviour - Definition - Scope and Application in Management - Contributions of Other Disciplines to OB. Emerging Issues in Organizational Behaviour- Organizational behaviour models

**UNIT II INDIVIDUAL PROCESSES**

Personality - types - Factors influencing personality- Theories. Emotions - Theories - Emotional Intelligence- Learning - Types of learners - The learning process - Learning theories.

Perceptions - Importance - Factors influencing perception- Attitudes - Nature of Attitudes Components of Attitudes Formation of Attitude Benefits of Positive Attitude Functions of Attitudes- Measurement-Motivation - Importance - Types - Theories.

**UNIT III LEADERSHIP AND POWER**

Meaning - Importance - Leadership styles - Theories - Leaders Vs Managers - Sources of power - Power centers - Power and Politics.

**UNIT IV GROUP DYNAMICS**

Meaning - Types of Groups - Functions of Small Groups - Group Size Status - Managerial Implications - Group Behaviour - Group Norms - Cohesiveness - Group Thinking

**UNIT V ORGANISATIONAL CHANGE AND DEVELOPMENT**

Organizational Change: Meaning - Nature of Work Change - Need for Change - Change Process - Types of Change - Factors Influencing Change - Resistance to Change - Overcoming Resistance - Organizational Development: Meaning and Different Types of OD Interventions.

**OUTCOMES:**

On completion of the course should be able to:

- Students will have a better understanding of human behavior in organization.
- They will know the framework for managing individual and group performance.
- Characteristics of attitudes and components of attitudes – A brief discussion
- List the determinants of personality
- List the characteristics of various leadership styles.

**REFERENCES:**

1. K. Aswathappa, "Organizational behaviour", Himalaya Publishing House Pvt. Ltd. 11th Edition.
2. Stephen P. Robins, "Organizational Behavior", PHI Learning / Pearson Education, Edition 17, 2016 (Global edition)
3. Fred Luthans, "Organizational Behavior", McGraw Hill, 12th Edition
4. Nelson, Quick, Khandelwal. "ORGB - An innovative approach to learning and teaching". Cengage, 2nd edition 2012
5. Ivancevich, Konopaske & Maheson, "Organizational Behaviour & Management", Tata McGraw Hill, 7th edition, 2008
6. Robert Kreitner and Angelo Kinicki, "Organizational Behaviour", Tata McGraw Hill, 10th Edition, 2016.
7. Frederick S Hillier, Gerald J. Lieberman, "Introduction to Operations Research", 10<sup>th</sup> Edition, 2017.

**OBJECTIVES:**

- Understand the basics of business analytics and its life cycle.
- Gain knowledge about fundamental business analytics.
- Learn modeling for uncertainty and statistical inference.
- Understand analytics using Hadoop and Map Reduce frameworks.
- Acquire insight on other analytical frameworks.

**UNIT I OVERVIEW OF BUSINESS ANALYTICS**

Introduction - Drivers for Business Analytics - Applications of Business Analytics: Marketing and Sales, Human Resource, Healthcare, Product Design, Service Design, Customer Service and Support - Skills Required for a Business Analyst - Framework for Business Analytics Life Cycle for Business Analytics Process.

**UNIT II ESSENTIALS OF BUSINESS ANALYTICS**

Descriptive Statistics - Using Data - Types of Data - Data Distribution Metrics: Frequency, Mean, Median, Mode, Range, Variance, Standard Deviation, Percentile, Quartile, z-Score, Covariance, Correlation - Data Visualization: Tables, Charts, Line Charts, Bar and Column Chart, Bubble Chart, Heat Map - Data Dashboards.

**UNIT III MODELING UNCERTAINTY AND STATISTICAL INFERENCE**

Modeling Uncertainty: Events and Probabilities - Conditional Probability - Random Variables - Discrete Probability Distributions - Continuous Probability Distribution - Bayesian probability - Statistical Inference: Data Sampling - Selecting a Sample - Point Estimation - Sampling Distributions - Interval Estimation - Hypothesis Testing - Certainty factors - Dumpster - Shafer theory - fuzzy logic.

**UNIT IV ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK**

Introducing Hadoop - RDBMS versus Hadoop - Hadoop Overview - HDFS (Hadoop Distributed File System) - Processing Data with Hadoop - Introduction to Map Reduce - Features of Map Reduce - Algorithms Using Map-Reduce: Matrix-Vector Multiplication, Relational Algebra Operations, Grouping and Aggregation - Extensions to Map Reduce

**UNIT V OTHER DATA ANALYTICAL FRAMEWORKS**

Overview of Application Development Languages for Hadoop - PigLatin - Hive - Hive Query Language (HQL) - Introduction to Pentaho, JAQL - Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala - Introduction to NoSQL Databases - Hbase and MongoDB.

**OUTCOMES:**

- On completion of the course, the student will be able to:
- Identify the real world business problems and model with analytical solutions.
- Solve analytical problem with relevant mathematics background knowledge.



- Convert any real world decision making problem to hypothesis and apply suitable statistical testing.
- Write and Demonstrate simple applications involving analytics using Hadoop and Map Reduce
- Use open source frameworks for modeling and storing data.

#### REFERENCES:

1. U. Dinesh Kumar, "Business Analytics: The Science of Data-Driven Decision Making", Wiley, First Edition, 2017.
2. Umesh R Hodeghatta, UmeshaNayak, "Business Analytics Using R - A Practical Approach", Apress, First Edition 2017.
3. Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R. Anderson, "Essentials of Business Analytics", Cengage Learning, second Edition, 2016.
4. Rui Miguel Forte, "Mastering Predictive Analytics with R", Packt Publication, First Edition 2015.
5. Vignesh Prajapati, "Big Data Analytics with R and Hadoop", Packt Publishing, First Edition 2013.
6. Anand Rajaraman, Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, First Edition 2012.
7. Ohri, "R for Business Analytics", Springer, First Edition, 2012

**OBJECTIVES:**

- Decompose a blockchain system's fundamental components, how they fit together and examine a decentralization using blockchain.
- Explain how Cryptocurrency works, from when a transaction is created to when it is considered part of the blockchain.
- Explain the components of Ethereum and Programming Languages for Ethereum.
- Study the basics Hyperledger and Web3.
- Provide a details of alternative blockchain and blockchain projects in different perspective.

**UNIT I INTRODUCTION TO BLOCKCHAIN:** History of Blockchain - Types of Blockchain - Consensus - Decentralization using Blockchain - Blockchain and Full Ecosystem Decentralization - Platforms for Decentralization.

**UNIT II INTRODUCTION TO CRYPTOCURRENCY:** Bitcoin - Digital Keys and Addresses - Transactions - Mining - Bitcoin Networks and Payments - Wallets - Alternative Coins - Theoretical Limitations - Bitcoin Limitations - Name Coin - Prime Coin - Zcash - Smart Contracts - Ricardian Contracts.

**UNIT III ETHEREUM:** The Ethereum Network - Components of Ethereum Ecosystem - Ethereum Programming Languages: Runtime Byte Code, Blocks and Blockchain, Fee Schedule - Supporting Protocols - Solidity Language.

**UNIT IV WEB3 AND HYPERLEDGER:** Introduction to Web3 - Contract Deployment - POST Requests - Development frameworks - Hyperledger as a protocol - The Reference Architecture - Hyperledger Fabric - Distributed Ledger - Corda..

**UNIT V ALTERNATIVE BLOCKCHAINS AND NEXT EMERGING TRENDS:** Kadena - Ripple-Rootstock - Quorum - Tendermint - Scalability - Privacy - Other Challenges - Blockchain Research - Notable Projects - Miscellaneous tools.

**OUTCOME:**

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

- Understand the technology components of Blockchain and how it works behind-the scenes.
- Aware of different approaches to developing decentralized applications.
- Understand the Bitcoin and its limitations by comparing with other alternative coins.
- Establish deep understanding of the Ethereum model, its consensus model, code execution.
- Understand the architectural components of a Hyperledger and its development framework.
- Come to know the Alternative blockchains and emerging trends in blockchain.

## REFERENCES:

1. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained", Second Edition, Packt Publishing.
2. Arshdeep Bahga, Vijay Madiseti, "Blockchain Applications: A Hands-On Approach", VPT, 2017.
3. Andreas Antonopoulos, Satoshi Nakamoto, "Mastering Bitcoin", O'Reilly Publishing, 2014.
4. Roger Wattenhofer, "The Science of the Blockchain" CreateSpace Independent Publishing Platform, 2016.
5. A. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction", Princeton University Press, 2016.
6. Alex Leverington, "Ethereum Programming", Packt Publishing, 2017.

**OBJECTIVES:**

- Determine the necessity of user interaction by understanding usability engineering and user modeling.
- Learn the methodologies for designing interactive systems.
- Investigate the core and complex design issues for interaction.
- Examine the evaluation methodologies of design.
- Understand design issues for web and mobile platforms

**UNIT I INTRODUCTION:** Context of Interaction -Ergonomics - Designing Interactive systems - Understanding Users cognition and cognitive frame works, User Centred approaches - Usability, Universal Usability, Understanding and conceptualizing interaction, Guidelines, Principles and Theories.

**UNIT II INTERACTION DESIGN:** Universal design principles, guidelines, heuristics, HCI Patterns, Design Frame Works, Design Methods, Prototyping, Understanding Interaction Styles, Direct Manipulation and Immersive Environments, Fluid Navigation, Expressive Human and Command Languages, Communication and Collaboration.

**UNIT III DESIGN AND EVALUATION:** Advancing the User Experience, Timely User Experience, Information Search, Data Visualization Evaluation Techniques- Assessing User Experience- Usability Testing - Heuristic Evaluation and Walkthroughs, Analytics Predictive Models.

**UNIT IV MODELS AND THEORIES:** Cognitive Models, Socio-Organizational Issues and Stake Holder Requirements, Communication And Collaboration Models task Analysis, Dialog Notations and Design, Models of the System, Modeling Rich Interaction, Ubiquitous Computing.

**UNIT V DESIGNING INTERACTIONS FOR WEB AND MOBILE PLATFORMS:** 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.

**OUTCOMES:**

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

- Understand the basics of human computer interactions via usability engineering and cognitive modeling.
- Understand the basic design paradigms, complex interaction styles.
- Understand the fundamental design issues.
- Evaluate of interaction designs and implementations.

- Use models and theories for user interaction.
- Use above concepts for web and mobile applications.

#### REFERENCES:

1. Ben Shneiderman, Catherine Plaisant, Maxine Cohen, Steven Jacobs, NiklasElmqvist, “Designing the User Interface: Strategies for Effective Human-Computer Interaction”, Sixth Edition, Pearson Education, 2016.
2. Jenny Preece, Helen Sharp, Yvonne Rogers, “Interaction Design: Beyond Human Computer Interaction”, Wiley Student Edition, 4th Edition, Wiley, 2015.
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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. Cameron Banga, Josh Weinhold, “Essential Mobile Interaction Design: Perfecting Interface Design in Mobile Apps”, Addison-Wesley Professional, 1 edition, 2014.
7. Bill Scott and Theresa Neil, “Designing Web Interfaces”, First Edition, O “Reilly, 2009.
8. Steven Hooper, Eric Berkman, “Designing Mobile Interfaces Patterns for Interaction Design”, O’Reilly, 2011.

**OBJECTIVES:**

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

**UNIT I FUZZY COMPUTING**

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

**UNIT II FUNDAMENTALS OF NEURAL NETWORKS**

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

**UNIT III BACKPROPAGATION NETWORKS**

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

**UNIT IV COMPETITIVE NEURAL NETWORKS**

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

**UNIT V GENETIC ALGORITHM**

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

**OUTCOMES:**

On completion of the course, the students will be able to:

- Identify and describe soft computing techniques and their roles in building intelligent

machines.

- Recognize the feasibility of applying a soft computing methodology for a particular problem.
- Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems.
- Apply genetic algorithms to optimization problems.
- Design neural networks to pattern classification and regression problems using soft computing approach.

#### **REFERENCES:**

1. S. Rajasekaran and G.A. Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications", Prentice Hall of India, 2003.
2. J.S.R. Jang, C.T. Sun and E. Mizutani, "Neuro - Fuzzy and Soft Computing", Pearson Education, ,2004
3. S. N. Sivanandam, S. N. Deepa, "Principles of Soft Computing", Second Edition, Wiley, 2007.
4. SimonHaykin, "Neural Networks", Prentice Hall, 2ndEdition,1999.
5. Timothy Ross, "Fuzzy Logic with Engineering Applications", Wiley Publications,4thEdition 2016.
6. David E. Goldberg, "Genetic Algorithms in Search, Optimization and Machine Learning", Pearson Education, First Edition, 2008.
7. Freeman, J.A and SKapura, "Neural Networks: Algorithms, Applications and Programming Techniques", Additional Wesley, 1992.

**OBJECTIVES:**

- Understand how to represent the high-dimensional data, such as images, text and data.
- Explain convolution neural network
- Introduce major deep learning algorithms and their applications to solve real world problems.
- Explore about optimization and generalization in Deep learning
- Understand about deep reinforcement learning

**UNIT I NEURAL NETWORK**

Building Intelligence Machine-Expressing Linear Perceptron as Neurons-Feed Forward Neural Networks - Activation function. Supervised and Unsupervised Learning: Single Layer Perceptron - Perceptron Learning Algorithm - Least Mean Square Learning Algorithm - Multilayer Perceptron - Back Propagation Algorithm - XOR problem - Limitations of Back Propagation Algorithm- Implementing Neural Networks in Tensor Flow.

**UNIT II CONVOLUTION NEURAL NETWORK**

Introduction-Filter and Feature Maps-Full Description of CNN-Max Pooling- Full Architectural Description of CNN-Image Preprocessing Pipeline Enable More Robust Models-Accelerating Training with Batch Normalization-Visualizing Learning with Convolution Network-Leveraging and Learning Convolution Filters - Predefined Convolutional Filters Network (PCFNet)- Transfer Learning with Convolutional Neural Networks.

**UNIT III DEEP NETWORKS**

History of Deep Learning- A Probabilistic Theory of Deep Learning- Backpropagation and regularization, batch normalization- VC Dimension and Neural Nets-Deep Vs Shallow Networks - Convolutional Networks- Generative Adversarial Networks (GAN), Semi-supervised Learning

**UNIT IV OPTIMIZATION AND GENERALIZATION**

Optimization in deep learning- Non-convex optimization for deep networks- Stochastic Optimization Generalization in neural networks- Spatial Transformer Networks- Recurrent networks, LSTM - Recurrent Neural Network Language Models- Word-Level RNNs & Deep Reinforcement Learning.

**UNIT V DEEP REINFORCEMENT LEARNING**

Markov Decision Processes-Explore versus Exploit-Policy versus Value Learning-Pole-Cart with Policy Gradients-Q Learning and Deep Q Networks-Improving and Moving Beyond DQN

**OUTCOME:**

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

- Describe the fundamental concepts of Neural Networks
- Apply Convolution Neural Network techniques to solve problems in image processing



- Summarize the characteristics of deep Learning
- Comprehend the Optimization and Generalization in Deep Learning
- Interpret the concepts of Deep Reinforcement Learning to solve real world problems.

## **REFERENCES**

1. Nikhil Buduma, Nicholas Locascio, “Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms”, First Edition, O'ReillyMedia, 2017.
2. Sudharsan Ravichandiran, Hands on Deep Learning Algorithms with Python, First Edition, Packt Publishing Limited, 2019.
3. François Chollet, Deep Learning with Python, First Edition, Manning Publications Company, 2017.
4. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, First edition MIT Press, London, 2016

**OBJECTIVES:**

- Know the fundamental concepts of big data and analytics.
- Explore tools and practices for working with big data.
- Explore association and recommendations systems.
- Learn about stream computing.
- Know about the research that requires the integration of large amounts of data.

**UNIT I INTRODUCTION TO BIG DATA**

Evolution of Big data - Best Practices for Big data Analytics - Big data characteristics - Validating - The Promotion of the Value of Big Data - Big Data Use Cases- Characteristics of Big Data Applications - Perception and Quantification of Value -Understanding Big Data Storage - A General Overview of High-Performance Architecture - HDFS - Map Reduce and YARN - Map Reduce Programming Model

**UNIT II CLUSTERING AND CLASSIFICATION**

Advanced Analytical Theory and Methods: Overview of Clustering - K-means - Use Cases - Overview of the Method - Determining the Number of Clusters - Diagnostics - Reasons to Choose and Cautions .- Classification: Decision Trees - Overview of a Decision Tree - The General Algorithm - Decision Tree Algorithms - Evaluating a Decision Tree - Decision Trees in R - Naïve Bayes - Bayes' Theorem - Naïve Bayes Classifier.

**UNIT III ASSOCIATION AND RECOMMENDATION SYSTEM**

Advanced Analytical Theory and Methods: Association Rules - Overview - Apriori Algorithm - Evaluation of Candidate Rules - Applications of Association Rules - Finding Association & finding similarity - Recommendation System: Collaborative Recommendation- Content Based Recommendation - Knowledge Based Recommendation- Hybrid Recommendation Approaches.

**UNIT IV STREAM MEMORY**

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. Using Graph Analytics for Big Data: Graph Analytics

**UNIT V NOSQL DATA MANAGEMENT FOR BIG DATA AND VISUALIZATION**

NoSQL Databases: Schema-less Models: Increasing Flexibility for Data Manipulation-Key Value Stores- Document Stores - Tabular Stores - Object Data Stores - Graph Databases Hive - Sharding --Hbase - Analyzing big data with twitter - Big data for E-Commerce Big data for blogs - Review of Basic Data Analytic Methods using R.

**OUTCOMES:**

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

- Work with big data tools and its analysis techniques
- Analyze data by utilizing clustering and classification algorithms
- Learn and apply different mining algorithms and recommendation systems for large volumes of data
- Perform analytics on data streams
- Learn NoSQL databases and management.

#### **REFERENCES:**

1. Jure Leskovec Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2ndEdition2016.
2. David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", Morgan Kaufmann/El sevier Publishers, First Edition2013.
3. EMC Education Services, "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", Wiley publishers, First Edition, 2015.
4. Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley Publishers, First Edition 2014.
5. Dietmar Jannach and Markus Zanker, "Recommender Systems: An Introduction", Cambridge University Press, First Edition2010.
6. Kim H. Pries and Robert Dunnigan, "Big Data Analytics: A Practical Guide for Managers "CRC Press, First Edition 2015.

**OBJECTIVES:**

- Learn the fundamentals of natural language processing
- Understand word level and syntactic analysis.
- Understand the role of semantics of sentences and pragmatics
- Get knowledge about the machine translation.
- Learn text classification methods.

**UNIT I INTRODUCTION OF BASIC TEXT PROCESSING**

Overview: NLP-Language - Basics of Text Processing - Spelling Correction - Weight Edit Distance- other Variations - Noisy Channel Model for spelling correction -N-Gram Language Models - Evaluation of Language models- Basic Smoothing.

**UNIT II LANGUAGE MODELLING AND SMOOTHING**

Language modeling - smoothing models - Computational Morphology - Finite state Methods for morphology - Introduction to POS tagging - Hidden Markov model for POS tagging - Models for sequential parsing - MaxEnt- CRF.

**UNIT III SYNTAX, PARSING, SEMANTICS**

Syntax - Parsing - CKY-PCFGs - Inside and outside probabilities - Dependency grammar and parsing - Transition based Parsing - Formulation - Learning. MST Based Parsing - Distributional model for semantics - Word Embeddings - Lexical Semantics-wordNet - Word Sense Disambiguation - Novel word sense detection.

**UNIT IV TOPIC MODELS AND INFORMATION EXTRACTION**

Topic Model- Latent Dirichlet Allocation - Gibbs sampling for LDA - Formulation and Application - LDA Variants- Entity Linking - Information extraction - Relation extraction- Distant Supervision

**UNIT V TEXT SUMMARIZATION & TEXT CLASSIFICATION**

Optimization Based models for summarization - Evaluation- Text classification - sentiment analysis - Affective lexicon -Learning affective lexicons - computing with affective lexicons

**OUTCOMES:**

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

- To tag a given text with basic Language features
- To design an innovative application using NLP components
- To implement a rule based system to tackle morphology/syntax of a language
- To design a tag set to be used for statistical processing for real-time applications
- To apply NLG and machine translation

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1. Daniel Jurafsky, James H. Martin—Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech, 3<sup>rd</sup> Edition, Pearson Publication, 2014.
2. Steven Bird, Ewan Klein and Edward Loper, —Natural Language Processing with Python, First Edition, OReilly Media, 2009.
3. Breck Baldwin, Language Processing with Java and LingPipe Cookbook, 1st Edition, Atlantic Publisher, 2015.
4. Richard M Reese, Natural Language Processing with Java, 2rd Edition, OReilly Media, 2015.
5. NitinIndurkha and Fred J. Damerau, —Handbook of Natural Language Processing, 2rd Edition, Chapman and Hall/CRC Press, 2010.