

**13. Courses of Study and Scheme of Assessment
MASTER OF COMPUTER APPLICATIONS**

(2023 REGULATIONS)
(Minimum No. of credits to be earned: 80#)

Course Code	Course Title	Hours/Week			Credits	Maximum Marks			CAT
		Lecture	Tutorial	Practical		CA	FE	Total	
I SEMESTER									
23MX11	Mathematical Foundations of Computer Science	3	1	0	4	40	60	100	PC
23MX12	Structured Programming Concepts	3	0	0	3	40	60	100	PC
23MX13	Data Structures	3	0	0	3	40	60	100	PC
23MX14	Database Systems	3	1	0	4	40	60	100	PC
23MX15	Web Technologies	3	0	0	3	40	60	100	PC
23MX16	C Programming Laboratory	0	0	4	2	60	40	100	PC
23MX17	Data Structures Laboratory	0	0	4	2	60	40	100	PC
23MX18	Web Application Development	0	0	4	2	60	40	100	EEC
Total 29 hrs		15	2	12	23	380	420	800	
II SEMESTER									
23MX21	Software Engineering	3	1	0	4	40	60	100	PC
23MX22	Design and Analysis of Algorithms	3	1	0	4	40	60	100	PC
23MX23	Object Oriented Programming using Java	3	0	0	3	40	60	100	PC
23MX24	Enterprise Computing Using Full Stack	3	2	0	5	40	60	100	PC
23MX__	Elective I	3	0	0	3	40	60	100	PE
23MX26	Java Programming Laboratory	0	0	4	2	60	40	100	PC
23MX27	Mobile Application Development	0	0	4	2	60	40	100	EEC
23MX28	Professional Communication And Personality Development	0	0	2	1	60	40	100	EEC
Total 29 hrs		15	4	10	24	380	420	800	
III SEMESTER									
23MX31	Cloud Computing	3	0	0	3	40	60	100	PC
23MX__	Elective II	3	0	0	3	40	60	100	PE
23MX__	Elective III	3	0	0	3	40	60	100	PE
23MX__	Elective IV	3	0	0	3	40	60	100	PE
23MX__	Elective V *	3	0	0	3	40	60	100	PE
23MX36	Cloud Computing Laboratory	0	0	4	2	60	40	100	PC
23MX37	Mini Project \$	0	0	4	4	60	40	100	EEC
23MXM__	Audit Course	2	0	0	Grade	100	0	100	MC
Total 25 hrs		17	0	8	21	420	380	800	
IV SEMESTER									
23MX41	Project Work	0	0	24	12	60	40	100	EEC

- the minimum number of credits to be earned by a student

\$-Mini Project should begin during the summer vacation at the end of Semester II.

* Elective V is a & Financial / Management Elective course

ELECTIVE COURSES (FIVE to be opted)									
Course Code	Course Title	Hours/Week			Credits	Maximum Marks		Total	CAT
		Lecture	Tutorial	Practical		CA	FE		
23MXAA	Design Patterns	3	0	0	3	40	60	100	PE
23MXAB	Software Project Management	3	0	0	3	40	60	100	PE
23MXAC	Security in Computing	3	0	0	3	40	60	100	PE
23MXAD	Soft Computing	3	0	0	3	40	60	100	PE
23MXAE	Computer Networks	3	0	0	3	40	60	100	PE
23MXAF	Data Mining and Analytics	3	0	0	3	40	60	100	PE
23MXAG	Artificial Intelligence	3	0	0	3	40	60	100	PE
23MXAH	Machine Learning	3	0	0	3	40	60	100	PE
23MXAI	Internet of Things	3	0	0	3	40	60	100	PE
23MXAJ	Wireless Networks	3	0	0	3	40	60	100	PE
23MXAK	Deep Learning	3	0	0	3	40	60	100	PE
23MXAL	Multidimensional Data Structures	3	0	0	3	40	60	100	PE
23MXAM	Open Source Systems	3	0	0	3	40	60	100	PE
23MXAN	Ubiquitous and Pervasive Computing	3	0	0	3	40	60	100	PE
23MXAO	Human Computer Interaction	3	0	0	3	40	60	100	PE
23MXAP	Principles of Compiler Design	3	0	0	3	40	60	100	PE
23MXAQ	Social Networking and Web Mining	3	0	0	3	40	60	100	PE
23MXAR	Virtual Reality Systems	3	0	0	3	40	60	100	PE
23MXAS	Block Chain Technologies and Use Cases	3	0	0	3	40	60	100	PE
23MXAT	DevOps	3	0	0	3	40	60	100	PE
23MXAU	Software Testing	3	0	0	3	40	60	100	PE
23MXAV	Operating Systems	3	0	0	3	40	60	100	PE
23MXBA	Optimization Techniques	3	0	0	3	40	60	100	PE
23MXBB	Numerical Methods	3	0	0	3	40	60	100	PE
23MXBC	Applied Graph Theory	3	0	0	3	40	60	100	PE
ELECTIVE V									
23MXCA	Entrepreneurship	3	0	0	3	40	60	100	PE
23MXCB	Principles of Management and Behavioural Sciences	3	0	0	3	40	60	100	PE
23MXCC	Accounting and Financial Management	3	0	0	3	40	60	100	PE

CAT – Category; PC – Professional Core; PE - Professional Elective EEC – Employability Enhancement Course; MC - Mandatory course, Grade - Completed / Not Completed

Elective V should be chosen from

23MXCA	Entrepreneurship
23MXCB	Principles of Management and Behavioural Sciences
23MXCC	Accounting and Financial Management

Audit course will be offered from the following list

23M XM1	English for Research Writing
23M XM2	Disaster Management
23M XM3	Constitution of India
23M XM4	Professional Ethics

ONE CREDIT COURSES

- 23XK01 Software Configuration Management and Continuous Delivery.
 23XK02 Trends in Digital Transformation
 23XK03 Design Thinking
 23XK04 Skills for Virtual Teams

SEMESTER I**23MX11 MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE****3 1 0 4**

DISCRETE MATHEMATICS: Set theory- Laws of set theory - partition - min sets- Principle of inclusion and exclusion. Relations - properties - closure operations. Functions - Injective, Surjective, Bijective functions - composition, identity, and inverse. Logic - Propositions - logical operators - truth tables - normal forms - laws of logic - proofs in propositional calculus – Predicates – variables – Quantifiers – Standard Forms – Inference in Predicate calculus. Mathematical Induction - Strong Induction and well-ordering – Recursive definitions and structural induction. (12+4)

MATHEMATICAL OPTIMIZATION: Statement of an optimization problem – classification. Formulation of LPP – Graphical method - Simplex – Algorithm – Phase I and Phase II of Simplex Method – Revised Simplex Method – Dual and Primal of LPP– Sensitivity Analysis. Transportation problem – Assignment problem. Programming with solvers. (10+3)

PROBABILITY AND STATISTICS: Graphical presentation of data – frequency distribution – measures of central tendency – measures of dispersion, Probability - Experiments and sample spaces – events – probability – conditional probability – Bayes' theorem. Random Variables - Distribution function – discrete, continuous random variables – equivalent events – functions of random variables – expectation – moment generating functions. Joint Probability Distributions - Joint distribution for two dimensional random variables – marginal distributions – conditional distributions – conditional expectation – regression of the mean – Independence of random variables – covariance. (12+4)

STATISTICAL ANALYSIS, PREDICTION AND FORECASTING: Linear regression – prediction of new observations – Correlation. Tests of Hypotheses - Statistical hypotheses – Type I and Type II errors – one sided and two sided hypotheses-Tests of hypotheses on a single sample – Tests of hypotheses on two samples – Testing for goodness of fit. Time Series Analysis - Components – Data types – Moving Average Models and variants. (11+4)

Total L: 45 + T: 15 = 60**REFERENCES**

1. Kenneth H Rosen, "Discrete Mathematics and its Applications", Tata McGraw Hill, 2017, 7th edition.
2. Bernard Kolman, Robert C Busby and Sharon Ross, "Discrete Mathematical Structures", Prentice Hall, 2015, 6th edition.
3. Hamdy A Taha , "Operations Research – An Introduction", Pearson Education, 2016, 10th edition.
4. William W Hines, Douglas C Montgomery, David M Goldsman and Connie M Borror, "Probability and Statistics in Engineering", John Wiley, 2008.
5. Ronald E Walpole, Raymond H.Myers, Sharon L Myers and Keying Ye, "Probability & Statistics for Engineers & Scientists", Pearson Education, 2016.
6. Douglas C Montgomery, Cheryl L Jennings and Murat Kulahci, "Introduction to Time Series Analysis and Forecasting", John Wiley, 2015.

23MX12 STRUCTURED PROGRAMMING CONCEPTS**3 0 0 3**

INTRODUCTION: Characteristics of programming languages, programming methodologies, desirable features and design issues- Programming language paradigms – Programming language processors: Structure and operations of translators, software simulated computer, syntax, semantics, structure, virtual computers, binding and binding time. Program development and execution environments - embedded system requirements and programming. Introduction to C Language - programs structure - main function and command line arguments - Identifiers, data types, variables, constants, operators, expressions, type conversions - Input / Output functions. (12)

Sequence controls in structured programming: Statements - Sequential statements and compound statement - Selection Statements – if, else if ladder and switch statements - Repetition statements - while, for, do-while statements - break, continue, goto statements, Statements vs Expressions. Functions: Designing structured programs, Functions, user defined functions and standard library functions, inter function communication, Scope, Storage classes: auto, register, static, extern - type qualifiers - Recursion - Limitations of recursions- recursive function - Pre-processor commands and Macros (12)

Structured data types and Files in programming: Arrays: Concepts, array applications, two-dimensional arrays, multidimensional arrays - Strings – Concepts, string input / output functions, arrays of strings, string manipulation functions, string/data conversion. Pointers: pointer declarations - pointers for inter function communication, pointers to pointers, compatibility, pointer applications- arrays and pointers, pointer arithmetic operations. Passing an array to a function, memory allocation functions, array of pointers, programming applications, pointers to functions. Structures: Declaration, initialization, accessing structures, operations on structures, structures and functions, passing structures through pointers, self-referential structures, unions, bit fields - Enumerated types - Input and Output – Concept of a file, streams, text files and binary files, file handling functions – applications for files. (12)

Best Practices in Modern Programming: Introduction to script programming and processing. Motivation and applications of scripting. Script and Mark-up versus System programming languages. Fundamentals interpreters - dynamic typing-, dynamic scoping - merits and demerits of scripting languages - Types of scripting languagesApplications - Multi-Paradigm programming languages - Domain specific languages - Software stacks and Script languages - Tools for Source Code Management and Testing, Best Practices in Programming – Patterns and Frameworks based development (9)

Total L: 45

REFERENCES:

1. Terrence W Pratt, Marvin V Selkowitz and T V.Gopal, "Programming Languages Design and Implementation", Pearson Education, 2016.
2. Robert W Sebesta, "Concepts of Programming Languages", Addison Wesley, 2016.
3. Al Kelley and Ira Pohl, " A Book on C " Pearson Education, 2015.
4. B.A. Forouzan and R.F. Gilberg,"A Structured Programming Approach Using C," Third Edition, Cengage Learning. 2017
5. Peter Prinz , Tony Crawford, "C in a Nutshell", O'Reilly, 2016.
6. Zed A. Shaw, "Learn C the Hard Way: Practical Exercises on the Computational Subjects You Keep Avoiding (Like C)", Addison Wesley, 2016

23MX13 DATA STRUCTURES**3 0 0 3**

ALGORITHM ANALYSIS: Abstract Data Types - Primitive data structures - Algorithms: Structure, properties, Fundamentals of the Analysis of Algorithmic Efficiency –Asymptotic Notations lower and upper bound: best case, worst case, average case analysis- Performance analysis of iterative constructs. Recurrences: Formulation and solving recurrence equations-Master theorem. Class of P and NP problem. (11)

LINEAR DATA STRUCTURES: **Arrays:** Definition- Operations - representation of multi dimensional arrays- addressing function - representation of special type of matrices – lower triangular - upper triangular – representation of sparse matrix. **Linked list:** Memory allocation and de-allocation for linked list - Insertion and deletion of nodes – Types – Applications **Stacks :** Operations -Implementation– Applications. **Queues:** Operations –Implementation – Types – Applications. (12)

NON-LINEAR DATA STRUCTURES: **Tree :** Terminologies - Implementation-Binary Tree-Properties - Sequential and linked representation - Binary tree traversals-Basic operations- Binary Search Tree: Operations. **Heap:** Priority Queue.**Graph:** Terminologies - types-representations – Connected Components- Graph Traversal: Breadth First Search and Depth First Search-Applications. (11)

SORTING AND SEARCHING: **Insertion Sort, Selection Sort, Bubble Sort, Heap Sort, Radix Sort.** **SEARCHING:** Linear and Binary Search- **HASHING:** Operations- Hash Table: Hash functions, Implementation, collision resolution and overflow handling techniques, Linear Open Addressing, Chaining (11)

Total L: 45

REFERENCES:

1. Michael H. Goldwasser, Michael T. Goodrich, and Roberto Tamassia, " Data Structures and Algorithms in Python", Wiley, 2021.
2. Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, "Fundamentals of Data Structures in C", University Press, 2012.
3. John Canning, Alan Broder, Robert Lafore, "Data Structures and Algorithms in Python", Addison Wesley, 2022.
4. Kent D. Lee, Steve Hubbard, " Data Structures and Algorithms with Python", Springer, 2015.

23MX14 DATABASE SYSTEMS**3 1 0 4**

INTRODUCTION: Databases – Conventional file Processing – Data Modeling for a database – Three level architecture – Data Independence – Component of a Database Management System –characteristics-Advantages and disadvantages of a DBMS-roles- Data base administrator-functions and responsibilities – In-memory database. **DATA MODELS:** Hierarchical- Network data model- ER model: Entity Relationship diagram – Data association - Entities-attributes, relationships- structural constraints– Extended ER diagram Generalization – Aggregation -Composition– Mapping ER diagram to relations, hierarchical and network Data models– applications. (11+4)

RELATIONAL MODEL: Relational data model basics - Codd's rules – properties of relations- Domains and Key concept – Integrity constraints over relations - Enforcing integrity constraints - Relational algebra – Relational algebra queries (11+3)

RELATIONAL DATABASE MANIPULATION: SQL- data types- types of SQL –static -dynamic - Embedded SQL- table-constraints- table handing commands- records handing commands- Basic data retrieval – Condition specification –aggregate function- order by/group by clause- sub queries-in-any-all- correlated sub queries-exists-not exists-multi table queries - SQL Join –set operations- synonyms- sequences- views- index- SQL API- triggers. (11+4)

DATA BASE DESIGN THEORY: Database design process - anomalies, redundancy, Functional dependencies, normal forms based on functional dependencies - Normalization: 1NF to 5NF- Domain Key Normal Form – Algorithms for Relational Database Schema Design - losses join and dependency preserving decomposition – Denormalization- Data base tuning - schema refinement in database design, case studies. **DATABASE TRANSACTION & SECURITY:** Transaction processing- properties-security and integrity threats- security violations-identification and authentication - discretionary access control based on grant and revoking privilege-mandatory control and role based access control. (12+4)

Total L:45+T: 15:60

REFERENCES:

1. Silberschatz A, Korth H , Sudarshan S, "Database System Concepts", McGraw-Hill, Seventh edition, 2021.
2. Bipin C Desai, "An introduction to Database Systems", Galgotia Publications, 2013.
3. Elmasri R and Navathe S B, "Fundamentals of Database Systems", Pearson Education, 2022.
4. Raghu Ramakrishnan and Johannes Gehrke, "Database Management System", McGraw Hill, Third edition, 2018.

23MX15 WEB TECHNOLOGIES**3 0 0 3**

INTERNET AND WORLD WIDE WEB : The TCP/IP layered architecture - Addressing in Internet: Physical and logical addresses, Concepts of IP, TCP, UDP, HTTP, URLs, DNS - Web Architecture - Web Browser - Internet vs Extranet - Web Server - Web Application and Application Security - Search Engines - Web Cache and Cookie - Web Crawlers (11)

FRONT END DESIGN: Mark-up Language HTML5 tags- Formatting, Commenting, Code, Anchors, Backgrounds, Images, Hyper-links, Lists, Tables, Semantic Elements in HTML, Multimedia, Forms: Validating and Processing. **Cascading Style Sheet (CSS):** Introduction to CSS – Basic syntax and structure, Backgrounds, manipulating text, Margins and Padding, Positioning using CSS - web Storage – Selectors and pseudo classes – Text effects – Transitions – Layouts – Media Queries. **Bootstrap :** Use of Bootstrap in web page design. (11)

CLIENT SIDE SCRIPTING :Javascript: Overview of JavaScript, Object orientation and JavaScript, Syntactic characteristics, Primitives, operations, and expressions, Screen output and keyboard input, Control statements, Object creation and modification, Arrays, Functions, Constructors, Pattern matching using regular expressions. **Document Object Model:** JavaScript Execution Environment, Document Object Model, Elements Access, Events and Event Handling, The DOM 2 Event Model, DOM Tree Traversal and Modification. **JSON :** Introduction - Syntax - Object Literals - Name-Value Pairs - Data Types. **JQuery :** document traversal and manipulation, event handling, animation (12)

FRAMEWORKS AND SERVER SIDE SCRIPTING: Introduction to NodeJs - The Node.js runtime and event loop - The Node.js global object - Working with modules - Working with the file system - Asynchronous Programming in Node.js: JavaScript Callbacks and error-first callbacks – Promises - Async/await. ExpressJS : Introduction – routing and Middleware. Working with Data : Writing data to a file, Work with database using any library. (Mongoose). Debugging techniques for Node.js - Introduction to testing with Mocha and Chai (11)

Total L : 45**REFERENCES:**

1. Sasha Vodnik, " HTML5 and CSS3 Complete", Cengage Learning, 2015.
2. Achyut Godbole, Atul Kahate, "Web Technologies", Tata McGraw Hill, 2013.
3. Thomas Powell , Fritz Schneider, "JavaScript 2.0: The Complete Reference", Tata McGraw Hill, 2016.
4. Greg Lim , " Beginning Node.JS , Express and MongoDB development, Greg Lim , 2020
5. Andrew Mead- Advanced Node.js Development: Master Node.js by building real-world applications, Packt Publishing, 2018

23MX16 C PROGRAMMING LABORATORY**0 0 4 2**

Experiments in the following topics:

1. Single and multi dimensional arrays.
2. Functions and recursive functions.
3. Structures, Unions and array of structures and unions.
4. Pointers, operation on pointers and dynamic and static storage allocation.
5. Data files Sequential, Random, Low-level and High Level file access.
6. Multi-file software and header file.
7. C on Host and Non-host environment and embedded programming.
8. Simple package development using markup and scripting language.
9. Source Code Management using Github

Total P:60**23MX17 DATA STRUCTURES LABORATORY****0 0 4 2**

Experiments in the following topics:

1. Applications of arrays
2. Applications of strings.
3. Implementation of searching algorithms.
4. Stacks: operations and applications.
5. Queues: operations and applications
6. Linked Lists: singly linked, doubly linked list and circular lists.

- 7. Linked stack and linked queue
- 8. Binary trees operations.
- 9. Implementation of graph.
- 10. Graph Traversals and its applications.
- 11. Hash Table: collision resolution techniques

Total P: 60**23MX18 WEB APPLICATION DEVELOPMENT****0 0 4 2**

1. Study and Develop experiments in the following topics:
 - i. HTML elements & attributes
 - ii. HTML tables, forms & Canvas
 - iii. HTML Multimedia, APIs
 - iv. CSS selectors
 - v. CSS Media queries, Layout, Transformation, transition
 - vi. Java Script - DOM , BOM methods, Form Validation, Functions
 - vii. CRUD operations in MongoDB/any database
 - viii. Build bar chart on the given data set
 - ix. Build temperature chart/data report
 - x. Develop a simple chat application
 - xi. Build web scraper application
 - xii. Develop a personal website with interactive chat bot
2. Develop and deploy applications not limited to the following areas:
 - i. Ticket reservation
 - ii. Online quiz
 - iii. Content Management System
 - iv. Web scraper and reporting system
 - v. Bot application for project management to manage productivity server

Total P: 60**SEMESTER II****23MX21 SOFTWARE ENGINEERING****3 1 0 4**

Software Engineering :Engineering approach to software development – role of Software Engineering towards success of large software projects – Project Estimation Techniques - Software development methodologies - Software life cycle models – Agile Development, Extreme Programming, Scrum; DevOps, DevOps Vs Agile. Case study: Identify the suitable development method for real world problems. (11+3)

REQUIREMENTS GATHERING: Requirements gathering tasks – Requirements Engineering Process - Qualities of good requirements -Types of Requirements-Requirements elicitation - Requirements Specification, Characteristics and components of SRS, Structure of SRS (IEEE format). Case study- Develop Software Requirement Specification for real world applications. (11+4)

OBJECT ORIENTED ANALYSIS & DESIGN: UML Diagrams to support Object Oriented Analysis and Design. - Software Design Documentation – User Interface Design. Case Study-Develop Object oriented models for real world applications. (11+4)

SOFTWARE TESTING FUNDAMENTALS: Testing fundamentals - Black-Box and White-Box testing – Basis Path testing – Boundary value analysis - Requirements phase testing - Design phase testing - Program phase testing - debugging and program peer view test tools - Evaluating test results - Installation phase testing - Acceptance testing – Testing GUI – Testing Web Applications. Case study- Software testing using open source tools. (12+4)

Total L: 45, T: 15 = 60**REFERENCES:**

1. Roger Pressman S and Bruce Maxim "Software Engineering: A Practitioner's Approach", Tata McGraw-Hill, 2020.
2. Ian Sommerville, "Software Engineering", Pearson Education, 2018.
3. Pankaj Jalote's "Software Engineering: A Precise Approach", Wiley,2010
4. James Rumbaugh, Ivar Jacobson and Grady Booch, "The Unified Modeling Language Reference Manual", Pearson Education, 2009.

23MX22 DESIGN AND ANALYSIS OF ALGORITHMS**3 1 0 4**

SEARCH TREES: Algorithmic complexity- Asymptotic Notations -AVL trees: Definition– Height – Operations: search– insert, delete - AVL rotations – Examples. **MULTI-WAY SEARCH TREES:** M-way search trees– B-Tree – B+ trees - Tries – Operations: Insert, delete, retrieve- Example. (11+4)

DIVIDE AND CONQUER: Method – Finding the maximum and minimum- Binary Search – Merge sort, Quick sort – Performance Analysis. **GREEDY METHOD:** Method – Knapsack Problem- Minimum cost spanning tree- Prim's algorithm- Single source shortest path- Optimal storage on tapes – Optimal merge patterns: Huffman Coding. (12+4)

DYNAMIC PROGRAMMING: Method –Principles of Optimality- All pairs shortest path problem – 0/1 Knapsack Problem - Traveling salesman problem-Multi stage decision graph- Single source shortest path - String Editing- Flow Shop Scheduling- Longest Common Subsequence. (11+3)

BACK TRACKING: Method – Eight queen's problem, Sum of subsets, Knapsack Problem, Graph coloring. **BRANCH AND BOUND:** Method - LC Search – FIFO Branch and Bound-0/1 Knapsack. (11+4)

Total L: 45+T :15=60**REFERENCES:**

1. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, "Fundamentals of Computer Algorithms" Universities Press, 2010.
2. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", Pearson Education, 2006.
3. Thomas H Cormen, Charles E Leiserson, Ronald L Rivest and Clifford Stein "Introduction to Algorithms", The MIT Press, 2022.
4. Stevens S Skiena, "The Algorithm Design Manual", Springer, 2020

23MX23 OBJECT ORIENTED PROGRAMMING USING JAVA**3 0 0 3**

OBJECT ORIENTATION: Object Orientation Programming - Basic Concepts - Abstraction – Classes and Objects – Encapsulation - Inheritance – Polymorphism - **JAVA FUNDAMENTALS:** Features of Java – Java Development Environment – Bytecode - Data types- Variables -Operators – Expressions – Functions – Static Members - Arrays - Strings. (11)

INHERITANCE: Inheritance – Types - Access rules, super – final – Abstract classes – Inner classes **POLYMORPHISM:** Static binding – Dynamic binding – Method overloading - Runtime Polymorphism. Package: Defining, Creating and Accessing a Package, Understanding CLASSPATH, Importing package - Interface: Create – Implement. **EXCEPTION HANDLING:** Exception - Types – try and catch - Multiple catch - Nested try - throw - throws – finally - User defined exception. (12)

INPUT / OUTPUT: Stream classes: Byte – Character - File class - File operations - Console class – Serialization – Garbage Collection. **MULTITHREADING:** Thread -based multitasking - Process-based multitasking - Java thread model - Creating threads - Thread priorities - Synchronization - Inter thread communication. (10)

EVENT DRIVEN PROGRAMMING: Basics - Applets Vs Applications – AWT: Containers, Components, Layout Managers – Event handling – Event Delegation model. **COLLECTIONS FRAMEWORK:** Collection: Interface – Classes – Generics. **JDBC:** JDBC Drivers, JDBC API, Executing statements, prepared statements and callable statements, Design and development of database applications. (12)

Total L: 45**REFERENCES:**

1. Herbert Schildt, "JAVA - The Complete Reference", 12th Edition, Tata McGraw Hill, 2021.
2. Cay S Horstmann, "Core Java Volume I: Fundamentals", 12th Edition, Oracle Press, 2021.
3. Cay S Horstmann, "Core Java Volume II: Advanced Features", 12th Edition, Oracle Press, 2022.
4. Deitel and Deitel, "JAVA - How to Program", 11th Edition, Prentice Hall International Inc, 2017.
5. Y. Daniel Liang, Pearson, "Introduction to JAVA Programming, 7th Edition, Tata McGraw Hill, 2017.

23MX24 ENTERPRISE COMPUTING USING FULL STACK**3 2 0 5**

ENTERPRISE FOUNDATIONS: Enterprise software characteristics – Enterprise Architectural overview- Component Based software development. Multi-tier/multilayer system - Use of patterns, frameworks, and software stacks for Enterprise application development. Enterprise software for Hospital, University and manufacturing firm. (12+6)

ENTERPRISE DATA ENABLING: Enterprise Data - Basis of JDBC, Drivers, Connection, Statement, Result Set, Advanced JDBC features, CRUD operations and Query Languages. NOSQL in Enterprise applications. **ENTERPRISE WEB ENABLING:** Enterprise-Web Programming, Java Servlets - Java Server pages, State and session management- MVC architecture- **Java based Frame works:** ORM, JPA, Hibernate, SPRING and SPRING BOOT (13+ 8)

JAVA SCRIPT BASED FRAME WORKS: Basics- MERN stack- MERN Components-React, Node.js, Express, MongoDB. React Components-React classes, composing components, passing data- using properties, property validation. Angular Component - CLI- Property Bindings, and Expressions - Event Bindings and Statements. (10+10)

DISTRIBUTED ENTERPRISE COMMUNICATIONS ENABLING: Distributed Enterprise Communications Basis – distributed object middleware – synchronous and asynchronous communications, Java web services using SOAP and RESTFUL. REST: HTTP method as Actions, JSON, Express, Routing Handler function, Request Object, Response objects - Micro services for Enterprise applications. (10+6)

Total L: 45 + P:30 = 75

REFERENCES:

1. SebastianDaschner, "Architecting modern Java EE applications", Packt Publishing, 2017
2. Prashantpadmanaban, "Java EE 8 and Angular", Packt Publishing, 2018.
3. Kogent Solutions Inc. "Java Server Programming", Dreamtech Press, 2018.
4. Peter Späth , "Beginning Jakarta EE Enterprise Edition for Java: From Novice to Professional", Apress publishing2020.
5. Carnell, John, and Illary Huaylupo Sánchez "Spring micro services in action", Manning, 2021.
6. Shama Hoque , "Full-Stack React Projects: Learn MERN stack development by building modern web apps using MongoDB, Express, React, and Node.js", Packt Publishing, 2020

23MX26 JAVA PROGRAMMING LABORATORY

0 0 4 2

- Implement the following concepts, using the problem sheets given during the lab sessions:
 - i) Object-oriented features.
 - ii) Arrays and strings.
 - iii) Inheritance
 - iv) Interfaces and packages.
 - v) User-defined exceptions.
 - vi) Stream classes.
 - vii) Multithreading.
 - viii) Operations on objects using Collections framework.
 - ix) Event driven programming with database connectivity.
- Design, develop and deploy packages to apply features of Java in solving real world problems.

Total P: 60

23MX27 MOBILE APPLICATION DEVELOPMENT

0 0 4 2

Study and Develop experiments in the following topics:

1. Design of simple apps using Text and Page Layout
2. Create apps using various Controls, Styles and Page Navigation.
3. Creating apps with menu, list, grid layouts and multimedia controls
4. Design apps with notification management
5. Design apps using server less functions
6. Creating apps with data storage, cloud and content provider support
7. Designing apps that supports Mobility and Location Based APIs
8. Design of apps using Jetpack Compose
9. Design of apps using cross platform mobile SDKs
10. Design of apps using MVVM pattern

Develop and deploy applications not limited to the following areas:

- i) Ecommerce Apps
- ii) Chatting Apps
- iii) Social media Apps
- iv) Location based Apps

Total P: 60

23MX28 PROFESSIONAL COMMUNICATION AND PERSONALITY DEVELOPMENT

0 0 2 1

1. Introduction to Personality Development

The Concepts of Personality – Significance of Personality development – Definition of success and failure – SWOT analysis (2)

2. Attitude and Motivation Definition of attitude – Concepts –Positive and negative attitude – Advantages and disadvantages. Concepts of motivation – Significance – Internal and External motives – Importance of self motivation.	(2)
3. Self esteem and other aspects of Personality Development Self esteem – Interpersonal relationships – Lateral Thinking – Problem solving – Conflict and stress Management – Decision making – Leadership skills – Team work – Workplace Etiquette	(6)
4. Professional Communication Types of Professional Communication – Oral and Written forms Body Language – Group Communication – Resume building – Interview Techniques – Academic Writing	(5)
PRACTICALS – Group Discussions Self Introduction (Oral) Listening activities Mock Interviews Written Assignments – E mails and Case Studies	(4) (3) (5) (3)

Total P:30**References**

1. Prashant Sharma, "Soft Skills - Personality Development for Life Success", BPB Publication, New Delhi, 2021
2. Barun K Mitra, "Personality Development and Soft Skills", Oxford University Press, New Delhi, 2016
3. V B Rao, "Personality Development and Soft Skills", BS Publication, Hyderabad, 2020
4. Shikha Kapoor, "Personality Development and Soft Skills", IK International, Bengaluru, 2018

SEMESTER III**23MX31 CLOUD COMPUTING****3 0 0 3**

INTRODUCTION TO CLOUD COMPUTING: Basics of Distributed Systems – Distributed Architectural Models – Parallelization – Cloud Computing Architecture – Deployment models - Infrastructure-as-a-Service (IaaS) – Platform-as-a-Service (PaaS) – Software-as-a-Service (SaaS) - Comparison of Cloud with Grid, Cluster, Utility, Edge and Fog Computing - Pros and Cons of Cloud Computing. (12)

VIRTUALIZATION: Virtual Machines - Types of Virtualization - Architecture of VMM - Implementation Levels of Virtualization - Tools for Virtualization – Virtualization for Cloud - Virtualization for Datacenter Automation. Case Study: Perform foundational infrastructure tasks in Cloud. (11)

CLOUD ARCHITECTURE AND PLATFORMS: HDFS Architecture - Google Big Table - Amazon AWS - EC2, Simple Storage Service (S3) – Windows Azure - Aneka Framework - IBM Blue Cloud - Eucalyptus – Open Stack. **CLOUD PROGRAMMING MODELS:** Implementation of Map-Reduce - Twister and Iterative Map Reduce. Case Study: Create and Manage Applications: Data, ML, AI tasks using Cloud. (11)

CLOUD SECURITY: Basics - Challenges and Risks – Software-as-a-Service Security – Security Governance – Risk Management – Security Monitoring – Security Architecture Design – Data Security – Application Security – Virtual Machine Security - Identity Management and Access Control – Autonomic security. Case Study: Networking and Security tasks in cloud (11)

REFERENCES:

1. Liu M L, "Distributed Computing Principles and Applications", Addison Wesley, 2019.
2. Rajkumar Buyya, Christian Vecchiola and S.Thamarai Selvi, "Mastering Cloud Computing", McGraw Hill Education, 2017.
3. Ted Hunter, Steven Porter, Legorie Rajan PS, Building Google Cloud Platform Solutions: Develop scalable applications from scratch and make them globally available in almost any language", Packt Publishing Limited, 2019.
4. Ronald L. Krutz, Russell Dean Vines, "Cloud Security – A comprehensive Guide to Secure Cloud Computing", Wiley – India, 2010.
5. Thomas Erl, Zaigham Mahmood and Ricardo Puttini, Cloud Computing: Concepts, Technology & Architecture, Prentice Hall, 2013.
6. VenkataJosyula, Malcolm Orr and Greg Page, "Cloud Computing Automating the Virtualized Data Center", Cisco Press, 2012.

23MX36 CLOUD COMPUTING LABORATORY**0 0 4 2**

- Implement the following concepts, using the problem sheets given during the lab sessions:
 - i. Parallel programming using open source tools.
 - ii. Install Virtualbox and Virtual machine on different Operating Systems.
 - iii. Create and access VM instances and demonstrate various computing services offered by AWS / IBM / Google / Microsoft Azure.
 - iv. Design applications to avail cloud computing service models. (IaaS, PaaS and SaaS)

- v. Setting up and deploying application using Public Cloud Service Providers.
- vi. Package development using tools supported by cloud providers.

Total P: 60**23MX37 MINI PROJECT****0 0 2 2**

Students should perform the following tasks:

1. Problem Identification.
2. Literature survey and exploring different solutions for the problem.
3. System requirements specification.
4. Model development and Design methodologies.
5. Implementation and Testing.
6. Report preparation.

Total P: 30**SEMESTER IV****23MX41 PROJECT WORK****0 0 24 12**

The Project work involves the following:

1. Preparing a brief project proposal including
 - a. Problem Identification
 - b. Literature Survey
 - c. System requirements and specification
 - d. Model Development and Design Methodologies
 - e. Time Line activities
2. A report highlighting the design finalization based on [functional requirements & standards (if any)].
3. A presentation including the following:
 - a. Implementation phase(Hardware/software/both)
 - b. Testing & Validation of the system
4. Consolidate report preparation.

Total P: 360**AUDIT COURSES****23MXM1 ENGLISH FOR RESEARCH WRITING****2 0 0 0****UNIT I INTRODUCTION TO RESEARCH PAPER WRITING**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness (6)

UNIT II PRESENTATION SKILLS

Clarifying Who Did What, Highlighting the Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction (6)

UNIT III TITLE WRITING SKILLS

Key skills for writing a Title, key skills needed for writing an Abstract, key skills needed for writing an Introduction, skills needed for writing the Review of Literature, Methods, Results, Discussion, Conclusions, The Final Check (6)

UNIT IV RESULT WRITING SKILLS

Skills needed for writing the Methods, skills needed for presenting the Results, skills needed for writing the Discussion, skills needed for writing the Conclusion. (6)

UNIT V VERIFICATION SKILLS

Useful phrases, checking Plagiarism, ensure the quality of the paper for first-time submission

(6)

TOTAL: L: 30

23MXM2 DISASTER MANAGEMENT**2 0 0 0**

INTRODUCTION: Disaster: Definition, Factors and Significance- Difference between Hazard and Disaster- natural and manmade disasters- difference, nature, types and magnitude. **REPERCUSSIONS OF DISASTERS AND HAZARDS:** Economic damage, loss of human and animal life, destruction of ecosystem, natural disasters: earthquakes, volcanisms, cyclones, tsunamis, floods, droughts and famines, landslides and avalanches- man-made disaster: nuclear reactor meltdown, industrial accidents, oil slicks and spills, outbreaks of disease and epidemics, war and conflicts (8)

DISASTER PRONE AREAS IN INDIA: Study of seismic zones- Areas prone to floods and droughts, landslides and avalanches- areas prone to cyclonic and coastal hazards with special reference to tsunami - Post-Disaster diseases and epidemics (7)

DISASTER PREPAREDNESS AND MANAGEMENT: Preparedness: monitoring of phenomena triggering a disaster or hazard - evaluation of risk: Application of remote sensing, data from meteorological and other agencies, media reports- Governmental and Community Preparedness. (7)

RISK ASSESSMENT AND MITIGATION: Disaster Risk: concept and elements, disaster risk reduction, global and national disaster risk situation- Techniques of risk assessment- global co-operation in risk assessment and warning,-People's participation in risk assessment- Strategies for survival- **RISK MITIGATION:** Concept and strategies for risk mitigation-Emerging trends – Structural and non – structural mitigation-Programs of disaster mitigation in India (8)

TOTAL: L: 30**REFERENCES**

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

23MXM3 CONSTITUTION OF INDIA**2 0 0 0**

INTRODUCTION: Evolution of Indian Constitution; significance of constitution; Composition; Preamble and its Philosophy.

RIGHTS, DUTIES AND DIRECTIVE PRINCIPLES: Fundamental Rights- Writs and Duties, Directive Principles of State Policy (7)

COMPOSITION OF PARLIAMENT AND FEDERALISM: Union Government, President and Vice President, Houses of the Parliament and their functions; Composition of State Legislature; Powers, Functions and Position of Governor, Function of Chief Ministers, Council of Ministers; The Indian Federal System, Administrative Relationship between Union and States (9)

BILLS AND CONSTITUTION AMENDMENT PROCEDURE: Types of Bills, Stages of passing of Bill into an Act, Veto Power, Constitution Amendment Procedure, Various Amendments made and their significance for India. (7)

JUDICIARY: Supreme Court and High Court; Functions and powers, Judicial Review (7)

Total L: 30**REFERENCES:**

1. Basu D.D., "Introduction to the Constitution of India", Prentice Hall of India, 2016.
2. Subash C. Kashyap, "Our Political System", National Book Trust, 2011.
3. Briji Kishore Sharma, "Introduction to the Constitution of India", Prentice Hall of India, 2010.
4. Hoshiar Singh, "Indian Administration" - Kitab Mahal, 2003.
5. Jain, M. C., "The Constitution of India", Law House, New Delhi, 2001.
6. Shukla. V. N., "Constitution of India", Eastern Book Company Ltd., New Delhi, 2011.

23MXM4 PROFESSIONAL ETHICS**2 0 0 0**

HUMAN VALUES: Morals, values and Ethics – Integrity- Academic integrity-Work Ethics- Service Learning- Civic Virtue Respect for others- Living peacefully- Caring and Sharing- Honestly- courage-Cooperation commitment Empathy-Self Confidence -Social Expectations. (7)

THEORIES AND PRACTICES: Senses of Engineering Ethics - Variety of moral issues- Types of inquiry- Moral dilemmas –Moral Autonomy – Kohlberg's theory- Gilligan's theory- Consensus and Controversy-Profession and Professionalism- Models of professional roles-Theories about right action –Self interest-Customs and Religion- Uses of Ethical Theories. (8)

SAFETY, RESPONSIBILITIES AND RIGHTS: Collegiality and loyalty – Managing conflict- Respect for authority- Collective bargaining- Confidentiality: Role of confidentiality in moral integrity-Conflicts of interest- Occupational crime- Professional rights - Employee right- IPR Discrimination. (8)

GLOBAL ISSUES: Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Professionals as Managers – Consulting Engineers – Moral Leadership – Code of Conduct – Corporate Social Responsibility. (7)

Total: L: 30

REFERENCES:

1. R S Naagarazan, A text book on professional ethics and human values, New age international (P) Limited , New Delhi,2017.
2. M Govindarajan, S Natarajan and V S Senthil Kumar, Engineering Ethics, PHI Learning Private Ltd, New Delhi,2012.
3. Mike W Martin and Roland Schinzingher, Ethics in Engineering,4th edition, Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi,2014.
4. Lieunt Gen Dr. M. L. Chibber : "Leadership-Education in Human Values", Sri Satya Sai Books and Publications Trust, Prasanthinilayam, 1st Edition, 2009.

ELECTIVES
23MXAA DESIGN PATTERNS

3 0 0 3

INTRODUCTION TO PATTERNS: Reusable object oriented software – Motivation - Best design practices of object oriented software - Benefits of patterns – Types - Pattern description - How design patterns solve design problems - Pattern Language IDIOMS. (10)

DESIGN PATTERNS: Creational pattern: Abstract factory – Builder - Factory method – Prototype – Singleton, Structural patterns: Adapter – Bridge – Composite – Decorator – Façade – Flyweight - Proxy, Behavioral patterns: Command – Interpreter - Iterator, Mediator - Memento – Observer - State – Strategy - Template method – Visitor - Chain of Responsibility, Case Study (12)

ARCHITECTURAL PATTERNS: From Mud to Structure: Layers - Pipes and Filters - Blackboard, Interactive Systems: Model View Controller (MVC), Case studies. (10)

CODE REFACTORING: Principles in refactoring - Bad smells in code - Composing methods - Moving features between objects - Organizing data - Simplifying conditional expressions - Making method calls simpler - Dealing with generalization. (13)

Total L : 45

REFERENCES:

1. Erich Gamma, Richard Helm, Ralph Johnsons and John Vlissides, "Design Patterns: Elements of Reusable Object Oriented Software", Pearson Education, New Delhi, 2015.
2. Frank Buschman, Regine Meunier, Hans Rohnert, Peter Sommerlad and Michael Stal, "Pattern-Oriented Software Architecture: A System of Patterns" Volume 1, Wiley, New Delhi, 2008.
3. Martin Fowler, Kent Beck, William Opdyke, Don Roberts, "Refactoring: Improving the Design of Existing Code", Addison Wesley, Massachusetts, 2011.
4. Alan Shalloway, James R.Trott, Design Patterns Explained: A New Perspective on Object Oriented Design, 2nd Edition, 2007

23MXAB SOFTWARE PROJECT MANAGEMENT

3 0 0 3

INTRODUCTION: Software Projects various other types of projects - Problems with software projects - an overview of project planning - Project evaluation - Project Analysis and technical planning - Project estimates - Preparation of Estimates - COCOMO model - Function Point Analysis - Putnam Model - Non-development overheads. (13)

ACTIVITY PLANNING: Project schedules - Sequencing and scheduling projects - Network planning models - Shortening project duration - Identifying critical activities. (11)

RISK MANAGEMENT: Identifying and managing risks - Risk analysis - Risk planning and control – Evaluating risks to the schedule. **RESOURCE ALLOCATION:** Identifying of resource requirements-scheduling of resources- publishing the resource schedule. (11)

MONITORING AND CONTROL: Visualization project progress – Earned value analysis – Change control. **MANAGING PEOPLE AND ORGANIZING TEAMS:** Understanding behavior – selecting right people for the job – Motivational models – working in groups – Leadership. **SOFTWARE QUALITY:** Quality and the quality system - standards and procedures – Techniques to help enhance software quality - Continuous Improvement - Management responsibility - Document Control. **CASE STUDY:** Using Project management tools. (10)

Total L : 45

REFERENCES:

1. Mike Cotterell and Bob Hughes, "Software Project Management", 5th Edition, Tata McGraw-Hill, 2011.

2. Robert K Wysocki, Robert Beck Jr. and David B Crane, "Effective Project Management , Traditional, Agile, Extreme", 7th Edition, John Wiley& Sons Inc, 2011.
3. Roger Pressman S and Bruce Maxim "Software Engineering: A Practitioner's Approach", Tata McGraw-Hill, 2020.Darrel Ince, "An Introduction to Software Quality Assurance and its Implementation", Tata McGraw Hill Book Company Ltd, 2002.

23MXAC SECURITY IN COMPUTING

3 0 0 3

SYMMETRIC KEY ENCRYPTION: Security Goals – Security Services- Security Attacks-Cryptographic tools - Classical Cryptosystem (Substitution and Transposition ciphers)- Stream ciphers – Block ciphers –Modes of Operation- Data Encryption Standard (DES) – Linear and Differential Cryptanalysis - Advanced Encryption Standard(AES) - RC4 (12)

ASYMMETRIC KEY ENCRYPTION ALGORITHMS: Public-key encryption Model (Secrecy & Authentication) - RSA – EIGamal Cryptosystem- Elliptic Curve Cryptosystem (ECC) -Security of RSA – The Integer Factorization Problem - Pollard's rho factoring algorithm – The Discrete Logarithm Problem: Baby-step giant- step algorithm (11)

KEY GENERATION AND DIGITAL SIGNATURES: Random Key Generation - Manual Key distribution – Key distribution centers – Diffie–Hellmann Key Exchange -Randomness - ANSI X9.17 generator - Linear Feedback Shift Registers (LFSR)- Message Digest Algorithm (MD5)- General Structure of Hash function – Secure Hash Algorithm (SHA – 1) – Digital Signature Algorithm (DSA) (11)

NETWORK AND SYSTEM SECURITY: Application Layer Security :E- Mail Security- Pretty Good Privacy (PGP) –Transport Layer security : Transport and Tunnel Modes – Secure Sockets Layer (SSL) Architecture and Protocol - IP Security- IP Sec-modes. Intruders and Intrusion – Viruses and Worms – Firewalls – Design Principles – Packet Filtering – Application gateways. (11)

Total L : 45

REFERENCES

1. Behrouz A Fououzan, "Cryptography& Network Security", Tata McGraw Hill, 2015.
2. William Stallings, "Cryptography and Network Security – Principles and Practice", Pearson Education, 2014.
3. Bruce Schneier, "Applied Cryptography", John Wiley, 2017.
4. Charles P Pfleeger and Shari Pfleeger, "Security in Computing", Pearson Education, Fifth Edition, 2015.

23MXAD SOFT COMPUTING

3 0 0 3

INTRODUCTION: Artificial Intelligence systems –Fuzzy systems – Neural networks – Evolutionary Computation. **NEURAL NETWORKS:** Basic concepts – model of an artificial neuron- Neural network architectures –learning methods –Perceptron-Back propagation networks – Associative Memory- Extreme learning machine – Applications to real world problems. (11)

FUZZY SYSTEMS: Fuzzy sets - Membership functions – Basic fuzzy operations- Fuzzy relations - operations on fuzzy relations – Fuzzy logic - Fuzzy rule based systems - Defuzzification - Graphical inference method – Applications to real world problems. (12)

EVOLUTIONARY COMPUTATION: Fundamentals. **GENETIC ALGORITHMS:** encoding methods – fitness function – reproduction methods - Genetic inheritance operators - Cross over operators - Mutation –Working principle. **EVOLUTION STRATEGIES:** $(\mu + \lambda)$ Evolution strategy- $(\mu\lambda)$ Evolution Strategy. **DIFFERENTIAL EVOLUTION:** fundamentals –operations – strategies – Applications to real world problems. (11)

HYBRID SYSTEMS: Integration of neural networks, fuzzy systems and evolutionary algorithms - Fuzzy Backpropagation neural network – architecture – learning algorithm- Evolutionary extreme learning machine- architecture – learning algorithm - Applications to real world problems. (11)

Total L:45

REFERENCES

1. Ross Timothy J, "Fuzzy Logic with Engineering Applications", 4th Edition, Wiley, 2016.
2. Rajasekaran S and Vijayalakshmi Pai G A, "Neural Networks, Fuzzy Systems and Evolutionary Algorithms- Synthesis and Applications", 2nd Edition, PHI Learning, 2017.
3. Amit Konar, "Artificial Intelligence and Soft Computing", CRC Press, 2008.
4. Simon Haykin, "Neural networks and Learning Machines", 3rd Edition, Pearson India, 2016.

23MXAF COMPUTER NETWORKS**3 0 0 3**

Introduction: Types of Networks - ISO/OSI architecture – Functions of OSI layers – TCP/IP architecture - Interconnecting devices: repeaters, hubs, switches, routers, gateways- Interconnecting technologies: multiplexing, switching - Need for Flow and error control - MAC - Need for Address Resolution Protocol (11)

Internetworking: IP Addressing: IPv4 Addressing – classful, classless IP addressing - Subnetting, Supernetting – CIDR –IPv6 addressing- Host Configuration – Error Reporting - Routing in Internet - Intra-domain routing: DVR, LSR – Inter-domain Routing: Path vector routing - Features of RIP, OSPF, BGP - IPv6 – Multicasting: its need and protocol architecture . Software Defined Networking (12)

End-to-End Protocols: Transport Services – Connection oriented, Reliable service, Flow and Error control – UDP - TCP: Connection establishment, Connection Termination, Data Transfer - Issues in resource allocation – Queueing disciplines – TCP Congestion Control – Congestion Avoidance mechanism. (11)

Internet Applications: HTTP – FTP - SMTP - Name services, Network management services – RTTP – VOIP - Overlay Networks – Routing overlays, Peer-to-peer networks, Content Distribution Networks. Use of NS2 network analysis. (11)

Total L: 45**REFERENCES:**

1. Behrouz A. Forouzan – “Data Communications and Networking” - McGraw Hill Education, 4th edition , 2017
2. Andrew S. Tanenbaum, David J. Wetherall – “Computer Networks”, Pearson Education India, 5th edition , 2013
3. Behrouz A. Forouzan – “TCP/IP Protocol Suite ”,McGraw Hill Education, 4th Edition, 2017
4. James F. Kurose, Keith W. Ross, “Computer Networking : A Top-Down Approach , Pearson, 6th Edition, 2017
5. William Stallings, "Data and Computer Communications", Prentice Hall, 2014.

23MXAF DATA MINING AND ANALYTICS**3 0 0 3**

DATA MINING: Motivation - Steps in Data Mining – Architecture - Data Mining and Databases – Data Warehouses – Data Mining functionalities – Classification – Data Mining primitives – Major issues.**DESCRIPTIVE ANALYTICS:** Descriptive data summarization –Types of measurement scales-Measures of central tendency- Measures of Variance – Data Visualization-Data cleaning – Data integration and transformation – Data reduction – Data discretization and concept hierarchy generation. (12)

CLUSTER ANALYSIS: Types of data – Categorization of clustering methods - Partitioning Methods: k means and k Medoids – Hierarchical Methods: Agglomerative and Divisive hierarchical clustering- Outlier analysis. **CLASSIFICATION:** Issues regarding classification – Classification by Decision Tree induction – Bayesian Classification – Rule based classification –Classifier accuracy measures – evaluating the accuracy of a classifier. (14)

PREDICTIVE ANALYTICS: Issues regarding prediction – comparison of classification and prediction – linear regression – applications to real world problems - predictor error measures – Evaluating the accuracy of predictors. **PRESCRIPTIVE ANALYTICS:** Trend analysis –regression analysis – moving average methods – time series forecasting – similarity search. (10)

MINING FREQUENT PATTERNS, ASSOCIATIONS AND CORRELATIONS: Market basket analysis - Frequent itemsets, Association rules – frequent pattern mining – mining various kinds of Association rules – The Apriori Algorithm – Generating association rules from frequent itemsets. (9)

Total L: 45**REFERENCES:**

1. Han Jiawei, MichelineKamber and Jian Pei “Data Mining: Concepts and Techniques”, Morgan Kaufmann, 2011.
2. U Dinesh Kumar, “ Business Analytics : The Science of Data-Driven Decision Making”, Wiley , 2018
3. G.K. Gupta “ Introduction to data mining with case studies”, PHI Learning Pvt. Ltd 2014.
4. Soman K P, ShyamDiwakar and Ajay V,” Insight into Data Mining Theory and Practice”, PHI Learning, 2009.
5. Arun K Pujari, “Data Mining Techniques”, University Press, 2013.

23MXAG ARTIFICIAL INTELLIGENCE**3 0 0 3**

INTRODUCTION: Definitions of Artificial Intelligence (AI) - Foundations of AI - History of AI - Intelligent Agents -Structure of Agents. **AI SEARCH ALGORITHMS:** State Space Model - Trial and Error - Breadth First Search - Depth First Search – Brute Force Search - A* Algorithms – Illustrative problems and real world applications. (11)

NON CLASSICAL AI SEARCH ALGORITHMS: Genetic Algorithms - Simulated Annealing. **GAME PLAYING:** AND/OR Search

Trees-Game Trees - Minmax Algorithm - Alpha-Beta Pruning, **CONSTRAINT SATISFACTION:** Definition – Inference - Backtrack Search and Local Search for Constraint Satisfaction Problems – illustrative problems and real world applications. (12)

KNOWLEDGE, REASONING, AND PLANNING: Logical Agents - Propositional Logic - First-order predicate Logic – real world modeling and Inference - Backward Chaining - Forward Chaining – Resolution - illustrative problems and applications. (11)

PROBABILISTIC REASONING: Semantics of Bayesian Networks – inference, **LEARNING:** Supervised learning – Unsupervised learning- reinforcement learning – illustrative problems and applications. (11)

Total L: 45

REFERENCES:

1. Stuart Russel and Peter Norvig, "Artificial Intelligence – A modern approach", Pearson, Fourth Edition, 2020.
2. Elaine Rich, Kevin Knight and Shivashankar B Nair, "Artificial Intelligence", McGraw Hill, 2008.
3. Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Education (India), 2013.
4. Patrick Henry Winston, "Artificial Intelligence", Addison Wesley, Third Edition, 1992.
5. Luger George F and Stubblefield William A, "Artificial Intelligence: Structures and Strategies for Complex Problem Solving", Pearson Education, Sixth Edition, 2008.
6. Ronald J. Brachman, Hector J. Levesque: Knowledge Representation and Reasoning, Morgan Kaufmann, 2004.

23MXAH MACHINE LEARNING

3 0 0 3

INTRODUCTION: Machine learning-Examples of machine learning applications. **SUPERVISED LEARNING:** Learning a class from examples-VapnikChervonenkis dimension – Noise - Learning multiple classes - Regression- Dimensions of a supervised machine learning algorithm. **BAYESIAN DECISION THEORY:** Classification – losses and risks – Discriminant functions – Association rules. (10)

PARAMETRIC METHODS: Maximum likelihood estimation – Bias and Variance – Baye's estimator – Parametric classification-Regression. **DIMENSIONALITY REDUCTION:** Subset selection – Principal component Analysis – Feature embedding – Factor Analysis. **CLUSTERING:** Mixture densities – k-Means clustering – Supervised learning after clustering- Hierarchical clustering. (12)

NON PARAMETRIC METHODS: Non parametric density estimation – non parametric classification- Distance based classification – Outlier detection. **DECISION TREES:** Univariate trees – Pruning – Learning rules from data. **MULTILAYER PERCEPTRON:** Understanding the brain - Perceptron –Training - Learning Boolean functions-Multilayer perceptrons- Universal approximator- Back propagation algorithms - Training. (11)

DESIGN AND ANALYSIS OF MACHINE LEARNING EXPERIMENTS: Factors, response and strategy of experimentation – randomization, replication and blocking – cross validation and resampling methods- Measuring classifier performance –internal estimation –Hypothesis testing –Comparing two classification algorithms. (12)

Total L:45

REFERENCES:

1. Ethem Alpaydin , "Introduction to Machine Learning ", PHI learning, 2014
2. Tom Mitchell, "Machine Learning" , McGraw Hill, 1997.
3. Peter Flach , "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", Cambridge Press, South Asia Edition, 2015
4. Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 2011.

23MXAI INTERNET OF THINGS

3 0 0 3

BASICS OF IOT: Introduction to Internet of Things (IoT) – Machine to Machine (M2M) — Features and Definition of IoT– Recent Trends in the Adoption of IoT – Societal Benefits-IoT Enabling Technologies – IPv6 - Basic Architecture (Three Layer and Five Layer Architecture) - Components of IoT: Embedded Computation Units, Microcontrollers, System on Chip (SoCs) - Sensors – Actuators – Communication Interfaces. (9)

PROTOCOLS OF IOT: Low Power Personal Area networks (Low PAN): Overview, 6Low PAN, IEEE 802.15.4, BLE, Zigbee, Zwave, and Thread - Wi-Fi - Low Power Wide Area Networks (LPWAN): Concepts and features, SigFox, LoRaWAN, LPWAN-3GPP, Comparing different LPWAN technologies-: Rest Architecture - HTTP – CoAP: Architecture, Features, Applications - MQTT: Architecture, Feature, Applications - Comparing different IoT Application Layer protocols. (12)

MODERN NETWORKING: Web of Things versus Internet of Things –Two Pillars of the Web –Architecture Standardization for WoT - Cloud Computing and IoT, Cloud services and providers, Load balancing Hypervisors, Comparison of Cloud providers - Software Defined Networking(SDN): Overview, Architecture, Rule placement, OpenFlow Protocol, Relevance of SDN to IoT (12)

PROTOTYPING AND APPLICATIONS IN IoT: Prototyping embedded devices - Open Source versus Closed Source – Embedded Computing Basics - Arduino - Raspberry Pi – Wasp Mote-Implementation. Smart homes – Energy – Health Care – Smart Transportation – Smart Living – Smart Cities- Smart Grid – Smart Agriculture- Disaster management. (12)

Total L:45

REFERENCES:

1. Dieter Uckelmann, Mark Harrison, Florian Michahelles, "Architecting the Internet of Things", Springer, New York, 2011
2. Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", CRC Press 2012.
3. Jim Doherty, "SDN and NFV Simplified: A Visual Guide to Understanding Software Defined Networks and Network Function Virtualization", Addison-Wesley, 2016
4. IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, Cisco Press, 2017.
5. William Stallings, "Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud" Addison-Wesley, 2015
6. Arduino Projects for Engineers Paperback ,Neerparaj Rai,BPB Publishers, 2016

23MXAJ WIRELESS NETWORKS

3 0 0 3

WIRELESS FUNDAMENTALS AND TECHNOLOGIES : Wireless Transmission- Spectrum allocations – Radio propagation models - signals, signal propagation, path loss of radio signals, Effects of signal propagation - Multipath propagation - Wireless impairments - Multiplexing - SDM,TDM, FDM, TFDM ,CDM - MAC – SDMA – TDMA – FDMA - CDMA. (11)

CELLULAR NETWORKS: Introduction - cellular system - Frequency reuse - Cell breathing - mobile telecommunication systems : 2G and 3G standards : GSM - Services , system Architecture , localization and calling, handover, security - GPRS : Architecture and protocol stack - 5G networks : Evolution of LTE, Pillars of 5G, 5G architecture, small cells , Mobility and handoff management in 5G networks - device to device D2D communication in 5G. (11)

WIRELESS LAN: IEEE 802 Architecture - 802.11 Architecture and services: 802.11 Physical, MAC layer details – Bluetooth: - Standards, Protocol Architecture, usage Models, Channel Control, State transition - LMP PDUs. (11)

AD HOC AND SENSOR NETWORKS: Ad-hoc networks : Issues, design - Routing in Ad-Hoc Networks: Classification – Destination sequenced Distance vector routing, Dynamic source routing, Zone based Hierarchical Link State routing, Power aware routing protocol. Sensor Networks: issues in design of sensor network, sensor network architecture, data dissemination and gathering, location discovery, Quality of a sensor network. (12)

Total L: 45

References:

1. Cory Beard, William Stallings, Wireless Communication Networks and Systems, Global Edition, Pearson Education, 2016
2. Afif Osseiran, Jose F. Monserrat, Patrick Marsch - "5G Mobile and Wireless Communications Technology" Cambridge University Press, 2016.
3. Jochen Schiller - "Mobile Communications" , Pearson Education Ltd., 2012.
4. Siva Ram Murthy C, Manoj. B.S., - "Ad-Hoc Wireless Networks: Architectures and Protocols", Pearson Education Ltd.2011.

23MXAK DEEP LEARNING

3 0 0 3

Introduction: Motivation for deep learning - **Machine learning Basics** - From machine learning to deep learning- Logistic regression- gradient descent-**Introduction to neural networks:** input units-output units-hidden units-cost functions- hypotheses and tasks- training data - maximum likelihood based cost - cross entropy - MSE cost- feed-forward networks- MLP - sigmoid units-. Learning in neural networks: output vs hidden layers; linear vs. nonlinear networks. Implementing neural nets (12)

Backpropagation: Back propagation neural nets; Learning via gradient descent- recursive chain rule - bias-variance tradeoff – **Regularization and output units:** linear- softmax – RELU. (10)

Deep Learning Methods: Linear Factor Models - Auto encoders - De-noising Autoencoders- Stacked Autoencoders- Monte Carlo methods – Hybrid Monte Method - - Deep Generative Models- **Convolutional neural networks:** Motivation –pooling- dropout-Variants of CNN-implementation of CNN. (12)

Sequence modeling: **Recurrent and Recursive nets-** Recurrent Neural Networks- Bidirectional RNNs-Encoder-Decoder Sequence-to-Sequence Architectures - Implementation of RNNs. (11)

Total L=45

REFERENCES:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2016.
2. Adam Gibson, Josh Patterson, "Deep Learning A Practitioner's Approach", O'Reilly, 2016.
3. Yasuka Sugamin, "Deep Learning with Java", Packt publishing, 2016.
4. Jeff Heaton, "Artificial Intelligence For Humans: Deep Learning and Neural Network", Lightning Source Inc, 2015
5. N D Lewis, "Deep Learning made easy with R: A Gentle Introduction for Data Science", 2016

23MXAL MULTIDIMENSIONAL DATA STRUCTURES**3 0 0 3**

PROBABILISTIC ANALYSIS AND RANDOMIZED ALGORITHMS: The hiring problem – Indicator random variables – Randomized algorithms- Probabilistic analysis - Identifying the repeated element - Primality Testing - Advantages and Disadvantages . (11)

MULTIDIMENSIONAL POINT DATA : Segment trees –Range trees - Priority search trees-Quad trees-Point Quad trees-Trie based Quad trees-K-d trees (11)

IMAGE AND TEXT DATA: Raw images - image segmentation-similarity based retrieval - R -trees - Precision and Recall - Latent Semantic Indexing - TV-trees - operations - Applications (12)

AUDIO AND VIDEO DATA: Frame Segment Tree-R-Segment Tree-Video Segmentation-Model of Audio Data-Metadata to Represent Audio Content-Capturing Audio Content-Indexing Audio Data - Applications (11)

Total L:45**REFERENCES:**

1. Hanen Samet, "Foundations of Multidimensional and Metric Data Structures", Morgan Kaufman, USA, 2001
2. Marcello La Rocca, "Advanced Algorithms and Data Structures", Manning, 2021.
3. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, "Fundamentals of Computer Algorithms", Universities Press,2010.

23MXAM OPEN SOURCE SYSTEMS**3 0 0 3**

PRINCIPLES OF OPEN SOURCE: Introduction to Open Source Systems (OSS) - The Philosophy of OSS - The Cathedral and Bazaar Model - Commercial Software and OSS - Free Software and Freeware – Open Source Licensing - Copyright vs Copyleft – Bug Fixing - Software patenting and violations. (11)

OPEN SOURCE LANGUAGES: Basics – Client-side scripting, Server-side scripting, Open Source middleware system- History and overview of R - R programming environment -Basic language elements and data structures Data input/output- Data storage formats -Subsetting objects -Vectorization -Control structures- Functions- Scoping Rules -Loop functions- Graphics and visualization -Grammar of data manipulation - Debugging/profiling- Statistical simulation. Case Study: Scripting Languages. (12)

OPEN SOURCE DATABASES: NoSQL Databases – Types - Documents Database – MongoDB - CRUD operations – Two phase commit - Data models – Aggregation – Indexes - Mongo shell – Query operators – Replication. Case Study: Column and Graph based databases. (11)

OPEN SOURCE SOFTWARE TOOLS: IDEs (Eclipse) - Model Driven Architecture tools (OpenXava)— Software Testing IDE (Selenium) – Version control system (Git) – Content Management System (Joomla) - Web server (Apache) – Framework (Rails, Bootstrap). (11)

Total L:45**REFERENCES:**

1. Karl Fogel, "Producing Open Source Software", O'Reilly, 2006.
2. Kristina Chodorow and Michael Dirolf, "MongoDB: The Definitive Guide", O'Reilly, 2010.
3. Jared P.Lander, "R for Everyone: Advanced Analytics and Graphics", Addison Wesley, 2017.
4. Bruce A Tate and Curt Hibbs, "Ruby on Rails: Up and Running", O'Reilly Media, 2008.
5. Peter Wainwright, "Professional Apache", Wrox Press, 2002.

23MXAN UBIQUITOUS AND PERVASIVE COMPUTING**3 0 0 3**

INTRODUCTION: Model ubiquitous &pervasive computing system to everywhere computing-applications of ubiquitous &pervasive computing: Healthcare, Tracking, emergency information systems, home networking appliances and entertainment. Emerging trends in Pervasive /Ubiquitous /Invisible Computing - Device Technology - Internet of Things paradigm - role of RFID tags. **WIRELESS CONNECTIVITY:** Connecting the world – wireless internet access technologies - Mobile internet protocols - short-range and wide-range, Wireless data networks - Pervasive networks. (10)

UBIQUITOUS & PERVERSIVE APPLICATION DEVELOPMENT: Design and implement interfaces - middleware technique - Web application development - Wireless Markup Language -Push and pull services- Developing mobile applications – device independent view component - Pervasive application design and implementation of real-time embedded smart systems of relevance - **CASE STUDIES:** Ubiquitous and pervasive computing systems to identify their strengths, limitations and the future directions: smart home, smart healthcare, smart traffic. (12)

CONTEXT AWARE SYSTEMS: Fundamentals of Context aware computing - Mobility awareness -Spatial awareness - Temporal awareness - ICT system awareness - Autonomous systems - Reflective and self-aware systems - Self management and autonomic computing - Context modeling languages. **LOCATION CONTEXT:** Mobile/cellular network - location modeling - location management - Mobile location protocol - Location framework - Location API – Open geospatial consortium location services. (11)

LOCATION BASED SERVICES: Location Based Services – Location Relatedness and Query Model - Location Dependent Data – Location Aware Queries – Location Dependent Queries – Moving Object Database Queries – Query Classification – Query Translation Steps in LDQ Processing - LBS Applications and Services case study: Development of the Yellow pages search, m-tourism- Find friend application- L-Commerce - Navigation Systems: A Spatial Database Perspective. Current trends in the area of data management in ubiquitous and pervasive environments. (12)

Total L:45

REFERENCES:

1. Stefan Poslad, "Ubiquitous Computing - Smart Devices, Environment And Interactions", John Wiley, 2016.
2. Adelstein F And Gupta S K S, "Fundamentals Of Mobile And Pervasive Computing", Tata Mcgraw Hill, 2018.
3. GuruduthBanavar, Norman Cohen, Chandra Narayanaswami, "Pervasive Computing: An Application-Based Approach", Wiley Inter Science, 2015.
4. Burkhardt, Henn, HepperAndRintdorff, Schaeck. "Pervasive Computing", Pearson Education, 2014.
5. A. Genco, S. Sorce, "Pervasive Systems And Ubiquitous Computing", Wit Press, 2016
6. Mohammad S. Obaidat,Mieso Denko, Isaac Woungang, "Pervasive Computing And Networking", Wiley, 2011

23MXAO HUMAN COMPUTER INTERACTION**3 0 0 3**

Introduction: The importance of User Interface – Characteristics of UI – Guidelines, Principles and Theories - Universal Usability - Design and evaluation in the real world: Designing for the desktop – Mobile and other devices –The Web. (12)

Design Processes: Understanding and conceptualizing interaction -Conceptual Model / Framework – Modeling Users: Personas and Goals– Setting the Vision: Scenarios and Design Requirements- Evaluation and the User Experience –Design Case Studies. (10)

Interaction Process: The process of interaction design– Lifecycle Models - User Centric Approach-Direct Manipulation and Immersive Environments - Expressive Human and Command Languages – Devices - Communication and Collaboration (12)

Prototyping and Evaluation: Prototyping and construction – Wireframes – Low-fidelity prototyping – High-fidelity prototyping – Tool support – Introducing Evaluation - What, why and when to Evaluate – Evaluation framework - D E C I D E: A framework to guide evaluation – Pilot studies - Future Interfaces and Grand Challenges. (11)

Total L: 45

REFERENCES

1. Ben Shneiderman, Catherine Plaisant, Maxine Cohen, Steven M. Jacobs – “Designing the User Interface – Strategies for Effective Human Computer Interaction”, Pearson, 6th Edition, 2021.
2. Wilbert O. Galitz – “The Essential Guide to User Interface Design ”, Wiley, 2nd Edition, 2015.
3. Jeff Johnson – “Designing with the mind in mind”, Morgan Kaufmann, 2nd edition, 2014.
4. Helen Sharp, Jennifer Preece, Yvonne Rogers, “Interaction Design: Beyond Human-Computer Interaction”, Fifth Edition 2019.
5. Alan Cooper, Robert Reimann, David Cronin, Christopher Noessel Cooper, Reimann, Cronin, &Noessel, “About Face: The Essentials of Interaction Design” Fourth Edition 2014.

23MXAP PRINCIPLES OF COMPILER DESIGN**3 0 0 3**

INTRODUCTION: Programming languages - language processing system - structure of a compiler – phases of a compiler - compiler writing tools.**LEXICAL ANALYSIS:** Role of a lexical analyzer – finite automata –regular expressions to finite automata – minimizing the number of states of a deterministic finite automata- LEX tool (12)

PARSING TECHNIQUES : Context free grammars– derivations and parse trees – ambiguous and unambiguous grammar - **BOTTOM UP PARSING:** LR parsers: SLR parser, CLR, LALR parser. **TOP DOWN PARSING:** Pitfalls – backtracking – left recursion – left factoring-Recurcive descent parsing – Predictive parsing-YACC tool (12)

INTERMEDIATE CODE GENERATION: Postfix notation – Three address code - Quadruples, triples , indirect triples – Syntax directed translation schemes - Intermediate code generation for assignment statements, Boolean expressions, Control statements: If-then-else, while loop. (10)

CODE OPTIMIZATION AND CODE GENERATION: Code optimization techniques – basic blocks – flow graphs - DAG representation – error detection and recovery - code generation-problems in code generation-Peephole optimization. (11)

Total L :45

REFERENCES:

1. Aho A V, Monica S Lam, Sethi R and Ullman J D, "Compilers Principles, Techniques and Tools", Addison Wesley, 2013.
2. Dhamdhere D M, "Compiler Construction Principles and Practice", Macmillan Publishers India, 2008.
3. Allen I.Holub "Compiler Design in C", Prentice Hall of India, 2015
4. Des Watson , "A Practical Approach to Compiler Construction" ,Springer,2017

23MXAQ SOCIAL NETWORKING AND WEB MINING**3 0 0 3**

INTRODUCTION: Data mining and web mining – social network analysis – Evolution of social networks – Basic concept in social networks. **SOCIAL NETWORK DATA AND REPRESENTATION:** Structural – composition - affiliation variables-modes-boundary specification and sampling- type of networks- measurement and collection – Notation for social network data - Review of graph theory - Data set- Tools - Pajek, Netdraw, UCInet. (12)

STRUCTURAL PROPERTIES OF SOCIAL NETWORKS: Notions of centrality, cohesiveness of subgroups, roles and positions, block models - Information diffusion – power law. (11)

WEB MINING: Web crawler – types of web crawler - Web search – Characteristic of Web data – types of web mining, **WEB CONTENT MINING:** Web Content Mining: Vector Space Model, Web Search, Personalized Web Search. (11)

WEB LINKAGE MINING: Hyperlinks- co-citation and bibliographic coupling- page rank and HITS algorithm – web community discovery-Privacy and Security. (11)

Total L:45**REFERENCES:**

1. Guandongxu and Yanchunzhang, "Web mining and social networking: Techniques and applications", Springer Science and Business Media, 2011.
2. Bing Liu, "Web Data MiningExploring Hyperlinks,. Contents, and Usage Data", Springer, 2011.
3. Stanley Wasserman and Katherine Faust, "Social network analysis: methods and applications", Cambridge University Press, 2012.
4. Anthony Bonato, "A Course on Web Graphs", American Mathematical Society, 2008.

23MXAR VIRTUAL REALITY SYSTEMS**3 0 0 3**

Basics of Virtual Reality Systems: Defining Virtual Reality (VR) – Five key elements of VR experience – History of VR –The Medium – Types of VR- Humans in the loop- Interfacing, presenting and interacting with the virtual world- -Input & output- Haptic Displays - Applications of Virtual Reality. (10)

The Virtual Environment: The virtual world space – positioning the virtual observer – the perspective projection – stereo perspective projection – Geometric Modelling - Simple 3D modeling – Illumination models – Reflection models – Shading algorithms - Rasterization - 3D clipping – Colour theory - Radiosity – Hidden Surface Removal – Visual Perception - Perception of Depth, Motion, and Colour - Sources of Information Visual Rendering – Realism-Stereographic image - Rotation- Viewing Transformations - Chaining Transformations - human eye movements - implications for VR (15)

Motion in Real and Virtual Worlds- Velocities and Accelerations - The Vestibular System - Physics in the Virtual World - Mismatched Motion and Evection Tracking - Tracking 2D & 3D Orientation - Tracking Position and Orientation - Tracking Attached Bodies (10)

Unity and Virtual Reality Projects: Types of VR experience – Types of HMD – Understanding Unity, content and scale – Setting up a VR project – Using Gaze-based Control – Interacting using hands- Canvasing World space UI – Lighting, Rendering and Realism – Exploring Interactive spaces – VRML – Definition - Using nodes and shapes – VRML browsers – Java 3D – visual object definition by shape 3D instances – ColorCube class – Geometric utility classes. (10)

Total L:45**REFERENCES:**

1. Alan B. Craig and William R. Sherman, "Understanding Virtual Reality: Interface, Application, and Design", Morgan Kaufmann Publishers, 2022
2. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, "3D User Interfaces, Theory and Practice", Addison Wesley, 2017.
3. Steven M. LaValle, "Virtual Reality", Cambridge University Press, 2016
4. Jonathan Linowes, "Unity 2020 Virtual Reality Projects", Third Edition, Packt Publishing Ltd., 2020
5. Grigore Burdea, Philippe Coiffet, "Virtual Reality Technology", Wiley, 2003.

23MXAS BLOCKCHAIN TECHNOLOGIES AND USE CASES

3 0 0 3

Introduction to Block Chain: Distributed Database, Two General Problem, Byzantine General Problem and Fault Tolerance, Hadoop Distributed File System, Distributed Hash Table, ASIC resistance, Turing Complete, Cryptography : Hash function, Digital Signature – ECDSA, Memory Hard Algorithm, Zero Knowledge Proof. Introduction, Scenarios, Challenges Articulated to Block Chain, Block Chain Characteristics and Evolution of Block Chain. (11)

Block Chain Concepts: Introduction, Changing of Blocks, Hashing, Merkle –Tree, Consensus, Mining and Finalizing Blocks, Currency aka tokens, security on Block Chain, data storage on Block Chain, Wallets, Coding on Block Chain: Smart Contracts, Peer –to–Peer network types of Block Chain Nodes, risk associated with Block Chain Solutions, Life cycle of Block Chain Transactions. (11)

Block Chain Platforms : Abstract Models of Block Chain- Proof of Work (POW) – Proof of Stake(POS) and Hybrid Models. Ethereum – Ethereum Virtual Machine (EVM)- Wallets for Ethereum- Solidity –Smart Contract- The Turing Completeness of Smart Contract . Smart Contract vs. Bit coin Scripting. Hyperledger Block Chain Implementation, Introduction, Use case – Car ownership Tracking, Hyperledger Fabric, Hyperledger Fabric Transaction flow, Use Case Implementation, Invoking Chaincode Functions using Client Applications. (12)

Use Cases and Future of Block Chain Technologies : Record Management System –Medical records and Land Registration using Block Chain. Block Chain and Government. Block Chain and Finance. The uses of Block Chain Technologies with Internet of Things and Artificial Intelligence / Machine Learning. Cloud Offerings and Block Chain. Future Potential of Block Chain Technologies. (11)

Total L : 45

REFERENCES:

1. Imran Bashir , Mastering Block chain: Deeper insights into decentralization, cryptography, Bitcoin, and popular Block chain frameworks , 2017.
2. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder, Bitcoin and cryptocurrency technologies: A Comprehensive Introduction, Princeton University Press, 2016
3. Joseph Bonneau et al, SoK: Research perspectives and challenges for Bitcoin and cryptocurrency, IEEE Symposium on security and Privacy, 2015.
4. S. Shukala, M Dhawan, S. Sharma, S. Venkatesan, Block chain Technology: Cryptocurrency and Applications, Oxford University Press, 2019.

23MXAT DevOPs

3 0 0 3

INTRODUCTION TO DEVOPS and SOURCE CODE MANAGEMENT: Introduction, DevOps Features, Work Management, Source Code Management, Build Automation, Delivery Automation, Understanding Code Quality, Automation of CI/CD. **SOURCE CODE MANAGEMENT (GIT):** Version controlling with SVN and GIT, Branching Workflows in SVN & GitHub Flow (11)

BUILD AUTOMATION and Build Server – CI: Build (CI) Orchestration using Jenkins Automation Server, Pipeline Basics – Jenkins Master, Node, Agent and Executor. **AUTOMATION SERVER: JENKINS** – Continuous Integration and Delivery server JENKINS – CD Orchestrator, UNIT TESTING – CODE COVERAGE: jUnit, nUnit & Code Coverage with Sonar Qube, SonarQube – Code Quality Analysis. **ARTIFACT MANAGEMENT:** Nexus, JFrog Artifactory, JFrog Artifactory as Kubernetes Registry, Helm chart for Microsoft Azure Pipeline. (11)

CONTINUOUS DELIVERY: Software components can be released in short cycles, **CONTINUOUS DEPLOYMENT:** Extends Continuous Delivery, Change is automatically deployed to Production, CD Flow. **Continuous Deployment:** Containerization with Docker: Introduction to Docker, Images & Containers, DockerFile. (11)

Continuous Deployment: Configuration Management – Ansible: Introduction to Ansible, Ansible tasks, Roles, Jinja templates, Vaults, Deployments using Ansible. **CONTAINERIZATION USING KUBERNETES (OPENSHIFT):** Introduction to Kubernetes Namespace & Resources. **AWS & AZURE – CLOUD:** Introduction to AWS & Azure Clouds, Pipeline of AWS & Azure Clouds – CI/CD. (11)

Total L : 45

REFERENCES:

1. Gene Kim, John Willis, Patrick Debois, Jez Humble, "The DevOps Handbook: How to create world-class Agility, Reliability and Security in Technology Organizations", O'Reilly Publications 2016.
2. Gene Kim, Jez Humble, Patrick Debois, John Willis, "The DevOps Handbook", IT Revolution Press, 2016
3. Prem Kumar Ponuthurai, Jon Loeliger, "Version Control with Git", O'Reilly Media, Inc. 2022.
4. Viktor Farcic, "The DevOps 2.0 Tool Kit: Automating the Continuous Deployment Pipeline with Containerized Microservices", Create Space Independent Publishing Platform Publications, 2016.
5. Harrison, Dave, Lively and Knox , " Achieving DevOPs: A Novel about Delivering the Best of Agile, DevOPs and Micro Services", Apress Publications , 2019.
6. Michael Huttermann," DevOps for Developers", Apress, 2016.

23MXAU SOFTWARE TESTING

3 0 0 3

INTRODUCTION: Fundamental concepts of testing – Types of testing - Classifications-Unit Testing, Module testing- Integration Testing, system and acceptance testing - Examples. **DEVELOPING A TEST APPROACH:** Addressing Software System business risk-Defining a software system testing strategy - Developing software system testing tactics - Testing tools – Test Plan and Test Cases. (12)

TESTING A SOFTWARE USING A LIFE CYCLE METHODOLOGY: Requirements phase testing - Design phase testing - Program phase testing - Desk debugging and program peer view test tools - Evaluating test results - Installation phase testing - Acceptance testing. **TESTING OBJECT ORIENTED SOFTWARE:** Challenges – Differences from testing non-OO software – Class testing strategies – class modality – State based testing. (12)

TESTING WEB APPLICATIONS: Functionality and Usability issues, Security Testing, Database Testing.

TESTING METHODOLOGY FOR SOFTWARE MAINTENANCE: Testing the correctness of the installing a software change - Testing the validity of a software cost estimate - Testing the progress of the software system - Inspecting test plan and test cases - Software Inspection - Costs and Benefits - Overview - The Inspection Process. (11)

ASSESSING CLIENT-SERVER AND LAN RISKS: A testing strategy for a rapid prototyping-Testing techniques-Testing tools.

TEST DOCUMENTATION: Reporting test results –Final test reporting- Evaluating test effectiveness – Use of testing metrics-improving the testing process. (10)

Total L: 45

REFERENCES:

1. William Perry, "Effective Methods for Software Testing", John Wiley, 2022.
2. John Watkins, "Testing IT: An off the shelf Software Testing Process", Cambridge Press, 2010.
3. John Watkins, "Agile Testing: How to succeed in an extreme Testing environment", Cambridge Press, 2009.
4. Boris Beizer, "Software Testing Techniques", Dream Tech Press, 2003.

23MXAV OPERATING SYSTEMS

3 0 0 3

INTRODUCTION AND MEMORY MANAGEMENT: Operating Systems Objectives and Functions – Structure of Operating System - Memory Hierarchy – Linking and Loading the process – Memory Management Requirement - Fixed Partitioning - Dynamic Partitioning – Simple paging – Multilevel paging – Inverted paging – Simple Segmentation – Segmentation and Paging. **VIRTUAL MEMORY MANAGEMENT:** Need for Virtual Memory management – Demand Paging - Page Fault Routine – Demand Segmentation – Combined Demand Segmentation and Paging - Operating systems policies. (11)

PROCESS DESCRIPTION AND CONTROL: Process Creation - Process states – Process Description – Process Control. Process Scheduling: Types of Scheduling – Scheduling Criteria – Scheduling Algorithms. **CASE STUDIES:** UNIX Process Creation and Termination. (10)

PROCESS SYNCHRONIZATION: Concurrent Process – Principles of Concurrency – Mutual Exclusion – Software and Hardware support - Operating System Support - Deadlock - Deadlock Prevention, Avoidance and Detection and recovery. Process and Threads: Relationship between process and threads - Types of Thread - Thread State - Thread Synchronization. **CASE STUDIES:** UNIX Threads. (12)

I/O MANAGEMENT AND FILE MANAGEMENT: Organization of I/O function – Evolution of I/O function – Types of I/O devices – Logical Structure of I/O functions – I/O Buffering – Disk I/O – Disk Scheduling algorithms – Disk Cache - Files – File management Systems – File System Architecture – Functions of File Management – File Directories – Secondary Storage Management – File Allocation. **CASE STUDIES:** Windows, Linux, and Android and UNIX commands for File Systems. (12)

Total L: 45

REFERENCES:

1. William Stallings, "Operating Systems: Internals and Design Principles", Prentice-Hall, 2020.
2. Silberschatz A, Galvin P and GagneG, "Operating System Concepts" John Wiley, 2019.
3. Charles Crowley, "Operating System a Design Oriented Approach", Tata McGraw-Hill, 2018.
4. Maurice J Bach, "Design of the Unix Operating System", Pearson, 2015.
5. Andrew S Tanenbaum, "Modern Operating System", Prentice Hall, 2018.

23MXBA OPTIMIZATION TECHNIQUES

3 0 0 3

INTRODUCTION: Statement of an optimization problem – classification of optimization problem – classical optimization techniques: Single variable optimization, Multi variable optimization, Equality constraints, Inequality constraints, No constraints.

(10)

LINEAR PROGRAMMING: Mathematical formulation of LPP – Graphical method for two dimensional problems – central problems of Linear Programming – Definitions – Simplex – Algorithm – Phase I and Phase II of Simplex Method – Revised Simplex Method – Dual and Primal of LPP– Sensitivity Analysis. Transportation problem and its solution – Assignment problem and its solution by Hungarian method. Programming with solvers. (13)

NON LINEAR PROGRAMMING – UNCONSTRAINED OPTIMIZATION: One dimensional minimization – Unimodal and Multimodal Function - Unrestricted search –Interval halving method – Fibonacci method. Multi-dimensional minimization – Univariate method – Pattern search method – Hooke and Jeeves method – Gradient of a function – Steepest descent method – Conjugate gradient method. Programming tools for solving NLP. (12)

DECISION MAKING: Decisions under uncertainty, under certainty and under risk – Decision trees – Expected value of perfect information and imperfect information. (10)

Total L : 45**REFERENCES:**

1. Kalyanmoy Deb, "Optimization for Engineering Design Algorithms and Examples", PHI Learning, 2014.
2. Singiresu S Rao, "Engineering Optimization Theory and Practice", New Age International, 2013.
3. Hamdy A Taha , "Operations Research – An Introduction", Pearson Education, 2016.
4. Kambo N S, "Mathematical Programming Techniques", Affiliated East – West Press, 2012.

23MXBB NUMERICAL METHODS**3 0 0 3**

SOLUTION OF ALGEBRIC SIMULTANEOUS EQUATIONS: Gauss – Jordan elimination, Cholesky method, Crout's method, Gauss – Jacobi method, Gauss – Seidel method. Matrix Inverse by Gauss – Jordan method. **EIGEN VALUES AND EIGEN VECTORS:** Power method of finding dominant eigen value and inverse power method for finding smallest eigen value, Jacobi method for symmetric matrices. (12)

FINITE DIFFERENCES AND INTERPOLATION: Finite difference operators- Interpolation-Newton-Gregory forward and backward Interpolation, Lagrange's Interpolation formula. Solution of linear second order difference equations constant coefficients. (12)

DIFFERENTIATION AND INTEGRATION: Numerical differentiation using Newton-Gregory forward and backward polynomials. Numerical integration-Gaussian quadrature, Trapezoidal rule and Simpson's one third rule. (10)

ORDINARY DIFFERENTIAL EQUATIONS: Taylor series method, Euler and Modified Euler method, (Heun's method), Runge-Kutta method, Milne's method, Adams-Moulton method, Solution of boundary value problems of second order by finite difference method. (11)

Total L : 45**REFERENCES:**

1. Stevan C Charpa and Raymond P Canale , "Numerical Methods for Engineers with Software and programming Applications", Tata McGraw Hill,2011.
2. Cuties F Gerald and Patrick O Whetby, "Applied Numerical Analysis", Pearson Education, 2011.
3. Yousef Saad, "Numerical methods for large Eigen value problems", University Press, 2011.

23MXBC APPLIED GRAPH THEORY**3 0 0 3**

INTRODUCTION: Review on Definition and Basic Terminologies of Graphs – Representations of Graphs – Walks in Graphs and Digraphs - Subgraphs-Vertex Degrees - Path and Cycles - Regular and Bipartite Graphs- Incidence Matrices - Graph Traversals- Applications: Markov Chains- Four Cubes Problem- Social Networks. (10)

EULERIAN AND HAMILTONIAN GRAPHS: Exploring and Travelling – Eulerian Graphs – Hamiltonian Graphs – Applications: Dominoes – Chinese Postman Problem. **PATHS AND CONNECTIVITY:** Connected Graphs and Digraphs-Menger's Theorem for Graphs-Applications: Reliable Telecommunication Networks. (11)

PLANARITY: Planar Graphs – Euler's Formula-Cycle Method for Planarity Testing – Kuratowski's Theorem – Duality. **COLORINGS AND DECOMPOSITIONS:** Vertex Colorings – Edge Colorings – Algorithm for Vertex and Edge Colorings – Vertex Decomposition – Edge Decomposition. (13)

MATCHING AND FACTORS: Matching, Perfect matching, Tutte's 1-factor theorem, weighted Bipartite matching, Hall's theorem. **NETWORK FLOWS AND APPLICATIONS:** Flows and cuts in Networks, Maximum-flow problem, flows and connectivity- applications. (11)

Total L : 45

REFERENCES

1. Douglas B West, "Introduction to Graph Theory", Pearson Education, New Delhi, 2015.
2. Joan M Aldous and Robin J Wilson, "Graphs and Applications- An Introductory Approach", Springer-Verlag, New York, 2007.
3. Reinhard Diestel, "Graph Theory", Springer-Verlag, Berlin Heidelberg, 2017.
4. Haynes T W, Hedetniemi and Slater P J, "Fundamentals of Domination in Graphs", CRC Press 2015.
5. Jonathan Gross and Jay Yellen, "Graph Theory and its Applications", CRC Press, 2005.

23MXCA ENTREPRENEURSHIP**3 0 0 3**

INTRODUCTION TO ENTREPRENEURSHIP: Definition – Characteristics and Functions of an Entrepreneur – Common myths about entrepreneurs – Importance or Entrepreneurship. **CREATIVITY AND INNOVATION:** The role of creativity – The innovation Process – Sources of New Ideas – Methods of Generating Ideas – Creative Problem Solving – Entrepreneurial Process. (11)

FORMS OF BUSINESS ORGANIZATION: Sole Proprietorship – Partnership – Limited liability partnership - Joint Stock Companies and Cooperatives. **DEVELOPING AN EFFECTIVE BUSINESS MODEL:** The Importance of a Business Model – Starting a small scale industry - Components of an Effective Business Model. (12)

APPRAISAL OF PROJECTS: Importance of Evaluating various options and future investments – Entrepreneurship incentives and subsidies – Appraisal techniques. **FINANCING THE NEW VENTURE:** Determining Financial Needs – Sources of Financing – Equity and Debt Funding – Case studies in Evaluating Financial Performance. (12)

THE MARKETING FUNCTION: Industry Analysis – Competitor Analysis – Marketing Research for the New Venture – Defining the Purpose or Objectives – Gathering Data from Secondary Sources – Gathering Information from Primary Sources – Analyzing and Interpreting the Results – The Marketing Process. **INTELLECTUAL PROPERTY PROTECTION AND ETHICS:** Patents – copyright – Trademark – Geographical indications – Ethical and social responsibility and challenges. (10)

Total L : 45**REFERENCES:**

1. Vasant Desai, "The Dynamics of Entrepreneurial Development and Management", Himalaya Publishing House, 2018.
2. Donald F.Kuratko, "Entrepreneurship: Theory, Process and Practice", Cengage Learning , 2017.
3. S.S. Khanka, "Entrepreneurial Development ", Sulthan Chand & Sons, 2012.
4. Prasanna Chandra, " Projects Planning, Analysis, Financing, Implementation and review", Tata McGraw Hill, 2012.

23MXCB PRINCIPLES OF MANAGEMENT AND BEHAVIOURAL SCIENCES**3 0 0 3**

PRINCIPLES OF MANAGEMENT: Definition and significance of management - functions of Management - society and environment, social responsibility of organizations. **BUSINESS ORGANISATION:** Forms of business Organizations and Resource Mobilization - internal and external sources of resources. (11)

GLOBALISATION: Evolving paradigm for the new Economic Era issues for global competitiveness, and proactive forces of globalization - Importance and functions of Marketing, Advertisement and sales promotion activities. **MATERIALS MANAGEMENT:** Importance and scope of materials management - Inventory control and its systems - ROL, EOQ, ABC Analysis, MRP, VED, FSN and value analysis. (12)

PROJECT MANAGEMENT: Definition and Objectives of Project Management - Phases in Project Management cycle - Project appraisal. **HUMAN RESOURCE MANAGEMENT:** Importance objectives and its functions, Motivation - Frustration - Conflict Management - Theories of Motivation - Stress Management. Leadership - Theories - Functions - Models. Human Resources development. (11)

GROUP BEHAVIOUR: Group dynamics, conformity, Sociometry and group cohesiveness leadership - Group Dynamics Informal Organization- sociometry- cohesiveness-Interaction analysis **WELFARE INDUSTRY:** Working Condition, service facilities and safety industries. (11)

Total L : 45**REFERENCES:**

1. Gupta,C.B., "Management Theory & Practice", Sulthan Chand & Sons, 2021.
2. Hahold Koontz and O'Donnel, "Essentials of Management", McGraw Hill, 2015.
3. Clifford F. Gray, Erik W. Larson, Gawtam V. Desai, "Project Management : The Managerial Process", McGraw Hill, 2014
Tripathi, P.C.& Reddy, P.N. "Principles of Management", Tata McGraw Hill, 2012

23MXCC ACCOUNTING AND FINANCIAL MANAGEMENT**3 0 0 3**

FINANCIAL ACCOUNTING AND RATIO ANALYSIS: Concepts and Conventions- Double Entry Book keeping -- Books of Accounts- Preparation of Journals, Ledger, Trial Balance, Profit and Loss Account and Balance sheet - simple problems - Methods of depreciation(theory only)- **RATIO ANALYSIS:** Uses and Nature - preparation of Liquidity Ratios – Activity ratios- Long term solvency ratios and Profitability Ratios. (11)

COST ACCOUNTING: Types of costs - Preparation of Cost sheet -simple problems - Concept of cost volume profit analysis - simple problems –cost control techniques (10)

FINANCIAL MANAGEMENT AND WORKING CAPITAL MANAGEMENT: Finance management - objectives- Finance function – Various sources of Finance – Dividend – Determinants of Dividend Policy. **WORKING CAPITAL:** Definition and importance of working capital - factors affecting working capital - Inventory management - basic problems - Receivables Management - working capital Estimation. (12)

CAPITAL BUDGETING AND INTERNATIONAL FINANCE: Kinds of capital Budgeting Decisions - Evaluation of proposals from the given cash inflows –Payback and discounted cash Flow Techniques – Problems - **INTERNATIONAL FINANCE:** International Business methods – Exchange Rate Mechanism – Interest Rate Parity (IRP) and Purchasing Power Parity (PPP) – Exchange Rate Risks - Exchange Rate Calculations -Simple Problems. Case Study: Tally software. (12)

Total L: 45**REFERENCES:**

1. M.N.Arora, "A Textbook of Cost and Management Accounting", Sulthan Chand & Sons, 2021
2. Prasanna Chandra, "Financial Management, Theory and Practice", Tata McGraw Hill, 2019.
3. Pandey I M, "Financial Management" Vikas Publishing, 2015.
4. Jain S P and Narang K L "Cost and Management Accounting", Kalyani Publication, 2014.

ONE CREDIT COURSES**23XK01 SOFTWARE CONFIGURATION MANAGEMENT AND CONTINUOUS DELIVERY****1 0 0 1**

Software Configuration Management (SCM):Components of Software Configuration Management Plan – Process of identifying, maintaining, controlling and baselining configuration items –case study from one of the live projects – tool set to assist SCM – Lab exercise on creating SCM plan for the project and set up the Development Environment. (2.5)

Version Control Systems (VCS):Importance ofcontrolling versions –life cycle / state of a configuration items – Role of coding standards and coding style – Product semantic versioning – Branching & Merging – case study from one of the live projects – Lab exercise using git – Role of Backups – Conducting configuration audit . (2.5)

Build and Unit Test Automation: Build life cycle – Build automation tools (Maven or Gradle or Webpack) –automate code review, unit test, code quality reports as part of build automation. (2)

Continuously Integrate (CI) and Integration Test Automation: Scope and advantages of Continuous Integration – Introducing complete toolset involved in CI – Case study from a live project – Lab exercise using Jenkins as CI, Selenium / Protractor as Integration Test Automation (2)

Continuous Deployment and Deployment Automation: Importance of Continuous Deployment – Setting up deployment environment in AWS instance – Automate application deployment using Docker and / or Ansible – Continuous monitoring or health check. (2)

PROJECT: Given a simple use case, define and implement the complete SoftwareConfiguration Management process along with Continuous Delivery leveraging the tools introduced in the class. (4)

Total L: 15**REFERENCES:**

1. Software Engineering Body of Knowledge, <https://www.computer.org/web/swebok/v3>
2. Test Driven Development, https://en.wikipedia.org/wiki/Test-driven_development
3. Continuous Integration (CI), <https://martinfowler.com/articles/continuousIntegration.html>
4. Continuous Delivery: <https://martinfowler.com/bliki/ContinuousDelivery.html>
5. Version Control System,
6. Build automation: <https://maven.apache.org/>
7. CI Automation: <https://jenkins.io/>
8. Continuous Delivery, <https://www.docker.com/>

23XK02 TRENDS IN DIGITAL TRANSFORMATION

1 0 0 1

Introduction to DevOps: Traditional Process – Agile Process – Pipeline - Different Stages in Pipeline - Types of Automations - Roles in Industry (2)

Introduction to Cloud Computing: Concepts in Cloud with AWS – Types of Services - Compute – Network – Storage – Database – Security (2)

Introduction to Microservices: Monolithic Development – Scaling – Design Principles – Twelve Factor App – Need for Polyglot (3)

CI/CD: Concepts in CI/CD – Tools Used (2)

Hands on Sessions (6)

Total L : 15**REFERENCES:**

1. Jez Humble, David Farley , "Continuous Delivery: Reliable Software Releases Through Build, Test, and Deployment Automation" Addison-Wesley, 2010.
2. Continuous Integration: <https://martinfowler.com/articles/continuousIntegration.html>
3. Cloud using AWS: <https://docs.aws.amazon.com/>
4. Twelve Factor App: <https://12factor.net/>
5. CI Automation: <https://jenkins.io/>

23XK03 DESIGN THINKING

1 0 0 1

Introduction- Advantages- Disadvantages (2)

Empathize: learning to do qualitative design research or Voice of the Customer research- conduct participant observations to help the design process -participatory design and co-creation in the design process- Methods: Interviewing Probes and Observations (2)

Define: idea generating exercises for new product and service opportunities- create effective value propositions - canvas – worksheets -distinguish the differences between features, attributes and benefit- conduct competitive market research and benchmarking (e.g. developing 2x2 matrices). (3)

Ideate: sketching, rendering, and storyboarding. (3)

Prototype: Proof of concept - prototype building - elicit feedback and answer specific questions about a concept (3)

Test:- getting specific feedback about how ideas can improve (2)

Total L: 15**REFERENCES**

1. Heath, Chip, and Dan Heath. Made to stick: Why some ideas survive and others die. Random House, 2007.
2. Madsbjerg, Christian, and Mikkel Rasmussen. The moment of clarity: using the human sciences to solve your toughest business problems. Harvard Business Review Press, 2014.
3. Norman, Donald A. Emotional design: Why we love (or hate) everyday things. Basic Civitas Books, 2004.
4. Hara, Kenya. Designing design. Lars Muller Publishers, 2007. Garrett, Jesse James. The Elements of User Experience: User-Centered Design for the Web and Beyond. New Riders, 2010.
5. Gallo, Carmine. Talk Like Ted: The 9 Public-Speaking Secrets of the World's Top Minds. St. Martin's Griffin, 2015

23XK04 SKILLS FOR VIRTUAL TEAMS

1 0 0 1

VIRTUAL TEAMS : Introduction to Geographically Distributed teams –Need –Difference between Virtual and physical teams - compositions- Advantages of virtual teams (2)

ISSUES AND RISKS : Communication Issues- Temporal Issues- Cultural Issues – Challenges - Project risks . (3)

TOOLS AND SOLUTIONS: Process changes, Tools - Planning , Tracking, Communication, Tool Issues (2)

SKILLS: Building Trust – Goal Orientation - Cross-Team Leadership - Communication – Interaction/Bonding – Teaming - Adherence to Process – Effective Tool Skills - Motivation (2)

CASE STUDIES: Different cases- Observation – Participation as team - Skill Building (6)

Total L: 15**REFERENCES:**

1. Michael Abrams et. al , "Big Book of Virtual Teambuilding Games: Quick, Effective Activities to Build Communication, Trust and Collaboration from Anywhere! ", Big Book Series,McGraw-Hill Education; First edition.
2. Hassan Osman, "Influencing Virtual Teams: 17 Tactics That Get Things Done with Your Remote Employees" , 2016, Kindle, ISBN-13: 978-1530005147
3. Deborah L. Duarte, Nancy Tennant Snyder," Mastering Virtual Teams: Strategies, Tools, and Techniques That Succeed", Wiley, Third Edition,
4. Online resource: Virtual teams : A new way to work - <http://dx.doi.org/10.1108/eb054625> .