IT Application Engineer (B-Level-IT)

(Model Curriculum)

1. List of Modules of IT Application Engineer B-Level

Module code	Title of the Components
Semester I	
B0.1 R5	Basic Mathematics
B1.1- R5	Management Fundamentals and Information Systems
B1.2 –R5	Discrete Structure
B1.3- R5	Software Engineering
B1.4- R5	Operating System
B1.5- R5	DATA COMMUNICATIONS AND COMPUTER NETWORKS
Semester II	
B2.1- R5	Computer Based Statistical and Numerical Methods
B2.2- R5	Professional & Business Communication
B2.3- R5	Advanced Database Technologies
B2.4- R5	Computer Graphics and Multimedia Systems
B2.5- R5	Cloud Computing and Internet of Things (IoT)
Semester III	
B3.1- R5	Software Project Management
B3.2- R5	Artificial Intelligence and Machine Learning
B3.3- R5	Web Technologies
B3.E1 R5	Digital Marketing
B3.E2 R5	-System Modeling & Computing Simulation

B3.E3 R5	Distributed and Parallel Computing	
B3.E4 R5	Data Warehousing and Data Mining	
B3.E5 R5	Software Testing and Quality Assurance	
B3.E6 R5	Digital Image Processing	
B3.E7 R5	Accounting and Financial Management	
B3.E8 R5	Wireless and Mobile Communication	
B3.E9 R5	Blockchain Technology	
Sub Total		
B-PJ_R5	Major Project	
	Employability Skill	

2. Detailed Syllabus with learning objectives

2.1. Module: B0.1-R5- Basic Mathematics

2.1.1. Introduction

The aim of this module is to make students aware about mathematics skills which are necessary for understanding essential topics in computer science. The module is developed as a bridge course for students of non-mathematical background. The module is framed in such a way that the students get exposure to basic topics in mathematics that would prepare the students to learn the advance level courses in the domain of computer science such as discrete structure, computer graphics, computer and communication networks, data analytics, simulation, operations research etc.

2.1.2. Objectives

After completing the module, the incumbent will be able to:

i. Understand concepts of basic mathematics used in Computer Science.

ii. Solve various basic mathematical problems.

2.1.3. Duration

120 Hours - (Theory: 48 hrs + Tutorial: 72 hrs)

2.1.4. Outline of Module

Module Unit	Duration (Theory) in Hours	Duration (Tutorial) in Hours	Learning Objectives
1. Sequences & Series	6	9	After completion of this unit of module, the Learner will be able to i. Understand concepts of Sequences & Series
2. Matrices and Determinant	6	9	After completion of this unit of module, the Learner will be able to i. Understand Matrices & Determinant and solve System of Equations

3. Analytical Geometry	6	9	After completion of this unit of module, the Learner will be able to i. Understand Concepts of Coordinates and solve various problems related to it.
4. Vectors	4	6	After completion of this unit of module, the Learner will be able to i. Understand Concepts of Vectors and solve various problems related to Vector.
5. Differential Calculus	10	15	After completion of this unit of module, the Learner will be able to i. Understand Concepts of Functions, Limits and Continuity ii. Understand Concepts of Differential Calculus and solve various problems based on it.
6. Integral Calculus	16	24	After completion of this unit of module, the Learner will be able to i. Understand Concepts of Integral Calculus and solve various problems based on it.
Total	48	72	

2.1.5. Marks Distribution

Module Unit	Written Marks (Max.)
1. Sequences & Series	12

2. Matrices and Determinant	13
3. Analytical Geometry	13
4. Vectors	08
5. Differential Calculus	27
6. Integral Calculus	27
Total	100

2.1.6. Detailed Syllabus

(i) Sequences & Series

Introduction to Sequences and Series, Arithmetic and Geometric Series, Harmonic Series, Infinite Series, Sandwich theorem. Ratio test, comparison test, integral test. Alternating series, Introduction to Power Series,Properties of Power Series,Convergence of Power Series, Taylor & McLaurin's series

(ii) Matrices & Determinants

Notion of matrices, Algebra of Matrices, Square Matrix, Determinants, properties of determinants, triangular, diagonal, identity matrices, transpose of a matrix, symmetric and skew - symmetric matrices, orthogonal matrices, rank of a matrix, inverse of a square matrix, Eigenvalues & eigenvectors of a matrix, characteristic roots and characteristic vectors of a matrix, Hermitian and skew Hermitian matrices, consistent and inconsistent system of linear equations, Cramer's rule, Gauss elimination method.

(iii) Analytical Geometry

Introduction to Coordinates, Coordinates of points, Polar coordinates, Straight Line, Pair of Straight Line, Circle, Introduction to Conic Section, Tangent and Normal to a Circle.

(iv) Vectors

Vectors, Introduction to Vector Analysis and Vector Calculus, dot & cross product of vectors, projections parametric equations of lines, planes in 3 -space.

(v) Differential Calculus

Fundamental Theorem of Calculus, Functions and their graph. Domain & ranges of functions. Real numbers, exponential & logarithmic functions. Limits & continuity of functions. Hospital's rule, Definition of the Derivative, Product and

Quotient Rules, Rates of Change, Successive Differentiation, The Chain Rule, Implicit Differentiation, Derivatives of General Exponential and Logarithmic Functions, Application of Derivatives, Mean Value theorem. Maxima & minima, asymptotes.

(vi) Integral Calculus

Introduction to Integration, Indefinite Integral, Integration by substitution, Integration by parts, Definite integral, Elementary Knowledge of Curve Tracing, Area between two curves.

2.1.7.   Recommended Books

Main Reading
1. H Anton, I. Bivens, S. Davis, "Calculus", John Wiley and Sons.
2. E. Kreysig, "Advanced Engineering Mathematics", 8th Edition. Wiley, 2002, McGraw Hill
3. G.B. Thomas, Jr. R.L. Finney, "Calculus and Analytic Geometry", Pearson Education Asia, Ninth Edition, 2002
4. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publisher

Supplementary Reading
   1. S.T.Tan, Applied "Calculus" , Kent Publishing Company.

2.2.1. Introduction

This module is concerned with the strategic importance of Management concepts and its processes in a business organization. This module provides a broad review of the field of Information system development, integration and managing security of such information systems in the modern business environment. It recognizes that many organizations employ information Technology (IT) Professionals, they have a key role to play in as the information provider that adds significant value to the ever-increasing volume of data processed for management decision making

2.2.2. Objectives

After completing the module, the incumbent will be able to:

i. Develop an understanding of general management and information system concepts and practices.

ii. Understand the technological environment of the contemporary organization and to apply a systematic approach to the use of information technology in organizations.

iii. Appraise the technological environment in order to support the practical aspects of information development, integration, usage and understand security holes and its security controls to prevent information from various frauds.

iv. Gain application ability of necessary controls and standards in computerized Information system.

2.2.3. Duration

120 Hours - (Theory: 48hrs + Practical: 72 hrs)

2.2.4. Outline of Module

Module Unit	Duration (Theory) in Hours	Duration (Practical) in Hours	Learning Objectives
1. Process of Management	8	12	After completion of this unit of module, the Learner will be able to understand the various processes involving in managing business. Further, learner will be able to learn how to plan, control and manage projects.

2. Information Systems Concepts	10	15	After completion of this unit of module, the Learner will be able to learn the commonly used information systems in any organization like financial, inventory etc.
3. Enterprise Systems	8	12	After completion of this unit of module, the Learner will be able to learn the enterprise level information system like ERP
4. System Development Process	12	18	After completion of this unit of module, the Learner will be able to learn the processes involved in developing the information systems at enterprise levels
5. Information Systems Security	6	9	After completion of this unit of module, the Learner will be able to learn the security risks in developing, deploying and implementing information systems. Further, the learner will be able to know the process to avoid or mitigate the risks.
6. Overview of Project Management	2	3	After completion of this unit of module, the Learner will be able to learn the basics of Project Management, its life cycle and different kind of management that are done during project execution.
7. Case Studies	2	3	After completion of this unit of the module, learner will be able to learn through case studies.
Total	48	72	

2.2.5. Marks Distribution

Module Unit	Written Marks (Max.)
1. Management Basics	20
2. Information Systems	25
3. Enterprise Systems	15
4. System Development Process	25
5. Information Systems security, overview of Project Management and Case Studies	15
Total	100

2.2.6. Detailed Syllabus

(i) **Management Basiscs**

Functions of Management Business Organization, Levels of Management, the classical organizational theory, the Behavioral Approach, the Management Science Approach**.**

Types of Management like strategic management, sale/Marketing Management, Operation Management, HR, Purchase etc.

Planning- Mission, Vision and goal setting; and SWOT Analysis;

Organizing -Types of Organizational Structures, Power, Authority, Delegation, Centralization and Decentralization, Formal and informal organizations, Functions and Design of an organization;

Leading - Motivation, Theories of Motivation;

Controlling: Control Process. Relevance of Computer applications in different functional areas of Management.

(ii) **Information Systems**

Definition of system, Types of systems: Physical and Abstract Systems, Deterministic and Probabilistic systems, Open and Closed systems. Need of an efficient information system. Major types of systems in organizations on the basis of organizational levels. Components of Information Systems: hardware, software, network, people & databases.

Examples and role of Information Systems in organization: Finance and Accounting Information systems, order processing, Inventory control Accounts receivable system Accounts Payable System, Payroll System, General ledger, Billing System, Purchase system. Marketing and Sales, Manufacturing and Productions, and Human Resources Information Systems. OAS, TPS, MIS, DSS, GDSS EIS, and ES.

(iii) **Enterprise Information Systems**

Evolution of Enterprise Information Systems, Redesigning the organization with information systems, Enterprise Resource Planning and management,

Enterprise System Architecture, Integration of business functions. ERP: Meaning and Characteristics, Benefits, Limitations, Risks in ERP implementations. ERP Market,

Supply Chain Management, Customer Relationship Management, Business Analytics based Enterprise Information Systems, Emerging technologies

(iv) **Systems Development Processes**

Introduction to SDLC/Basics of SDLC; Requirements analysis and systems design techniques; Strategic considerations:-Acquisition decisions and approaches; Software evaluation and selection/ development; Hardware evaluation and selection; Systems operations and organization of systems resources; Systems documentation and operation manuals; User procedures, training and end user computing; System testing,

Assessment, conversion and start-up; Hardware contracts and software licenses System implementation; Post-implementation review; System maintenance.

Alternate development methodologies- RAD, Prototype, agile, scaled Agile, Scaled Agiled Framework (SAF), SAF Implementation Roadmap, DevOp

(v) **Information System Security**

System Vulnerability, Computer frauds, computer abuse , preventing computer frauds , Ensuring System Quality , Information Security – Need, Contents of information security plan , Principles of information security ,Best approach to implement information security, tools for information security: Authentication, access control, encryption, password, backups, firewalls, Security policy

(vi) **Project Management**

Overview of Project Management, Project Life Cycle, Scope, management, time management, quality Management, risk management, Integration Management.

(vii) **Case Studies**

Case Studies: Case study of Insurance sector in CRM, Educational Institute in ERP, Retail industry in Supply Chain Management.

2.2.7. Recommended Books

1) Management Information System by James O'Brien and other, 2017
2) Management Information System by Kenneth C Laudon, Jane Laudon, 2019, Pearson

3) Principles and Practices of Management, L. M. Prashad, 2021
4) Fundamental of Management, Stephen Robbins, Mary Coulter, David Ce Cenzo
5) Management Principles and Practices, CB Gupta, 2016
6) Software Engineering, A Practitioner's Approach, 2017
7) Fundamentals of Software Engineering, Rajib Mall, 5th Edition

2.3.1. Introduction

Discrete Structure is the backbone of Computer Science and IT. Concepts and notations from discrete mathematics are useful in studying and describing objects and problems in all branches of computer science, such as computer algorithms, programming languages, cryptography, decision theory, Designing Data Analytics and Machine Learning Algorithms, automated theorem proving, and software development. It also plays a significant role in Big Data Analytics. Discrete Structure produces a significant collection of powerful methods, including mathematical tools for understanding and managing very high-dimensional data, inference systems for drawing sound conclusions from large and noisy data sets, and algorithms for scaling computations up to very large sizes. Discrete Structure may be termed as mathematical language of data science, and as such, its importance has increased dramatically in recent decades.

In this module candidate will learn various concepts of discrete structure used in various domain and its implementation using Python.

2.3.2. Objectives

After completing the module, the incumbent will be able to:

i. Understand various concepts of discrete structure used in different domains of Computer Science.

ii. Find best algorithms among the available for a problem.

iii. Implement different algorithms used in Graphs and Tress in a given scenario.

iv. Understand and solve recurrence relations.

v. Solve a problem using Dynamic problems.

2.3.3. Duration

120 Hours - (Theory: 48hrs + Practical: 72hrs)

2.3.4. Outline of Module

Module Unit	Duration (Theory) in Hours	Duration (Practical) in Hours	Learning Objectives
1. Sets & Functions	04	06	After completion of this unit of module, the Learner will be able to i. Understand concepts of Sets.

			ii. Implement Sets on given data.
2. Formal Logic	04	06	After completion of this unit of module, the Learner will be able to i. Understand and implement the concept of mathematical logic.
3. Analysis of Algorithms	08	12	After completion of this unit of module, the Learner will be able to i. Understand the mathematical foundation in analysis of algorithms. ii. Analyze the efficiency of algorithms using time and space complexity theory.
4. Storage and Feature Extraction of Graphs and fTrees	12	18	After completion of this unit of module, the Learner will be able to i. Understand the concept of storage and feature extraction of Graphs and Trees. ii. Implement various related algorithms.
5. Counting and Combinatorics	12	18	After completion of this unit of module, the Learner will be able to

			i. Understand fundamentals of combinatory. ii. Formulate and solve recurrence relations.
6. Dynamic Programming	08	12	After completion of this unit of module, the Learner will be able to i. Examine the different dynamic programs. ii. Apply the dynamic programs to solve any scenarios.
Total	48	72	

2.3.5. Marks Distribution

Module Unit	Written Marks (Max.)
1. Sets & Functions	08
2. Formal Logic	08
3. Analysis of Algorithms	17
4. Storage and Feature Extraction of Graphs and Trees	25
5. Counting and Combinatorics	25
6. Dynamic Programming	17
Total	100

2.3.6. Detailed Syllabus

(i) Sets & Functions

Sets, Subsets, Relations and their properties. Representing relations, Equivalencerelation, partial orderings, maximal & minimal elements of a poset ,functions , inversefunctions. Composition of functions and recursive functions

(ii)Formal Logic

Logic operators, proposition equivalence involving tautologies contradiction , predicate &quantifiers, computer representations of sets.

(iii)   Analysis of Algorithims

Algorithms and programs, efficiency of algorithms,Understanding Big 'O' notation, comparison ofalgorithm, sorting algorithm, Searching Algorithms,Complexity of Sorting and Searching Algorithms,UnderstandingPython Library for analysis of algorithims and its implementation.

(iv)   Storage and Feature Extraction of Graphs and Trees

Introduction to Graph Theory, Understanding Paths and Cycles, understanding graphs, trees, Multi graph and weighted graphs, paths & circuits, Euclidian paths and circuits, the traveling salesman problem, planer graphs, trees, spanning trees, cut sets, minimum spanning tree using graphs, trees, and networks, Storage of graphs and networks, Feature extraction of graphs, Searching Graph and Tree data structures, Depth-first search (DFS),the shortest path problem and variations of the problem, Finding Shortest Paths with Brute Force, Dijkstra's Algorithm for Finding Shortest Paths and its implementation.

(v)Counting and Combinatory

The fundamental counting rule, Basics of counting, the Pigeonhole principle, permutation and combination, Discrete Probability generating functions, recurrence relation, Divide and conquer relation, Inclusion and exclusion with applications.

(vi)   Dynamic Programming

Basic Concepts of Dynamic Programming, How Dynamic Programming Works, Recursion vs. Dynamic Programming, Greedy Algorithms vs. Dynamic Programming,
Sub problems and overlapping sub problems, optimal sub structure, Backtracking, Memorization, understanding state in dynamic programming, constructing a DP solution using Python, Understanding Iterative vs. recursive approach, Applications of Dynamic Programming Approach: Matrix Chain Multiplication, Longest Common Subsequence, Travelling Salesman Problem and its implementation.

2.3.7.   Recommended Books

Main Reading

1. Kenneth N. Rosen, "Discrete Mathematics and its applications", Tata McGraw Hill, 08[th]Edition

2. C.L. Liu, "Elements of Discrete mathematics" Tata McGraw Hill., 4th Edition

3. Norman L. Biggs "Discrete Mathematics Oxford University Press", 2nd Edition

4. Trembling, J.P. & Manohar P, "Discrete mathematical structure with applications,

Tata McGraw Hill., 3rd Edition

5. Vinay Kumar, Discrete Mathematics, BPB, India, 5th Edition

6. Dynamic Programming: A Computational Tool Author: Authors: Holger Mauch, Art Lew, 1st Edition

7. Python Programming: Using Problem Solving Approach Paperback by Reema Thareja (Author), 1st Edition

Supplementary Readings

1. Practical Discrete Mathematics By Ryan T. White, Archana Tikayat Ray, 1st Edition

2. John Truss, "Discrete mathematics for computer scientists, Addison – Wesley", 2nd Edition

3. M. Lipson and Lipchitz, "Discrete Mathematics, Schaum's Outline series.", 3rd Edition

2.4. Module: B3.3-R5- Software Engineering

2.4.1. Introduction

In this course, students will study the various topics relevant to development of modern quality software system. The course will deal with the methodologies involved in the development and maintenance of software over its entire life cycle and make aware of different life cycle models, requirement dictation process, implementation and testing strategies and planning and management of software. This course is also aims to impart knowledge on different architectural patterns & some case studies that use design practices.

2.4.2. Objectives

After completing the module, the incumbent will be able to:

➢ To provide knowledge on life cycle models of a software

➢ To measures the software complexities

➢ To analyze, design software.

➢ To develop models as per the user requirements using available UML diagrams

➢ To test the software using testing strategies

➢ To impart knowledge on different architectural patterns

2.4.3. Duration

120 Hours - (Theory: 48 hrs + Practical/ Tutorial: 72 hrs)

2.4.4. Outline of Module

Module Unit	Duration (Theory) in Hours	Duration (Practical/ Tutorial) in Hours	Learning Objectives
1. Software Engineering Fundamentals	2	3	After completion of this unit of module, the Learner will be able to understand the concept of the Software Engineering fundamentals
2. Software Requirements Analysis & Specification	4	6	Familiarize with the i. Software requirements specification standards, methods, and tools

			ii. Analysis Modelling using models -Data, Dataflow, Control Flow etc.
3. CASE diagrams and Tools	4	6	Practice on preparing i. User story on given scenarios ii. Use Cases using UML diagrams of [Structural diagrams & Behavioural diagrams
4. Software Design	8	12	Familiarize with i. Design Concepts and Principles, Design Process, Design Methods ii. Design thinking, functional design, prototype design iii. Theories on UI/UX, Dashboard iv. Design of documents- Business Requirements Document, Statement of work, High Level Design Document, Technical Detailed Design Specifications, Requirements Traceability Matrix
5. Development of Use cases and UML diagrams	8	12	Familiarize with i. Design Concepts and Principles, Design Process, Design Methods ii. Design documents- Business Requirements Document, Statement of work, High Level Design Document, Technical Detailed Design Specifications, Requirements Traceability Matrix

6. Coding and Software Testing	6	9	Familiarize the i. Coding standards ii. Testing driven design, Domain testing iii. Practice to Software Testing activities iv. Dynamic and pyramid testing v. Test result analysis
7. Software Quality and Metrics	4	6	Familiarize the Software Quality Assurance, ISO9000 and 9001, CMM Levels and SIX sigma etc.
8. Software Maintenance and Configuration management	2	3	i. Can do hands-on Software Maintenance Process & Models, ii. Familiarize on the Configuration Management, Process
9. Object-Oriented Software Engineering	4	6	Familiarize with the OO Concepts and Approach, OO Analysis
10. Advanced Software Engineering Topics	6	9	Understand the concept of i. Advanced Software Engineering Topics Clean room approach and strategy, Component-based software engineering process, Reusability and Reengineering process. Agile and Scrum practices ii. Introduction to Software architecture: Architectural Styles, Pipes, and filters, MVC etc.
Total	48	72	

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2.4.5. Marks Distribution

Module Unit	Written Marks (Max.)
1. Software Engineering Fundamentals	05
2. Software Requirements Analysis & Specification	15
3. CASE diagrams and Tools	06
4. Software Design	20
5. Development of Use cases and UML diagrams	15
6. Coding and Software Testing	15
7. Software Quality and Metrics	06
8. Software Maintenance and Configuration management	05
9. Object-Oriented Software Engineering	05
10. Advanced Software Engineering Topics	08
Total	100

2.4.6. Detailed Syllabus

(i) **Software Engineering Fundamentals**

Definition of software product and process, Software Characteristics, Components, Applications, Layered Technologies, Processes and Product, Methods and Tools, Generic View of Software Engineering, Software Crisis, Software development paradigms, Techniques of Process Modelling, Software lifecycle. Models -Waterfall, Prototyping, Iterative, Evolutionary Development, Incremental, Spiral, Agile etc

(ii) **Software Requirements Analysis & Specification**

System specification, Software requirements specification (SRS) standards, methods, Specification tools, Requirement' svalidation, and management. Problem Recognition, Evaluation and Synthesis, Modelling, Specifications and Review Techniques. Software Prototyping. Analysis Modelling: Data Modelling, Functional Modelling, Dataflow Model, Control Flow Model, Control and Process Specification, Data Dictionary.

(iii) **CASE diagrams and Tools**

Computer-aided software engineering, Introduction to CASE, Building Blocks of CASE, Relevance of CASE tools, High-end and low-end CASE tools, DFD, ER diagrams, Integrated Case Environment and CASE workbenches.

(iv) **Software Design**

Design Concepts and Principles, Design Process, Design Methods- Architectural Design, Modular, Process-oriented, Data-oriented, User-interface, Real-time software, Architectural, Interface, Procedural, Object Oriented. Design Process: - Abstraction, Architecture, patterns, Modularity, Information Hiding, Functional Independence, Refinement etc. Design Model: Data, Architectural. Design

thinking, functional design, and proto type design. Theories on UI/UX, Dashboard, Internal and External Design, Evaluation, Interaction, and Information Display. Design of Knowledge based systems. Design of documents-Business Requirements Document, Statement of work, High Level Design Document, Technical Detailed Design Specifications, Requirements Traceability Matrix

(v) **Development of Use cases and UML diagrams**
User story and Use Cases, Noun / Verb approach, UML diagrams –[a] Structural diagrams -Class, object, Component, Package, Composite Structure, Deployment, Profile. [b] Behavioural diagrams -Use Case, Activity, Sequence, State Machine, Communication, Interaction Overview, Timing

(vi) **Coding and Software Testing**
Choice of Programming languages, coding standards. Software Testing: Software Testing Fundamentals, White Box Testing, Basis Path Testing, Unit testing, Control Structure Testing, Black Box Testing, Integration & System Testing etc. Testing driven design, Domain testing. Examples of Dynamic and pyramid testing. Test planning, Test case design, Test Criteria, Test Design, Test Strategy, Test Stub, Test Suite, Execution of test cases, Test result analysis. Testing tools and workbenches.

(vii) **Software Quality and Metrics**
SQA-Software Quality Assurance, Debugging and reliability analysis, Program complexity analysis, Software quality and metrics, Software Measures, Quality Control, Approaches to SQA, Reliability, ISO9000 and 9001, CMM Levels and SIX sigma.

(viii) **Software Maintenance and Configuration management**
Software Maintenance Process & Models, Reverse Engineering, Software re-engineering, Configuration Management issues and concept, Configuration planning & techniques, Software versions and change control process, Documentation, Concepts
in Configuration Management, Process: Planning and Setting up Configuration Management, Perform Configuration Control, Status Monitoring and Audits.

(ix) **Object-Oriented Software Engineering**
OO Concepts and Approach, OO Analysis, Domain Analysis, OOA Process and Object Models, OO Design, System Design process and Models, UML, and diagrams

(x) **Advanced Software Engineering Topics**
Clean room approach and strategy, Component-based software engineering process, Reusability and Reengineering process. Agile and Scrum practices.
Introduction to Software architecture: Architectural Styles, Pipes and filters, Black board, Distributed system, Adaptive system; Patterns and View handler. Introduction to Event Handling Patterns, Reactor, Proctor, Acceptor, Connector, Synchronization Patterns, MVC etc.

2.4.7. Recommended Books

Main Reading

1. Ian Sommerville, Software Engineering, Addison-Wesley, 2009 [9th Edn]
2. Roger S. Pressman, Software Engineering - A Practitioners Approach, McGraw Hill, 2010 [7th Edn]
3. W.S. Jawadekar, Software Engineering – A Primer, TMH-2008
4. Bob Hughes and Mike Cotterell, *Software Project Management* (5th Edition), McGraw-Hill,

Supplementary Reading

5. IEEE PMBOK
6. RINCE2 materials
7. Shari Ptleeger, "Software Engineering", 2001, Pearson Education.
8. Stephen Schach, Software Engineering, TMH, 2007
9. Sommerville I., Software Engineering, Addision-Wesley

2.5. Module: B1.4-R5- Operating System

2.5.1. Introduction

Operating Systems are an essential part of any computer system. The field is undergoing rapid change, as OS is integral to laptops, embedded devices and mobiles. An operating system is the program that manages all of the other application programs in a computer. The applications interact with the hardware without knowing any details about the hardware. An operating system handles the launch and management of every application.

The fundamental roles of an operating system are the same but many operating systems serve a wide range of hardware and user needs. Common desktop operating systems are Microsoft Windows; Mac OS for Apple, Open source OS like UNIX and Linux.

Mobile operating systems are designed to accommodate the unique needs of mobile computing and communication-centric devices, such as smart phones and tablets. Apple iOS and Google Android are examples of mobile operating systems. Embedded operating system is present in dedicated devices like home digital assistants, ATMs, POS terminals and IoT devices.

2.5.2. Objectives

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

- ➢ Understand the significance and working of Operating Systems
- ➢ Dive into the operating systems concepts such as processes, inter-process communication, storage systems, virtual memory, file systems and security.
- ➢ Learn into depth the concepts, structure and mechanism of modern day operating systems.
- ➢ Relate to contemporary design issues in the development of operating systems.
- ➢ Learn the OS principles through Linux/ Ubuntu / Windows like operating systems.
- ➢ Learn the concept of Virtualization and work on Virtual Machines.
- ➢ Write and simulate various OS algorithms for scheduling and Management.
- ➢ Learn about the Timesharing, Distributed, Embedded and Real Time OS.
- ➢ Practice the commands and programming on OS.

2.5.3. Duration

120 Hours - (Theory: 48hrs + Practical: 72 hrs)

2.5.4. **Outline of Module**

Module Unit	Duration(Theory) in Hours	Duration (Practical) in Hours	Learning Objectives
1. Operating System Structures	2	3	i. Learn the OS structures
2. File System	4	6	i. Learn about the File System techniques in OS
3. Process Management	6	9	i. Learn about the concept of process. ii. Simulate communication between the processes.
4. Process Synchronization	6	9	i. Learn the synchronization concept among processes. ii. Simulate tools for synchronization iii. Understand Deadlock Handling and learn the algorithms
5. Memory Management	6	9	i. Learn how OS manages memory ii. Learn how OS may improve the utilisation of the RAM iii. Understand Memory Management Schemes
6. Storage Management	6	9	i. Learn how mass storage and I/o are handled in OS ii. Understand I/O System Design and Interfaces iii. Work on Performance issues with I/O devices
7. Protection and Security	4	6	i. Learn about authorisation to operate in memory, CPU and files.

			ii. Controls an enforcement for security from unauthorised access, malicious destruction or alteration, and inconsistency
8. Virtualization	4	6	i. Learn about creating Virtual Machines ii. Learn types of VM's and their implementation iii. Create Virtual Machines
9. Distributed, Networks and Embedded OS	4	6	i. Know about Distributed , Network and Embedded OS ii. Learn their Network and Communication structure iii. Learn the Distributed File System and Remote File Access. iv. Know various Real Time OS
10. Case Study: Linux and Microsoft Windows	6	9	i. Learn the difference between Windows, and Linux Architecture ii. Learn Process Management and Scheduling iii. Learn about Memory and File Management iv. Learn the various commands of Linux and windows.
Total	48	72	

2.5.5. Marks Distribution

Module Unit	Written Marks (Max.)
1) Operating System Structures	8
2) File System	10

3) Process Management	10
4) Process Synchronization	10
5) Memory Management	10
6) Storage Management	10
7) Protection and Security	10
8) Virtualization	8
9) Distributed, Networks Systems and Embedded OS	8
10) Case Study: Linux and Microsoft Windows	16
Total	100

2.5.6. Detailed Syllabus

i) **Operating System Structures**

Introduction to Operating System, Computer System Organization and Architecture, OS Components, Layered Structure of OS, System Services, System Calls, Booting and OS, Resource allocation and management, Security and Protection, Distributed Systems, Network System, Kernel Concept and Kernel Architecture, Different Operating System, Proprietary and Open Source OS.

ii) **File System**

Files and Access Methods, Directory Structure, Protection, Partitions, Simple Volumes, Shadow Volumes, Virtual Disks, Memory-Mapped Files.
File-System Structure, Directory, Protection, File System Structure and Operations, Allocation Methods, Free Space Management, Efficiency and Performance, Recovery, UNIX File System. File System Mounting, Partitions, File Sharing, Virtual file Systems, Remote File Systems, Network File Systems

iii) **Process Management**

Processes: Process Concept, its states and characteristics, Process Scheduling, Operation on Processes, Cooperating Processes, Interposes Communication, IPC in message-passing and shared system, Symmetric vs. asymmetric multiprocessing, Background Processes

CPU Scheduling: Scheduling Criteria, Scheduling Algorithms, Context Switching, Multiple Processor Scheduling, Real Time Scheduling, Algorithm Evaluation, Threading, Multithreading models, Thread Scheduling, Threading issues.

iv) Process Synchronisation

The Critical Section Problem, Peterson's solution, Synchronization Hardware, Mutex Locks, Semaphores, , Critical Regions, Monitors, Likeness, Classical Problems of Synchronization, Bounded-Buffer, Dining Philosophers Problem, The Readers Writers Problem

Deadlocks: Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Deletion, Recovery from Deadlock, Deadlock in Multithreaded environment, lock free programming.

v) Memory Management

Logical versus Physical Address Space, Contiguous Allocation, paging, Swapping, Page Table, Segmentation, Segmentation with paging.
Virtual Memory: Demand Paging, Performance of Demand Paging, Copy-on-Write, Page Replacement Algorithms, Allocation of Frames, Thrashing, Demand Segmentation, Memory Compression, Allocating Kernel Memory.

vi) Storage Management

Mass Storage Structure, Disk Management, Swap Space Management, RAID Structure, Disk Structure, HDD Scheduling, NVM Scheduling, Error Detection, Error Correction, Swap Space Management, RAID.

vii) Security and Protection
Program Threats, System Threats, Network Threats, Threat Monitoring, and Crypto graphy for Encryption, VPN, Protocol security, Access Checks (ACL, DACLs), Auditing, Policy Management, and User Account Controls (UAC).

Goals of Protection, Domain of Protection, Protection Rings, Access Matrix, Implementation of Access Matrix, Revocation of Access Rights, Role Based Access Control, Mandatory Access Control (MAC), Security-Enhanced Linux (SE Linux).

viii) Virtualisation
Introduction, Benefits, Characteristics, Types of Virtual Machines, Implementing VM's, Virtualization and OS Components, VMware, Virtualization Security, Types of Hypervisors, Cloud Computing Concepts, Introduction to Docker Containers.

ix) Distributed, Networks and Embedded Systems

Network and Distributed OS: Design issues in Distributed OS, Network Structure, Distributed File System, Naming and Transparency, Remote File Access, Stateful versus Stateless Service, File Replication.

Distributed Coordination: Event Ordering, Mutual Exclusion, Atomicity, Concurrency Control, Deadlock Handling, Election Algorithms, Reaching Agreement

Embedded OS: Types of Embedded OS, Characteristics, Advantages and Disadvantages, Tasks in Real time Systems, Goals of RTOS, Hard, Soft and Firm RTOS, Working with RTOS, examples of RTOS, ARM based Embedded Systems, OS in Hand held devices, Android, Vx Works, Windows for IoT.

x) **Case Study: Linux System and Microsoft Windows**

Linux Case Study: Linux history, its architecture, System Calls with examples, Process Management and its commands, Scheduling algorithms used in Linux, Memory Management in Linux, File System components, File and directory manipulation commands, Security through ACL and its commands, Password and Shadow files, their structure and various commands, Device management in Linux and its commands, System administrator roles and commands, other Linux commands.

Windows Case Study: Evolution, Design Principles, System Components, File System, Virtual and Physical memory in Windows, Networking, Terminal and Remote Desktop Server, Process Control, File Management and Device Management in Windows, Multitasking OS, Plug and Play, Multiple accounts, Cortana Assistant, Windows Security, Windows Control Panel.

2.5.7. Recommended Books

1. Silberschatz, Galvin, Gagne "Operating System Concepts", Willey
2. Andrew S. Tanenbaum, Albert S. Woodhull, "Operating Systems: Design & Implementation", 2002, Pearson Education Asia.
4. Real Time Embedded Components and Systems with Linux and RTOS by Sam Siewert and John Pratt
5. D.M. Dhamdhere, "Operating Systems: A Concept Based Approach", Tata McGraw Hill Publishing Company.
6. A.S. God bole, "Operating Systems", Tata McGraw Hill
7. Richard L.Petersen, "LINUX: The Complete Reference "fifth edition, Tata McGraw Hill
   Note:
1. For All units, explanation must carry case study of either UNIX family or Windows family or both and the last topic can be covered with features of the case study studied throughout.

2. The algorithms may be implemented using Python or Java.

2.6.   B1.5-R5: DATA COMMUNICATIONS

AND COMPUTER NETWORKS

2.6.1.   Introduction

This course will allow students to develop background knowledge as well as core expertise in data communication and networking technologies, which is one of the fastest growing industries in today's world. It forms an integral part of the modern Information and Communications Technology (ICT) in any organizations. Starting from intranet/extranet in small offices to the World Wide Web, principles of Data Communications and Computer Networks play an important role in designing any modern telecom infrastructure. Networking technology have evolved significantly over the years as demands on Ethernet and Wi FI have tremendous increased. Apart from supporting a range of devices Local area networks require to manage traffic getting generated from many other sources such as live streaming video, Voice over IP (VoIP), virtualization, Cloud and IoT devices and services have generated demand for additional bandwidth. The world of networking is thriving with technology trends such as cloud, telecommuting, IoT, IPv6.Software Define Network etc.

The students will be exposed to communication principles, different types of media, modulation techniques, multiplexing, switched networks, the Internet, ISO OSI Reference Model, TCP/IP suite, streaming protocols in multimedia ,Protocols used in IoT, Software Defined Networks(SDN), Network Function Virtualization (NFV), Intent-based networking (IBN),High-Speed Networks, QoS in Data Networks.

2.6.2.   Objective

At the end of the course the students would understand:

- ➢ Evolution of data communication, networking paradigms and its components.
- ➢ Principles of data communication, channel characteristics, signaling, modulation and encoding, and multiplexing
- ➢ Various transmission media, their comparative study, fibre optics and wireless media
- ➢ Identify the different types of network topologies and protocols.
- ➢ Layered architecture (OSI and TCP/IP) , protocol suites and functions of the layers
- ➢ Channel error detection and correction, MAC protocols, Ethernet and Wireless LAN.
- ➢ Details of IPv4 and IPv6 and associated routing principles
- ➢ Operations of ARP, ICMP, TCP/UDP, FTP, HTTP, SMTP, SNMP,DNS ,DHCP etc.

- ➢ Multimedia traffic and protocols in data communication.
- ➢ Network Programming using Python.
- ➢ The principles behind the Modern Network approaches such as SDN ,NFV and IBN
- ➢ The differences between traditional networks and software defined networks
- ➢ Various High-Speed Networks
- ➢ QoS in Data Networks

2.6.3. Duration

120 Hours - (Theory: 48 hrs + Practical: 72 hrs)

2.6.4. Outline of Module

S. No	Module Unit	Duration (Theory) in Hours	Duration (Practical /Tutorials) in Hour	Learning Objectives
1.	Introduction to Data Communications	2	3	After completion of this unit the candidate will be able to i. Various modes of Data communication ii. Components of data communications iii. Transmission modes
2.	Introduction to Computer Networks	6	10	After completion of this unit the candidate will be able to i. Understand the concept of networking, various terminologies used in Networking ii. Understand various types of Networks, Network topologies iii. Network layers concepts and its merits and de-merits iv. Basics of OSI model and TCP-IP protocol suite

3.,	Physical Layer	3	4	After completion of this unit the candidate will be able to Understand how data travels physically and understand concepts of signals, modulation, multiplexing etc.
4.	Data Link Layer	3	6	After completion of this unit the candidate will be able to i. Understand function of Data link layer, data framing, Addressing, error detecting codes ii. DLL-sublayers, Physical layer protocols iii. IEEE standards for wired and Wireless LAN
5.	Network Layer	6	10	After completion of this unit the candidate will be able to Understand IP addressing (IPV4,IPV6) i. Understand Network layer protocols ii. Understand Routing Protocols
6.	Transport Layer	5	6	After completion of this unit the candidate will be able to i. Understand function of transport layer and port addressing ii. Understand Transport layer protocols. iii. Understand basics of congestion in network and various congestion control techniques
7.	Application Layer	3	6	After completion of this unit the candidate will be able to Understand function of application layer and various protocols of this layer.
8.	Multimedia in Data	3	4	After completion of this unit the candidate will be able to Understand Multimedia in

	Communication			data communication and streaming protocols.
9.	Communication Protocols in IoT	3	3	After completion of this unit the candidate will be able to : i. Explore data protocols for IoT ii. Explore Network Protocols for IoT.
10.	Network Programming using Python	5	10	After completion of this unit the candidate will be able to : i. Work with TCP/UDP Sockets ii. Write Simple TCP/UDP Client and Server Program using Python iii. Handle Received Client Data over TCP Socket using Python. iv. Perform Operation on Data in Client-Server Program.
11.	High Speed Networks	3	2	After completion of this unit the candidate will be able to Understand Packet Switching, Gigabit Ethernet, MPLS over IP , IP over SONET or SDH, IP over WDM , IP over DWDM, IP over fiber,GPON
12.	QoS in Data Networks	3	4	After completion of this unit the candidate will be able to : i. Understand Integrated and Differential Services: ii. Understand protocols for QOS Support:
13.	Introduction to Software Defined Networking	3	4	After completion of this unit the candidate will be able to: i. Understand SDN (Software Defined Networking). ii. Understand Software-Defined Wide Area Networking (SD-WAN)

				iii. Understand Network Function Virtualization (NFV).
	Total	**48**	**72**	

2.6.5. Marks Distribution

Unit	Module Name	Written Marks (Max.)
1.	Introduction to Data Communications	03
2.	Introduction to Computer Networks	10
3.	Physical Layer	05
4.	Data Link Layer	06
5.	Network Layer	15
6.	Transport Layer	15
7.	Application Layer	08
8.	Multimedia in Data Communication	07
9.	Communication Protocols in IoT	05
10.	Network Programming using Python	12
11.	High Speed Networks	04
12.	QoS in Data Networks	05
13.	Introduction to Software Defined Networking	05
Total		**100**

2.6.6. Detailed Syllabus

i. Introduction to Data Communications

Introduction, Data Communication Systems, Signal and data, Synchronous and asynchronous transmission mode, Simplex, Half Duplex, Full Duplex communication, Concept of Channel, Circuits, and multichanneling, Signaling, Switching techniques: Datagram, Virtual circuit and Permanent Virtual Circuit, Connectionless and connection-oriented communication.

ii. Introduction to Computer Networks

What is Networking, Benefits, Components , Client/Server vs Peer to Peer Model, Classification of networks; Local Area Networks(LANs), Metropolitan

Area Networks (MANs), Wide Area Networks(WANs), Network topologies , Linear Bus, Ring, Star, Mesh Hierarchical or Tree Topology, Internetwork, Network Segmentation, Collision and Broadcast Domains, Repeaters, Switch, Hub, Bridge, Router, L3 Switch, optical submarine telecommunication link SEA-ME-WE3.

Classification Of Transmission Media, Coaxial Cable, Twisted-pair cables, STP and UTP cables, Categories of Twisted cable, Cabling types, UTP Categories, Exploring UTP, Categories of Ethernet Cable, Fiber Optics Cable, OFC Connectors, Types of Fiber Optics Cable, Single vs Multi-Mode Fiber, Ethernet Cabling, Straight-Through Cable, Crossover Cable, Rolled over Cable, Causes of Transmission Impairment, Unguided Media (Radio, VHF, microwave, satellite, Infrared).

Protocol hierarchy, Design issues for the layers, Merits and De-merits of Layered Architecture, Service Primitives: Reference models; The OSI Reference Model, Layers and functions of the OSI Reference Model, OSI PDU Term, Devices at OSI layer,

TCP/IP Protocol Suite, The roots of the internet, Some important TCP/IP milestones Comparison of the OSI Reference Model & the TCP/IP Protocol Models:

TCP/IP Troubleshooting utilities, hostname, ipconfig/ ifconfig , arp, ICMP Protocol, ICMP Protocol -Type, Ping, TTL, Default TTL Values, Changing the TTL On Popular Operating Systems, Ping Command Error Messages ,tracert/traceroute, Pathping, route, netstat, the Possible Session States in netstat output, getmac, nslookup, DNS Resource Records. Maximum transmission unit Checking with MTU, Changing the MTU size in Operating System, Path MTU Discovery (PMTUD), Maximum Segment Size (MSS)

Role of ITU, IETF, ISOC, IAB, IRTF, W3C, IEEE, Request For Comments (RFC), Regional Internet Registry (RIR), Internet Exchange Point, IANA , Number Resources , Root Zone Database, Root Servers(A-M).

iii. **Physical Layer**

Introduction: Functions of Physical Layer, Digital Signals: Bit rate, Bit length, Transmission of digital Signals, Analog Signals: Amplitude, Phase, Frequency, Wavelength, Transmission Impairments, Data Rate limits: Noiseless Channel: Nyquist Bit Rate, Noisy Channel: Shannon capacity, Performance: Bandwidth, Throughput, Latency (Delay) ,Bandwidth-Delay Product, Jitter. Serial and Parallel transmission, Switching; Circuit switching, Message switching, Packet switching, Virtual Switching, Multiplexing; FDM , WDM , TDM: Synchronous and Statistical, Spread Spectrum techniques, CDMA, DSSS, FHSS;, PSTN, Modems, Concept of Modulation, Baseband versus Broadband; Pulse Code Modulation (PCM), Shift Keying [ASK, FSK, PSK, QPSK, DPSK]; Encoding techniques and CODEC, DSL and other standards, Cable Networks: HFC,CM,CMTS. Access Techniques (STDM, FDMA, TDMA).

iv. Data Link Layer

Introduction, functions of Data Link Layer (LLC and MAC Sublayers):MAC Addressing, Ethernet Frame Header Format ,CRC, Checksum, Protocols: Stop and Wait, Go- Back-N, Selective Repeat, Piggybacking, HDLC, Point to Point, Multiple Access: Random Access :ALOHA,CSMA / CA, CSMA / CD, Controlled Access: Reservation, Polling, Token Passing, Link Control and MAC Protocols, Framing, Error Detection and Correction; Window-based Flow Control; Logical Link Control, HDLC Protocol, Point-to-Point Protocol (PPP), X.25 CCITT standard for packet data transmission; Media access control, Random Access Techniques, Scheduling Mechanisms.

v. Network Layer

Introduction, functions of Network Layer, IPv4 Addressing, IPv4 Classes , Public & Private IP Addresses ,Special and Reserved IP Address IP Packet Format, Subnet Masks ,Subnetting: CIDR, , NAT, ARP, RARP, ARP Header Format, BOOTP, DHCP, ICMP ,ICMP Codes and types ,ICMP Header and IGMP, Routing, Static and dynamic routing, Distributed routing, Hierarchical Routing; Distance Vector Protocol, Link State protocol, Open Shortest Path First (OSPF), Unicast, Broadcast, Multicast ,Anycast Routing Protocols, Intra Domain Routing Protocols, Inter Domain Routing Protocols, Border Gateway Protocol(BGP), Autonomous system , BGP Neighbors ,External and Internal BGP,
IPv6 Addressing, Representation, Unicast, Multicast,Anycast IPv6 Address, Address Space, Address Space Allocation, Autoconfiguration, IPv6 Packet Format, Extension Header ICMPv6 protocol, Error-Reporting Messages, Informational Messages, Neighbor-Discovery Messages, Transition mechanism for IPv4 to IPv6

vi. Transport Layer

Introduction, Functions, TCP& UDP Ports ,socket, Connectionless and Connection Oriented, delivery in Transport Layer: User Datagram Protocol (UDP), Transmission Control Protocol (TCP), TCP Segment Header Format, UDP datagram Header Format ,congestion control, Reliable Communication with TCP, 3-Way Handshake, TCP Sliding Window, Congestion Control, Flow control, Open-Loop, Closed-Loop, Quality of Service, Introduction to Stream Control Transmission Protocol (SCTP).

vii. Application Layer

Introduction, Function of Application Layer, Namespace and DNS, Remote Logging (telnet and ssh), E-mail: Architecture, SMTP, POP3, IMAP protocols, File Transfer: FTP, Anonymous FTP and TFTP, www, http, https protocols, Network Management System: SNMP protocol, , Network File System (NFS), Dynamic Host Configuration Protocol (DHCP).

viii. Multimedia in Data Communication

Multimedia Application Services type (Conversational, Retrieval, Messaging , Distribution), Multimedia Application Requirements: Reliability, Delay, Bandwidth, Delay Variation, Multimedia Networking Communication Protocols, Multimedia, Streaming Stored Audio/Video, Streaming Live Audio/Video, Real-

Time Interactive Audio/Video ,Real-Time Interactive Protocols, RTP ,RTCP , Voice Over IP(VOIP),VoIP Protocols : H.323,Session Initiation Protocol (SIP),Session Description Protocol (SDP),Media Gateway Control Protocol (MGCP),Real-time Transport Protocol (RTP) Content Delivery Network(CDN), Types of CDN: Peer to Peer CDN, Push CDN, Origin Pull CDNs ,Content networking techniques: Web caches, Server-load balancing, Request routing, Anycast Network Address.

ix. **Communication Protocols in IoT**

Overview of IoT, IoT data protocols (Presentation / Application layers), Network protocols for IoT (Datalink / Physical layers) , IoT data protocols: MQTT (Message Queuing Telemetry Transport) ,CoAP (Constrained Application Protocol), AMQP (Advanced Message Queuing Protocol) ,DDS (Data Distribution Service) ,HTTP(Hyper Text Transfer Protocol),WebSocket , IoT protocols. Network Protocols for IoT, WiFi, Bluetooth, ZigBee , Z-Wave , LoRa ,LoRaWan, etc.

x. **Network Programming using Python**

Introduction To Network Programming,- Levels of access to network services, Low Level Access ,High Level Access, What is Sockets?, Python Socket Methods, socket(),Socket Family, Socket type and protocol - SOCK_STREAM and SOCK_DGRAM, Socket Module in Python, Client Socket Methods, Server Socket Methods ,bind( ), listen(backlog), accept( ), General TCP/UDP Socket Methods, recv(),send(),sendto(),recvfrom() Socket Methods close() , gethostname() ,gethostbyname() ,Working with TCP Sockets, Writing a Simple TCP Client and Server Program, Working with UDP Sockets, Writing a Simple UDP Client and Server Program, Handling Received Client Data over TCP Socket, Performing Operation on Data in Client-Server Program.

xi. **High Speed Networks**

Need of High-Speed Networks, Cell Switching ATM (Asynchronous Transfer Mode). Frame Relay Networks - Asynchronous transfer mode - ATM Protocol Architecture, ATM logical Connection, ATM Cell - ATM Service Categories. Packet Switching, Gigabit Ethernet, MPLS over IP, IP over SONET or SDH, IP over WDM, IP over DWDM, IP over fiber, Gigabit Passive Optical Networks (GPON).

xii. **QoS in Data Networks**

Introduction to QoS, QoS frameworks for IP internets,Integrated Service(IntServ) Differential Services(DiffServ): Integrated Services Architecture - Approach, Components, Services Queuing Discipline, FQ, PS, BRFQ, GPS, WFQ - Random Early Detection,
Protocols for QoS Support: RSVP - Goals & Characteristics, Data Flow, RSVP operations, Protocol Mechanisms -Multiprotocol Label Switching - Operations, Label Stacking, Protocol details - RTP - Protocol Architecture, Data Transfer Protocol, Real-time Transport Control Protocol(RTCP).

xiii. **Introduction to Software Defined Networking**

Introducing SDN: SDN Origins and Evolution, Introduction, Centralized and Distributed Controller and Data Planes, Traditional Networking, Control Plane, Data Plane, Management Plane, Limitations of traditional networking, SDN (Software Defined Networking), Southbound Interface, Northbound Interface, Models of SDN: Open SDN, SDN by APIs, SDN Overlay Model, Hybrid SDN Software-Defined Wide Area Networking (SD-WAN) Network Function Virtualization (NFV) , NFV architecture. Intent-based networking (IBN).

2.6.7. Recommended books

1. Behrouz A Forouzan, "Data Communication and Networking", Tata McGraw-Hill, 06th Edition ,2021
2. William Stallings, "Data and Computer Communications",   Pearson Education.
3. A. S. Tanenbaum, "Computer Networks", Fourth Edition, Pearson Education.
4. William Stallings, Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud, 2016, Addison-Wesley Professional

2.7. B2.1-R5: Computer Based Statistical and
Numerical Methods

2.7.1. Introduction

There is a vast amount of data being generated in all the fields of human activity. In order to use this data, one needs to organize and analyze it. The analysis of data is a scientific endeavor which needs knowledge of numerical techniques, probability and statistical methods. The numerical techniques offer computational frameworks to solve real-life problems. Probability theory provides a rational framework to deal with uncertainty which is ubiquitous. Further, probability theory also provides a foundational basis for statistical techniques.

This module attempts to familiarize students with much needed concepts from numerical analysis, probability and statistics. A good grounding of these concepts is essential for better understanding of topics such as Data Analytics, Artificial Intelligence, Machine Learning, Mobile Communications, Performance Modeling of Computer Networks, Soft Computing, Pattern Recognition, Image Processing, Data Mining.

2.7.2. Objectives

After completing the module, the incumbent will be able to:

- Apply understand various statistical techniques used in different domains.
- Design Statistical Model to solve a problem.
- Use statistical tests on different problems.
- Recognize modern statistical methods and software to solve different problems.
- Interpret the statistical results.
- Understand the ways of solving complicated mathematical problems numerically.
- Obtain numerical solutions to problems of mathematics.
- Describe and understand several errors and approximation in numerical methods.

2.7.3. Duration

120 Hours - (Theory: 48hrs. + Practical: 72 hrs.)

2.7.4. Outline of Module

Module Unit	Duration (Theory) in Hours	Duration (Practical) in Hours	Learning Objectives
1. Introduction to Statistics & Probability	08	12	After completion of this unit of module, the Learner will be able to : i. Understand basic concepts of probability & Statistics ii. Solve basic Statistical problems.
2. Distribution Functions	04	06	After completion of this unit of module, the Learner will be able to Understand and implement discrete and continuous distribution functions like Binomial, Poisson and Normal.
3. Statistical Inference	08	12	After completion of this unit of module, the Learner will be able to i. Understand the concepts of Testing of Hypothesis and its various terms. ii. Test various hypotheses on given data.
4. Regression Analysis	08	12	After completion of this unit of module, the Learner will be able to Understand concept of different types of Regression Analysis and its implementation.
5. Computer Arithmetic and Errors	04	06	After completion of this unit of module, the Learner will be able to Understand and

Module Unit			Learning Outcomes
			implement the concept of Number representation and errors.
6. Algebraic and Transcendental Equations	04	06	After completion of this unit of module, the Learner will be able to i. Understand Algebraic and Transcendental Equation, ii. Implement Bisection Method, Iteration Method, and Newton – Rap son Method.
7. System of Linear Equations	04	06	After completion of this unit of module, the Learner will be able to i. Understand various concepts in System of Linear Equations. ii. Solve System of Linear Equations using different methods.
8. Numerical differentiation & Integration	08	12	After completion of this unit of module, the Learner will be able to i. Understand various concepts in numerical differentiation and integration. ii. Apply different techniques related ND and NI.

2.7.5. Marks Distribution

Module Unit	Written Marks (Max.)
1. Introduction to Statistics & Probability	17
2. Distribution Functions	08
3. Statistical Inference	17
4. Regression Analysis	18
5. Representation of Numbers	08

6. Algebraic and Transcendental Equations	08
7. System of Linear Equations	08
8. Numerical differentiation & Integration	16
Total	100

2.7.6. Detailed Syllabus

(A) Statistical Methods
(i) Introduction to Statistics & Probability

Introduction to Statistics, Statistic (Descriptive & Inferential), Random Variable (RV), Sample Space, Events and Probability, Introduction, Discrete and continuous Random Variables, Distribution Function, Probability Mass function, probability density function, Expectations, Descriptive Statistics, Correlation, Measure of Variability and Moments, jointly distributed RVs, Independent RVs, Using Statistical library for implementation in Python.

(ii) Distribution Functions (Discrete and Continuous)
Binomial, Poisson, Normal Distribution, Central Limit Theorem and its application, Distribution Fitting using Python/R.

(iii) Statistical Inference
Testing of Hypothesis: Introduction to Testing of Hypothesis (ToH), Understanding Null and Alternative hypothesis, Critical Region: Level of Significance, P Value, T Test, Z Test, Goodness of fit Test: Chi Square Test, Implementing ToH using Python/R.

(iv) Regression Analysis
Introduction, Least squares regression curve, Understanding Scatter Plot, Working with Linear Regression, Generalized Linear Regression, Logistic Regression, Multiple regressions, Poisson Regression. Constructing Training and Test Data and regression analysis using Python/R.

(B) Numerical Techniques
(v) Computer Arithmetic and Errors

Base-N and Binary, Floating Point Numbers, Errors and their computation using Python/R, Round-off Errors, Round-off error by floating-point arithmetic, Representation of error, Accumulation of round-off error, Error in Series Approximation, Approximations with Taylor Series and its implementation.

(vi) Algebraic and Transcendental Equations

Understanding Algebraic and Transcedental Equation, Understanding Bisection Method, Iteration Method, Solution of Polynomial and Transcendal Equations by Bisection Method, False Position Method/Regula Falsi Method, Secant Method, Newton – Raphson Method,

(vii)   System of Linear Equations

Basics of Linear Algebra, System of Linear Equations, Solutions to Systems of Linear Equations,Jacobi Method, Gauss EliminationMethod and Iterative Methods(Gauss-Joldan and Gauss-Seidel)

(viii)   Numerical differentiation & Integration

Introduction to Numerical Differentiation, Finite Difference Operators, Approximation of Derivatives using Finite Difference, Approximating Derivatives with Taylor Series, Introduction to Numerical integration, Riemann's Integral, Approximating Integral using Trapezoidal and Simpson's rule and its implementation.

2.7.7.   Recommended Books
Main Readings
1. Sastry, S.S, "Introductory Methods of Numerical Analysis", 5th Edition.
2. Curtis F. Gerald and Patrick O. Wheatley, "Applied Numerical Analysis", 7th Edition
3. Ross, S.M, "A First Course in Probability"., 8th Edition
4. Trivedi, K.S., "Probability & Statistics with Reliability, Queuing, and Computer Science Applications", 2nd Edition
5. Python Programming: Using Problem Solving Approach Paperback by Reema Thareja (Author), 1st Edition

Supplementary Reading
1. Ross, S.M, "Probability and Statistics for engineers and Scientists", 4th ed., Elsevier.
2. Pal, S, "Numerical Methods- Principles, Analyses and Algorithms", Oxford University Press., 1st Edition

2.8.1. Introduction

This module encompasses various communication techniques and skills required by the learners for effective business communication especially in digital age. Technical business communication is a pivotal tool in productivity and performance of an organization. Strong interpersonal skills allow the learners to be proficient in various area of expertise and thereby contribute towards the success of the organization they work for.

2.8.2. Objectives

After completing the module, the incumbent will be able to:

➢ Learn Communication skills for effective communication.

➢ Prepare Technical Reports and Presentations.

➢ Build Interpersonal Networks.

➢ Use of Collaborative Tools.

2.8.3. Duration

120 hours - (Theory: 48 hrs + Case Study/Seminars/Presentations: 72 hrs)

2.8.4. Outline of Module

Module Unit	Duration (Theory) in Hours	Duration (Practical) in Hours	Learning Objectives
1. Basics of Communication	4	6	After completion of this unit of module, the Learner will be able to i. Understand the need of good communication skill ii. Learn Basics of Communication
2. Communication Techniques	4	6	After completion of this unit of module, the Learner will be able to learn i. Speaking skills

			ii. Negotiating Skills, Etiquettes iii. Comprehension Skills

3. Listening Practices	4	6	After completion of this unit of module, the Learner will be able to know
			    i. Importance of listening
			    ii. Good Body Language
			    iii. Effective Listening

4. Communication in Groups and Teams	4	6	After completion of this unit of module, the Learner will be able to
			    i. Performing Effectively in Teams;
			    ii. Communication in meetings

5. Technical Communication	4	6	After completion of this unit of module, the Learner will be able to
			    i. Write Technical Reports
			    ii. Write letters, Memos, emails etc.

6. Interpersonal Communication Skills	6	9	After completion of this unit of module, the Learner will be able to
			    i. Build Interpersonal Skills in the Workplace.
			    ii. Communicate in official environment

7. Resumes and Interviews	6	9	After completion of this unit of module, the Learner will be able to
			    i. Write resume, cover letters etc.
			    ii. Learn how to face Employment and Appraisal interviews etc.

8. Presentation Skills	4	6	After completion of this unit of module, the Learner will be able to learn
			  i. Facets of Presentation
			  ii. Extempore Speech, Public Speaking etc.

9. Technology in Communication	6	9	After completion of this unit of module, the Learner will be able to learn
			  i. Role of communication technology in office.
			  ii. Concept of virtual office

10. Collaborative Technology	6	9	After completion of this unit of module, the Learner will be able to
			  i. Use groupware
			  ii. Learn Collaborative Computing

2.8.5. Marks Distribution

Module Unit	Written Marks (Max.)
1. Basics of Communication	10
2. Communication Techniques	10
3. Listening Practices	8
4. Communication in Groups and Teams	10
5. Technical Communication	12
6. Interpersonal Communication Skills	12
7. Resumes and Interviews	8
8. Presentation Skills	12
9. Technology in Communication	10
10. Collaborative Technology	8
Total	**100**

2.8.6. Detailed Syllabus

(i)   Basics of Communication

Introduction to Communication. Objective of Communication, Role of communication in successful Business . Types of Communication. Communication competence.

(ii)   Communication Techniques

Verbal Communication; Speaking in Public; Negotiating Skills; facilitator and Participant skills in meetings; Proper Business Writing; Email Etiquettes; Reading and Comprehension skills.

(iii)   Listening Practices

Importance of listening in communication, Types of listening, Benefits, Hearing versus Listening; A Model of Listening; Assessing Differences and Listening, Improving Your Listening Skills; How to talk so that Others will Listen; Body language

(iv)   Communication in Groups and Teams

The Elements of Successful Group Communication; Types of Small Groups Operating in an Organization; Demographic Variables that affect Group Life; The Group Decision Making Process; Tools for Effective Problem Solving; Performing Effectively in Teams; managing Meeting mania; probing skills, Voice Characteristics in Articulate Speaking, Tone, Pitch, Rate of Speech and Volume; Self Communication;

(v)   Technical Communication

Framing of Technical Reports; Forms, Memos, Letters and emails; Graphics; Reports; White Papers.

(vi)   Interpersonal Communication Skills

Defining Interpersonal Communication; The Impact of Conversations on Relationships; Formal and Informal Communication; Vertical versus Horizontal Organizations; Communication Styles; Communication Climate; Job Productivity and Satisfaction at Work Place; Building Interpersonal Skills in the Workplace, Etiquettes

(vii)   Resumes and Interviews

Introduction to Resumes; Cover Letters; The Employment Interview; Surviving the Group Employment Interview; The Informational interview; Mock Interviews, The Performance Appraisal Interview.

(viii)   Presentation Skills

Facets of Professional Presentations; Understanding Your Audience and the Speaking Occasion; Time Management; Presentation Goals; Selecting the Best Format for your Presentation. Brainstorming; Developing Logical Sequences for

Your Messages; Supporting Ideas; Generating Appeals and gathering evidence; Setting and Achieving your Image Goals; Optimizing; your PERC-Quotient, Being spontaneous – Capturing and holding your audience's attention

(ix)   Technology in Communication
Communication Technology Today; Use of Technological tools in Business Communication, Etiquettes, Changing Role of Communication Technology in the Workplace; Conducting Webinars, Video conferencing, Concept of Virtual Office; Mobile Communication and social media;

(x)   Collaborative Technology
Collaborative tools, Innovations, Legal Issues & Electronic Business communications.

2.8.7.   Recommended Books

Main Reading
1 Business Communication Today | Fourteenth Edition | By Pearson by Courtland L. Bovee, John V. Thill, et al. 2018
2 Fundamentals of Business Communication, 1e by Mukesh Chaturvedi ,2012
3 Business Correspondence and Report Writing - A Practical Approach to Business and Technical Communication | 6th Edition by R C Sharma, Krishna Mohan, et al. 2020

Supplementary Reading

1 J. Penrose ET. "Advanced Business Communication", Thomson Asia Ltd., 2002.

2.9. B2.3-R5: Advanced Databased Technologies

2.9.1. Introduction

In this course, students will study the various topics to implement simple and multi-user business applications using database technologies. It also introduced several advanced concepts –Distributed Database, Object-oriented databases, Image, multimedia and spatial databases and Indexing techniques. It aims to Implement the possible ACID operations and transaction properties using Oracle/SQL/DB2 or similar tools

2.9.2. Objectives

After completing the module, the incumbent will bibelot:

➢ Explain how relational views achieve logical data independence using schema, E-R Models, normalizations.

➢ Explain and describe the Database architecture, Open source databases, DBMS properties, database securities, transaction management, concurrency control, and recovery.

➢ Implementation of possible operations: transaction management, concurrency and recovery.

➢ Explain how a distributed database system maintains transaction integrity.

➢ Describe the purpose, architecture, and operations of a typical data warehouse system.

➢ Implement the possible ACID operations and transaction properties using Oracle/SQL/DB2 or similar tools

➢ Introduction to several advanced Topic-Distributed Database, Temporal databases, Object-oriented databases, Image, multimedia, and spatial databases and Indexing techniques

2.9.3. Duration

120 Hours - (Theory: 48 hrs + Practical/Tutorial: 72 hrs)

2.9.4. Outline of Module

Module Unit	Duration (Theory) in Hours	Duration (Practical/Tutorial) in Hours	Learning Objectives
1. Recap1 on Relational model and relational algebra	2	3	After completion of this unit, the Learner will be able to understands the

			concept of Relational model and relational algebra, and related topics
2. Recap2 on E-R models and Normalization	4	6	To Familiarize with the E-R models and Normalization process etc
3. Database Architectures and Open source databases	6	9	To Understand the application Architectures, Database Schema, Concept of Open source databases such as Maria DB and Mongo DB, Database-as-a-service (DBaaS);
4. Database Properties and Database securities	6	9	Familiarize with Database Properties, Database Consistency, Constraints and Data Integrity, Database Transactions, The concept of Database securities, Common threats, Security Levels, some possible solutions
5. Query languages-SQL/Non-SQLs	6	9	Develop use cases using the Procedural or Non- Procedural Query Language /SQLs/Non-SQLs
6. Transactions and Concurrency	6	9	Familiarize with the Transactions and Schedule, Concurrency Control and Develop use cases using Queries
7. Durability	4	6	Familiarize with the Durability process and Checkpoint facilities and Develop

			use cases using Queries
8. Recovery manager	4	6	Familiarize with the Recovery manager and its process and Developed use cases using Queries
9. Data Warehouses and OLAP	4	6	Familiarize with the Steps to develop a Data Warehouse and ETL process
10. Advance topics	6	9	Understand the advanced Topic-Distributed Database, Object-oriented databases, Temporal databases, Image, multimedia, and spatial databases and Indexing techniques
Total	48	72	

2.9.5. Marks Distribution

Module Unit	Written Marks (Max.)
1. Recap1 on Relational model and relational algebra	04
2. Recap2 on E-R models and Normalization process	10
3. Database Architectures and Open-source databases	10
4. Database Properties and Database securities	11
5. Queries Languages/ SQL	12
6. Transactions and Concurrency	10
7. Durability	10
8. Recovery manager	08
9. Concept of Data Warehouses and OLAP	10
10. Advance topics	15
Total	100

2.9.6. Detailed Syllabus

(i) Recap1 on Relational model and relational algebra
Relational model and relational algebra, relational calculus and relational calculus, Relational model concepts, relational databases and schemas; Relational algebra operations, queries in relational algebra; overview of relational calculus;

(ii) Recap2 on E-R models and Normalization process
E-R model, E-R diagrams, design of E-R model, Transformation of ER model to relational schema, Normalization process -1NF, 2NF, 3NF, BCNF, 4 NF, etc..

(iii) Database Architectures and Open source databases
Database application Architectures, Database Schema, DML, DDL, and DCL
Concept of Open source databases such as Maria DB and Mongo DB, Database-as-a-service (DBaaS); examples of SQL databases and No SQL databases

(iv) Database Properties and concept of Database securities
Database Consistency, Constraints and Data Integrity, Database Transactions-ACID properties (Atomicity, Consistency, Isolation, Durability), Data Quality Problems

The concept of Database securities:
Common threats and challenges: Insider threats, Human error, SQL/NoSQL injection attacks, Buffer overflow exploitations, possible attacks, Data Security Risks, Data Tampering, Data Theft, Password-Related Threats, Unauthorized Access etc.

Security Levels: Physical, Human, Operating System, Network, Database System
Some possible solutions:-Security log and audit trails, Encryption, SQL-based data control languages, Mitigation of SQL Injection, Internet-based Database securities methods, Certification authorities, Laws and standards requiring controls on access, disclosure, and modification of sensitive data, etc.

(v) Procedural or Non- Procedural Query Language SQL

PL/SQL-Block Structure, Declare Section, Execution Section, Loop Statement, Exception Section, etc,
Stored Procedure, Exception Handling, Triggers
Views, Indexes, Synonyms, sequence, Data Dictionary Queries
Query Optimization

(vi) Transactions and Concurrency
Transactions and Schedule, Concurrency Control-Pessimistic and Optimistic, and related Policies and technology, Dirty Read & Write, Locking Policies, Deadlock and Locking, Isolation Levels, Multiversioning, etc.

(vii)   Durability

Process architecture-Database Writer, Log Writer, Check pointer, Transaction Processing-Logging facilities, Checkpoint facility, Database writer, Database Buffer, Rollback Segment, Log records, and Buffer

(viii)   Recovery manager

Log files Principles, System failure and Recovery mechanism, Media Failure

(ix)   Concept of Data Warehouses and OLAP

Steps to develop a Data Warehouse, Dimension and fact table, Data cleaning process, ETL process, Data Cube, and Basic analysis using OLAP operations

(x)   Advance topics

Distributed Database-Fragmentation, Design aspects, Distributed Transactions, Distributed Deadlock Management, Distributed DB Recovery, 2-Phase Commit, Example of Distributed Query Processing,

Object-oriented databases: the concepts, Standards, languages, and design; Object relational database systems.

Overview of the Temporal databases
Image, multimedia, and spatial databases: Concepts of Image, multimedia, and spatial databases; Content-based indexing and retrieval
Indexing techniques and Tress- R trees, R+ trees, KD trees, FP tree, etc
Note: Lab work/Assignment: Using MariaDB/ Mongo DB/ DB2/Oracle/ SQL or similar tools to implement the possible ACID operations and transaction properties

2.9.7. Recommended Books

1. Bales, Beginning PL/SQL: From Novice to Professional; Springer 2007
2. Connolly T, Begg C, Database Systems, Fourth Ed, Addison/Wesley 2008
3. Connolly T, Begg C, Holowczak R, Business Database Systems. Pearson/Addison-Wesley, 2008
4. Kifer et al. Database Systems
5. Oracle 9iR2 data warehousing Boston, MA: Digital Press, 2003.
6. Kimball, Ralph, The data warehouse ETL toolkit practical techniques for extracting, cleaning, conforming, and delivering data Indianapolis, Ind.: Wiley, c2004
7. Kimball, Ralph & Ross, Margy, The data warehouse toolkit the complete guide to dimensional modeling, second edition New York: Wiley, c2002.
8. Hobbs, Lillian, et al. , Oracle 9iR2 data warehousing Boston, MA : Digital Press, 2003

2.10.1. Introduction

This course aims to impart fundamental concepts of computer graphics and multimedia so that students are able to understand the basic concept of computer graphics. Further this module will help to use algorithms to draw various graphics primitives, use of 2D, 3D transformations and Multimedia concepts and various I/O technologies and to enable the students to develop their creativity.

2.10.2. Objectives

The purpose of the Computer Graphics and Multimedia programme is to teach students about computer graphics and multimedia theory, technology, methods, and abilities. Graduates plan to work in research and development of systems that use computers to manipulate visuals and sound.

2.10.3. Duration

120 Hours - (Theory: 48hrs + Practical: 72hrs)

2.10.4. Outline of Module

Module Unit	Duration (Theory) in Hours	Duration (Practical) in Hours	Learning Objectives
1. Graphics Hardware – Primitives	05	05	After completion of this unit of module, the Learner will be able to Understand the basic hardware primitives used in Computer Graphics.
2. Basic Mathematical Concepts for Computer Graphics	05	02	After completion of this unit of module, the Learner will be able to Understand the Mathematics behind the implementation of Computer Graphics
3. Graphics Operations – Clipping, Filling	05	15	After completion of this unit of module, the Learner will be able to Understand the various algorithms for clipping and filling of various shapes.
4. Transformation 2D – 3D & Projections	10	15	After completion of this unit of module, the Learner will be able to Understand the transformations of 2D and 3D.

			Further, learner will learn the Parallel, Perspective and Isometric projections are illustrated in this unit.
5. Object Representation	10	15	After completion of this unit of module, the Learner will be able to i. Understand the representation of various surfaces. ii. Understand the Hermit curve, Bezier curve and B-spine curve. iii. Understand the Shading Algorithms.
6. Multimedia Systems	13	20	After completion of this unit of module, the Learner will be able to i. Learn Basics of Multimedia. ii. Basic editing in Image. Editing Software. iii. Concepts of Audio. Basic Video Editing.
Total	48	72	

2.10.5. Marks Distribution

Module Unit	Written Marks (Max.)
1. Graphics Hardware – Primitives	15
2. Basic Mathematical Concepts for Computer Graphics	15
3. Graphics Operations –Clipping, Filling	15
4. Transformation 2D – 3D & Projections	20
5. Object Representation	15
6. Multimedia Systems	20

Total	100

2.10.6. Detailed Syllabus

Unit 1. Graphics Hardware – Primitives

Display devices – Refresh Cathode Ray Tube, Raster Scan Display, Plasma Display, Liquid Crystal Display, Plotters, Printers, PCI / PCIe Graphics Cards. Input Devices – Keyboard, Trackball, Joystick, Mouse, Pen Tablet Digitizer and Digital Camera.

Unit 2 Basic Mathematical Concepts for Computer Graphics

Matrices and Determinants. Operations related to Matrices and Determinants. Vectors : Definition , Vectors and Co-ordinate System

Drawing algorithms – DDA algorithm Breshenham's Line algorithm, Breshenham's Circle generation algorithm.

Unit 3. Graphics Operations –Clipping, Filling

Clipping – Point Clipping, Line Clipping, Polygon Clipping Sutherland-Cohen line clipping algorithm. Midpoint Sub-division algorithm

Filling – Flood fill algorithm, Boundary fill algorithm and scan-line polygon fill algorithm.

Unit 4. Transformation 2D – 3D & Projections

2D Geometrical transformation -translation, scaling, rotation, reflection and shear transformation matrix representation and homogenous co-ordinates, composite transformations, transformation between co-ordinates.

3D Geometrical transformation – Representation of points, 3D scaling, shearing, rotation, reflection, translation, multiple transformation, rotation about and axis parallel to a coordinate axis.

Projections: Parallel, Perspective and Isometric. Viewpoints

Unit 5. Object Representation

Polygon surfaces, quadric surfaces, spline representation, Hermite curve, Bezier curve and B-spline curve. Bezier and B-Spline surfaces. Basic illumination models, shading algorithms

Unit 6. Multimedia Systems

Introduction to Multimedia: Definition of Multimedia, Multimedia objects: Text, Graphics, Animation, Audio, Images, Video. Definition of Hypertext and Hypermedia. Components of a Multimedia System.

Image and Graphics:

Vector vs. Bitmap. Creating Basic Shapes and Layers, setting up the document, painting, drawing lines and curves, Transforming Objects using the free transform tool, changing the perspective, making multiple transformations. Blending Shapes and Colors by creating a gradient fill. Creating layers. Adjusting Levels, auto levels. Clone Stamp. Healing Brush. Feather Effect. Crop & Resize image.

Audio: Audio software and hardware. Sound Card, Stereo/Mono, Types of Audible Sounds, Basics of Acoustics, and Digitization of sound, frequency and bandwidth, decibel system, data rate, audio file format, MIDI Files, Synthesis of MIDI Sounds.

Video and Animation: Video Basics, How Video Works, Introduction to MPEG-1, MPEG-2, MPEG-4, MPEG-7, MPEG-21. Basic Video Editing. Basic Animation Techniques (Frame by Frame, Twining), Morphing.

2.10.7. Recommended Books

1. David F. Rogers and J. Alan Adams "Mathematical Elements for Computer Graphics"(Paperback) McGraw-Hill Science/Engineering/Math; 2nd edition (July 17 Edition)
2. Schaum's Outline of "Theory and Problems of Computer Graphics" (Paperback) by Zhigang Xiang & Roy A. Plastic McGraw-Hill; 2nd edition (Jan 2015 Edition)
3. Prabhat K Andleigh and Kiran Thakrar, "Multimedia Systems and Design", PHI, 2003
4. Mark J. Bunzel and Sandra K. Morris "Multimedia Application Development" Mcgraw-Hill Osborne Media; 2nd edition (September 1993)
5. Donald Hearn and M. Pauline Baker, "Computer Graphics C Version", (Papaerback)
   3rd Edition Prentice Hall (2002)
6. Parekh Ranjan, "Principles of Multimedia", Tata McGraw-Hill, 2017
7. Prawal& B. B Tiwari, "Multimedia Systems", Excel Publication, New Delhi, 2007.
8. "Multimedia Demystified" – by Jennifer Coleman, Dowling; McGraw Hill.

2.11. B2.5-R5: Cloud Computing and Internet of Things (IoT)

2.11.1. Introduction

The objective of this module is to impart comprehensive understanding and knowledge of Cloud Computing and Internet of Things (IoT). Furthermore, course comprehends the uses of Cloud Computing along with the design and implementation of typical IoT based system. The course gives insight into various Cloud services and its usage in current ITES ecosystem. The course also aims at providing competent, and innovative with a strong cognizance in the area of sensors, IoT, data science.

The course introduces low power microcontrollers and feasibility to develop the skillset required for programming low power sensing applications. The course focuses discussion on IoT reference layer model and protocols at different levels.

The course aims at providing technical skills in building and using Cloud Services and designing secured and trustable IoT systems with various sensor interfaces.

2.11.2. Objectives

After completing the module, the incumbent will be able to:

➢ Configure and Deploy applications on public Cloud platforms

➢ Different Cloud Computing architecture

➢ Identify and analyze the applications in different areas of IoT ecosystem

➢ Understand and apply techniques for using sensors and actuators to solve different aspects of industry

➢ Understand the architecture of Industry standard low power ARM Cortex Microcontroller.

➢ Built real world problem in areas of IoT and cloud-based solutions.

➢ Gain ability to build and operationalize and IoT end-to-end system.

➢ Know the working of different network infrastructure equipment and their role in securing network.

➢ Understand the various network protocols used in IoT

➢ Open-source IoT framework vs Commercially available IoT frameworks.

➢ Issues related with Identity and access management, while developing end-to-end IoT products

➢ Understand the core issues of IoT such as privacy, security and interoperability

2.11.3. Duration

120 Hours - (Theory: 48 hrs + Practical: 72 hrs)

2.11.4. Outline of Module

Module Unit	Duration (Theory) in Hours	Duration (Practical) in Hours	Learning Objectives
1. Cloud Computing	12	18	After completion of this unit of module, the Learner will be able to understand i. Cloud Computing Architecture, Models ii. Virtualization iii. Security aspects
2. IoT Hardware Platform, Sensors & Actuators	8	10	After completion of this unit of module, the Learner will be able to i. Hardware platform for IoT ii. Low power microcontrollers-ARM cortex M Series iii. Hardware for prototyping IoT Gateway
3. IoT Connectivity & Cloud Platform	12	18	After completion of this unit of module, the Learner will be able to i. IoT connectivity standards ii. IoT layered architecture & Protocols iii. Network Topologies iv. IoT Cloud Platform
4. IoT Framework	10	16	After completion of this unit of module, the Learner will be able to i. IoT architecture reference model ii. Identity and Access management

			iii. IoT open-source framework, commercial framework
5. Use Cases – IoT & Cloud Services	6	10	After completion of this unit of module, the Learner will be able to IoT Case studies in Agriculture, Healthcare, Manufacturing
Total	48	72	

2.11.5. Marks Distribution

Module Unit	Written Marks (Max.)
1. Cloud Computing	25
2. IoT Hardware Platform, Sensors & Actuators	15
3. IoT Connectivity & Cloud Platform	25
4. IoT Frameworks	20
5. Use Cases – IoT and Cloud Services	15
6. **Total**	100

2.11.6. Detailed Syllabus

Cloud Computing

Cloud Computing concepts and their usage.

Concept of Virtualization, hypervisor and Load Balancing, Cloud computing platforms

Cloud Architecture- Layers and Models- IaaS, SaaS, PaaS

Cloud Deployment Models- public, private, hybrid

Security and privacy issues in Cloud Computing

IoT Hardware Platform, Sensors & Actuators

Introduction to IoT devices node, gateway, selection criteria for Hardware platform for IoT, Low power microcontrollers for IoT node

Introduction to ARM cortex M series, different low power techniques, Microcontroller peripherals (timer, GPIO, ADC, PWM, DAC) interfacing sensors and actuators to Cortex M series controllers

Hardware for prototyping IoT Gateway -ARM Cortex Application processor series, overview of Multicore architecture

Hardware requirements for EDGE & FOG computing.

Overview of open-source hardware platforms for IoT.

IoT Connectivity & Cloud Platform

IoT connectivity standards: Zigbee, Zwave, Bluetooth, BLE, different Bluetooth generations, NBIoT, LoRa, LoRaWAN, WiFi for IoT

IoT layered architecture & Protocols:

- Application Layer Protocols: MQTT, CoAP, AMQP,

- Transport Layer Protocols: Embed TLS, REST Full services, webservers, IPv6 standards, 6lowPAN

Point to Point Data transfer, Point to Multi Point Data transfer & Network Topologies, Sub-netting

Network Topologies referred with Web, Introduction to Web Servers

IoT cloud platforms: Opensource cloud platforms of IoT, Commercial IoT cloud platforms and services.

IoT Framework

IoT components and Technologies, IoT Architecture, IoT Analytics Life cycle, IoT Application domain.

IoT architecture reference model – requirement, connectivity and communication, device management, data collection, analysis, and actuation, scalability and security

Identity and Access Management – OAuth2, LDAP, access control

IoT open-source frameworks vs IoT commercial frameworks

IoT dashboard solutions – open-source vs commercial

IoT security fundamentals, security threats etc.

Use Cases – IoT and Cloud Services
- Agriculture -

- o Crop monitoring, irrigation scheduling, plant disease detection, soil texture mapping, health assessment, crop yield mapping, livestock applications, Food supply chain tracking
- Manufacturing -
  - o Industry 4.0, Remote Monitoring, Supply Chain Management & Optimization, Predictive maintenance, Fleet Management, Digital Twins, Industrial IoT
- Healthcare -
  - o Model for IoT Healthcare systems, Wearable Devices and medical sensor, Communication between devices
- Role of Cloud, Bigdata and Security

2.11.7. Recommended Books

1. Cloud Computing : A Hands-on Approach, Arshdeep Bahga, Vijay Medisetti,
2. The Definitive Guide to the ARM Cortex-M3, Joseph Yiu, Second Edition, Elsevier Inc.
3. The Internet of Things: Key Applications and Protocols, David Boswarthick, Olivier Hersent, and Omar Elloumi, Wiley
4. Building the Internet of Things with IPv6 and MIPv6, Daniel Minoli, Wiley.
5. Cloud Computing: A Hands-on Approach, Arshdeep Bahga and Vijay K. Madisetti
6. Enabling Things Talk, Alessandro Bassi, Martin Bauer, Martin Fiedler, Thorsten Kramp, Springer Open

2.12.1. Introduction

The purpose of this module is t expose candidates to the range of project management practices that are used in software development projects

2.12.2. Objectives

After completing the module, the incumbent will be able to:

➢ Identify and classify project activities

➢ Describe a project in terms of scope, time, cost, and quality on for a given project scenario

➢ Estimate duration and schedule project activities using planning techniques

➢ Measure the size, the complexity of code, and use these measures to identify the defects

➢ Identify the risk and prioritise risks based on the impact and probabilities to manage these risks

➢ Use and describe techniques for tracking the progress and status of a project

➢ Use the possible CASE tools for developing and managing the projects

➢ Adoption of Agile practice -Team management and Leadership, Scrum practices

2.12.3. Duration

120 Hours - (Theory: 48 hrs + Practical/Tutorial: 72hrs)

2.12.4. Outline of Module

Module Unit	Duration (Theory) in Hours	Duration (Practical/ Tutorial) in Hours	Learning Objectives
1. The recap on Software Project and Introduction to Project Management	4	6	After completion of this unit, the Learner will be able to i. Understand the concept of Software Engineering, its Process and Models etc.

				ii. The concept of a project, its principles, project life cycle, and CMM model
2. Project Management Issues	4	6		Familiarize with the Basic project management functions and forces of a project. Product and service management, Knowledge management
3. Project Planning and Project Estimation	6	9		Practice the Project Planning and Project Estimation using the available methods and algorithms models and tools
4. Project Scheduling	4	6		Familiarize with Project Scheduling activities, sequencing using available techniques and tools
5. Risk Analysis and management	6	9		Can do the identification of risk, assessment and tracking for better Risk Mitigation and Management
6. Software measures and metrics	4	6		Practice to measure the software details using available metrics
7. Quality Management	4	6		Can do hands-on practice on quality management of a project using the models and can generate review reports- defect and quality etc.
8. Project Tracking Techniques and Monitoring	8	12		Can do hands-on practice on Tracking and Monitoring of a

			project using available Chart and graphical tools
9. Configuration Management, and Project Closure	4	6	Familiarize with the activities in the Configuration Management and planning, Change management and Version Control System etc. and familiarize with Defect Collection, Audit and Project Closure analysis
10. Agile Management	4	6	Understand the concept of Agile Management-Team members and Leadership together with Scrum practices
Total	48	72	

2.12.5. Marks Distribution

Module Unit	Written Marks (Max.)
1. The recap on Software Project and Introduction to Project Management	06
2. Project Management Issues	10
3. Project Planning and Project Estimation	15
4. Project Scheduling	10
5. Risk Analysis and management	10
6. Software measures and metrics	10
7. Quality Management	15
8. Project Tracking Techniques and Monitoring	10
9. Configuration Management, and Project Closure	08
10. Agile Management	06
Total	100

2.12.6. Detailed Syllabus

The recap on Software Project and Introduction to Project Management
Principles of software engineering, Software Process and Models, Product, Tools, and techniques of process modelling. The concept of a project, project specification and parameters, Principles of Project management, Project management life cycle, Capability Maturity Model

Project Management Issues
Basic Management Functions: Scoping, Planning, Organization, Staffing, Directing, Monitoring (Controlling). The project forces-Scope, Time, Cost, Quality etc. Product and service management, Knowledge management

Project Planning and Project Estimation
Planning-Project activities and techniques-Work Breakdown Structure (WBS) etc. Project Estimation-Time and Effort, Ideal Time vs Ideal Effort.Project Costing, Estimation Techniques, Effort Estimation Techniques, Velocity, Decomposition Techniques, Algorithms models, Automated Estimation Tools, COCOMO and functional points etc

Project Scheduling
Milestones and Deliverables of a project.Task Network and activity sequencing-inter-dependences. Scheduling types- Time-boxed, activity based, other techniques-Critical path, PERT, Gantt chart etc.

Risk Analysis and management
Common categories of project Risk, risk identification, Risk Assessment and Control, components of Rick, and Risk Drivers-KoST. Risk prioritisation, Risk Tracking and Monitoring, Risk Mitigation and Management

Software measures and metrics
Measures of software- (direct, indirect), metrics and indicators, Size and complexity metrics, Statistical Metrics and Process Monitoring, Function-point and project management Metrics tools, Relationships between defects and metrics, Standards-CMMI, ISO etc

Quality Management
Software Quality and its attributes, Quantitative Quality Models. Defect classification, defect tracking tools, Defect isolation, Quality reviews, Defect reporting, Change logs

Project Tracking Techniques and Monitoring

Tracking-Setting check points, Data collection, 3-Point time tracking, Monitoring using -Burn down chart, Graphical Reporting Tools, Progress Report and Risk reporting

Configuration Management, and Project Closure
Activities in Configuration Management and planning, Change management, Change requests, change impact analysis, Version Control System (VCS), Repository browsing tools.Defect Collection and Audit, Causal and Pareto Analysis, Project Closure Analysis

Agile Management
Team management and Leadership, Agile and fishbowl technique, Scrum practices

2.12.7. Recommended Books
1. Ian Sommerville, Software Engineering, Addison-Wesley, 2009 [9ᵗʰEdn]
2. Roger S. Pressman, Software Engineering - A Practitioners Approach, McGraw Hill, 2010 [7ᵗʰEdn]
3. Pankaj Jalote, Software Project Management in Practice, Addison-Wesley, 2002
4. Bob Hughes and Mike Cotterell, Software Project Management, McGraw-Hill, 2017 [6th Edn]
5. Robert K. Winsock, Effective Project Management: Traditional, Adaptive, Extreme Wiley, 2007 (4th Edn)
6. Ken Schwaber, Agile Project Management with Scrum, Microsoft Press, 2004.
7. Kent Beck, Martin Fowler, Planning Extreme Programming, Addison-Wesley, 2001
8. Ben Collins- Sussman et al., Version Control with Subversion, 2002
9. IEEE PMBOK
10. PRINCE2 materials

2.13. B3.2-R5: Artificial Intelligence and Machine Learning

2.13.1. Introduction

Artificial Intelligence is the intelligence exhibited by machines or software. The application areas of artificial intelligence are very vast and so this is a field of study which is gaining importance day by day. This branch of engineering emphasizes on creating intelligent machines that work and reacts like humans. There are different dimensions for artificial intelligence, in which the decision taking capacity is most important. The course would cover the spectrum of Artificial Intelligence, data analytics, machine learning, deep learning, and natural language processing and computer vision. The student would dive straight into data analytics and mathematics behind applied machine learning algorithms and deep learning algorithms. They will also be able to develop AI Model using python programming.

2.13.2. Objective

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

- ➢ Identify the scope and limits of the Artificial Intelligence (AI) field.

- ➢ Analyse the application areas of Artificial Intelligence.

- ➢ Explore data, process it and make it ready for developing AI based systems.

- ➢ Solve real world problems through machine learning implementation leading to predictions.

- ➢ Understand various learning models, methods and applications under supervised and unsupervised learning.

- ➢ Understand unsupervised machine learning problems such as clustering.

- ➢ Understand mathematics behind machine learning algorithms.

- ➢ Understand computer vision, face recognition and detection using Open CV.

- ➢ Understand deep learning, artificial neural network, feed forward neural network and neural network using tensor flow.

- ➢ Understand basics of text processing and use NLTK Library which helps in text analytic.

2.13.3. Duration

120 Hours - (Theory: 48 hrs + Practical/Tutorial: 72hrs)

2.13.4. Outline of Course

Module Unit	Duration(Theory) in Hours	Duration (Practical) in Hours	Learning Objectives(Learner will learn after completion of unit)
1. Introduction to Artificial Intelligence	6	9	i. Describe the building blocks of AI Systems. ii. List the environment and goals of agent-based systems and draw the design of an Agent.
2. Applications of AI	2	3	Identify the suitability of applying AI as a solution, based on context of applications.
3. Advanced Python (Numpy, Pandas, Matplotlib)	8	12	i. Understand Numpyndarray and various functions of numpy ii. Importing Data from various sources (csv, txt, excel) iii. Reading and manipulate csv files iv. Use Pandas for data science, Performing EDA, Data Wrangling, Combining Datasets-Merge and Join, Grouping Data. v. Make various types of Graphs and Plots using Python Graphical libraries.
4. Machine Learning	14	21	i. Machine Learning Introduction, Supervised and Unsupervised Learning.

				ii.	Tasks performed by Machine Learning Algorithms – Classification, Regression, Clustering
				iii.	Concept of Training and Testing Data, Splitting the data using python modules
				iv.	Solving a Regression Problem using Python: Data Preparation, Apply Machine Learning Algorithm: Linear Regression, Decision Tree Regress or etc. , use of Sklearn package
				v.	Solving a Classification Problem using Python: Data Preparation, Apply Machine Learning Algorithm: Logistic Regression, Decision Tree Classifier, K-Nearest Neighbour Classifier etc.
				vi.	Understanding Mathematics behind Machine Learning Algorithm
				vii.	Solving a Clustering problem by applying K-Means Algorithm in Python.
				viii.	Performance evaluation metrics of machine learning algorithms- Accuracy Score, Confusion Matrix,

			Root Mean Squared Error etc.
			ix. Over fitting, under fitting.
			x. Cross Validation, Optimizing Model Hyper parameters.
5. Deep Learning	6	9	i. Learn basics of deep learning concepts.
			ii. Learn to train and implement deep learning algorithms.
			iii. Understand the implementation of AI through real world examples of images.
			iv. Learn neural network using tensor flow.
			v. Making Deep Learning model using Image Data: Digit Recognition Model.
6. Computer Vision	6	9	i. Introduction to Computer Vision
			ii. Image Representation and Analysis
			iii. Write programs using machine learning algorithms in Open CV for detection and recognition of images.
			iv. Learn Face recognizers.
			v. Training image data and prediction.

7. Natural Language Processing	4	6	i. Understand the basics of text processing. ii. Working with Text Data, Count Victimization, and sparse matrix. iii. Learn application of natural language processing. iv. Understand the concepts of NLP and process linguistic data using the popular algorithms.
8. Case Study	2	3	Case Study of use of Machine Learning in Real Life Applications

2.13.5. Detailed Syllabus

Introduction to Artificial Intelligence

Introduction to Artificial Intelligence (AI), history of AI. Advantages of AI need for AI for modern applications, intelligent agents, structure of Agents, agent program: goal-based agents, utility-based agent, learning agents, agent environment, multi agent systems, components of intelligence. Foundations of AI based Systems. Introduction to Business Intelligence, Business Analytics, Data, Information, how information hierarchy can be improved/introduced, understanding Business Analytics, Introduction to OLAP, OLTP, data mining and data warehouse. Difference between OLAP and OLTP. Use of AI in data analytics.

Applications of AI

Applications of AI, health care sector, finance sector, smart cars, devices and homes, travel and navigations, entertainment, security, automation, automobile industry.

Advanced Python

Modules and Packages, Numpy Library, Numpy Basics, Subset, slice and index, Broadcasting and numpy functions. Pandas Library, Pandas Series, Indexing and selecting data, working with data frames, grouping and summarizing data frame, loading csv, reading data from various sources, manipulating data frames, Aggregation functions, Analysis, Visualization using mat plot lib, functionalities of plots, sub plots,

Machine Learning
Basics of Machine Learning (ML), Need for Machine Learning, Machine Learning Definitions, Type of Machine Learning Problems. Data Pre-processing, Why Data Pre-processing, Data, Pre-processing Process, Independent and Dependent Variables, Missing Data in Dataset, Checking Missing Values, Replacing missing values, Data Imputation, Imputing numerical values, Imputing Categorical values, Encoding Categorical Data, Label encoding, One Hot encoding, Feature Scaling, Training data and Testing data, train_test_split.

Machine Learning (Regression), Kind of Machine Learning Regression Problems, Applying Linear Regression Algorithm, Score of the applied model, Predicting the x_test on the model, Performance Evaluation of Regression ML Model, Deployment of model. Machine Learning (Classification Problem), Classification: Use Cases, Applying Classification Algorithms: Logistic Regression, Support Vector Machines, Decision Tree Classifier, Gaussian NB, Neighbors Classifier etc., Performance evaluation: Confusion Matrix, Deployment of Classification Model. Introduction to Clustering, Use of clustering in ML, Applications of clustering, Clustering v/s classification, Types of clustering, Types of clustering algorithms, Features of good clustering, Clustering Problem in Machine Learning, Applying K-Means Clustering Algorithm. Mathematics behind Regression Algorithms, Mathematics behind Classification Algorithms, Purity metric, Gini and Entropy.Overfitting, under fitting, Cross Validation, features engineering.

Deep Learning
Deep Learning Concepts, Reinforcement Learning, Artificial Neural Networks and Model, ANN structure, Feed Forward Neural network, Back Propagation, Convolution Neural Network (CNN), Neural Network using Tensor Flow. Learning Algorithms, Error correction and Gradient Descent Rules, Perception Learning Algorithm. Making Deep Learning model using Image Data: Digit Recognition Model

Computer Vision
Introduction to Computer Vision, Image Representation and Analysis, Face Recognition and Detection with Open CV, Face Recognizers, Training data, Prediction.

Natural Language Processing
Natural Language Processing, Working with Text Data, Count Victimization, sparse matrix, NLTK, Basics of text processing, Lexical processing, NLP tasks in syntax, semantics, and pragmatics. Applications like Automatic Summarization, Sentiment Analysis and Text Classification. Solving Text Classification Problem, Making Model, Model Evaluation and confusion matrix.

2.13.6. Recommended Books

1. Introduction to Artificial Intelligence and Experts System, by Patterson Dan, W., PHI
2. Artificial Intelligence a Modern Approach, by Peter Novig, S. J. Russel, Pearson
3. Machine Learning an algorithmic Perspective by Stephen Marshland
4. Learning Python By Mark Lutz, David Ascher
5. Introduction to Machine Learning with python by Andreas C Muller, Sarah Guido
6. Open CV Essentials by Oscar Deniz Suarez, NoeliaVallezEnano by Packt Publishers
7. Deep Learning with Python by Francois Chollet.

2.14. Module: B5.3-R5- Web Technologies

2.14.1. Introduction

Java is a language and J2EE is a platform, which implements Java language. J2EE is a standard for Java 2 Enterprise Edition. Core Java and advanced java are the standard editions of Java whereas `J2EE is the enterprise edition, which is a combination of both Core & Advanced Java. It is used for creating enterprise web applications. This course is designed to meet the needs of Java programmers who want to be professional in building enterprise applications and web portal using Java Technologies.

2.14.2. Objective

The course is designed to impart knowledge and develop skills required to solve real world problems using object oriented approach, Java Language. After the completion of the course the student is expected to understand:

➢ Basics of Object Oriented Programming.

➢ Various Object Oriented programming concepts - Abstraction, Objects and Classes, Inheritance, Polymorphism and how to achieve reusability using these concepts.

➢ Concrete collection implementations and apply sorting and searching through collections

➢ Knowledge of Server Side programming by implementing JSP. Understand and write the deployment descriptor and enterprise application deployment. Design and implement components like: Session, Java Beans, JSTL, Tag Extension and Filter.

➢ Frameworks such as Spring Architecture and Hibernate Architecture, Distinguish JDBC and Hibernate.

➢ Design and Develop various application by Integrating any of JSP, spring, Hibernate by analyzing requirements and evaluating existing system.

2.14.3. Duration

120 Hours - (Theory: 48 hrs + Practical: 72 hrs)

2.14.4. Outline of Module

Module Unit	Duration (Theory) in Hours	Duration (Practical) in Hours	Learning Objectives
1. Introduction to Java and OOPs concepts	2	3	After completion of this unit of module, the candidate will be familiar to i. OOPs Concept ii. Java Execution Model
2. Java Concept	12	18	After completion of this unit, candidate will have in depth knowledge of i. Use of variables, literals, data types and arrays. ii. Working with each data item iii. Java operations, loops, conditional & jump statements
3. Database Concept and JDBC Connectivity	6	9	After completion of this unit, candidate will be will be familiar with the i. JDBC Architecture ii. JDBC APIs that provide various classes and interfaces to develop a JDBC application using SQL Transactions
4. Servlet API	6	9	After learning this unit, candidate will be able to: i. Understand role of Java Servlets in the overall Java 2 Enterprise Edition architecture, and as the best Java solution to HTTP application development ii. Use request and response objects

			provided to a servlet to read parameters and to produce an HTML response iii. Develop interactive web applications using HTML forms and servlets
5. JSP and database connectivity	6	9	After learning this unit, candidate will be able to: i. Design and build robust and maintainable web applications ii. Create dynamic HTML content with Servlets and Java Server Pages, using the JSP Standard Tag Library (JSTL) iii. Use JSTL and other Custom Tag Libraries to separate Java and HTML code iv. Access databases with JDBC
6. Hibernate Framework	8	12	After completion of this unit, candidate will have in depth knowledge of i. Understand the concepts of object/relational mappings ii. Create Hibernate mappings iii. Retrieve and update persistent objects using Hibernate iv. Use HQL (Hibernate Query Language) and criteria queries
7. Java Web Frameworks: Spring MVC	8	12	After completion of this unit, candidate will be able to

			i. Use the Spring MVC web framework and form tag library to develop flexible web applications ii. Understand the need for the Spring framework iii. Use inversion of control to increase flexibility and testability of applications iv. Integrate Spring with the Hibernate ORM framework

2.14.5. Marks Distribution

Module Unit	Written Marks (Max.)
1. Introduction to Java and OOPs concepts	5
2. Java Concept	15
3. Database Concept and JDBC Connectivity	15
4. Servlet API	10
5. JSP and database connectivity	15
6. Hibernate Framework	20
7. Java Web Frameworks: Spring MVC	20
Total	100

2.14.6. Detailed Syllabus

Introduction to Java and OOPs concepts

Introduction to Java, Java Programming Features, Object Oriented Programming, OOPS concepts and terminology, Advantages of OOPS, Fundamentals of OOPS, Concept of Classes and Objects, Encapsulation, Abstraction , Polymorphism , Overloading, Execution Model of Java, Byte code, Compiling and Interpreting Java program

Java Concept

Data Types, Variables, Arrays, Operators, Control Statements, Java Classes and Objects, Methods and lambda expression, Inheritance, Packages and Interfaces, Exception Handling, String Handling , Introduction to Java Collections and Stream API

Database Concept and JDBC Connectivity

Introduction to JDBC, JDBC Architecture, Types of JDBC Drivers, Common JDBC Components, Registering JDBC Drivers, Opening Connection, connecting a Java program to a Database, Executing Query, Statement Class & Objects, Getting Information from Database, Obtaining Result Set Information and DML Operations through JDBC

Servlet API

Overview of Servelt, Servelt Life Cycle, HTTP Methods Structure and Deployment descriptor Servlet Context and Servelt Config interface, Attributes in Servelt, Request Dispatched renter face, Cookies and Session Management: Understanding state and session, Understanding Session Timeout and Session Tracking, URL Rewriting

JSP and database connectivity

Introduction to JSP , JSP Architecture, JSP Life Cycle, JSP Scripting Elements, JSP Directives, JSP Action, JSP Implicit Objects, JSP Expression Language, JSP Standard Tag Libraries, JSP Session Management, JSP Exception Handling, Form validation and CRUD Application

Hibernate

Introduction to Hibernate, Exploring Architecture of Hibernate, O/R Mapping with Hibernate, Hibernate Annotation, Hibernate Query Language, CRUD Operation using Hibernate API.

Java Web Frameworks: Spring MVC

Spring Introduction, Spring Architecture, Spring MVC Module, Life Cycle of Bean Factory, Explore: Constructor Injection, Dependency Injection, Inner Beans, Aliases in Bean, Bean Scopes, Spring Annotations, Spring AOP Module, Spring DAO, Database Transaction Management, CRUD Operation using DAO and Spring API

2.14.7. Recommended Books

1. Java - The Complete Reference by H. Schildt, Tata McGraw-Hill.
2. OCA Java SE Programmer I Certification Guide by Mala Gupta, Dramatic Press
3. Professional Java Server Programming by Subrahmanyam Allamaraju, Cedric Buest Wiley Publication

4. Spring in Action 3rd edition , Craig walls, Manning Publication
5. Hibernate 2nd edition, Jeff Linwood and Dave Minter, Beginning Après publication

2.15. Module: B3.E1-R5- Digital Marketing

2.15.1. Introduction

In the modern days, consumers are being influenced by various popularly increasing online trends viz online shopping, audio and video streaming, education, banking, tours & travels and e-Governance services. With the increasing number of netizens, the Digital Marketing has emerged as one of the most cost-efficient and also one of the most effective ways for a business to market itself.

The curriculum of the course has been designed with an objective to develop professionals who not only possess theoretical knowledge of the subject but also have practical hands-on of the best practices prevalent in the field of Digital Marketing. The Fundamentals of Digital Marketing lays the foundation for understanding how to exploit the different digital marketing tools and gradually it moves towards the advanced techniques and best practices in the field of digital marketing that ensures businesses deliver better and integrated consumer experiences.

2.15.2. Objective

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

➢ Identify the scope and limits of the Digital Marketing (DM)field

➢ Apply techniques of Search Engine Optimization (SEO) and Search Engine Marketing (SEM)

➢ Effective Content Writing and Ad campaigns

➢ Learning the best practices to tap the potential of social media for marketing purpose

➢ Understand strategies involved in marketing of products and services digitally

2.15.3. Duration

120 Hours - (Theory: 48 hrs + Practical: 72 hrs)

2.15.4. Outline of Course

Module Unit	Duration (Theory) in Hours	Duration (Practical) in Hours	Learning Objectives(Learner will learn after completion of unit)
1. Fundamentals of Digital Marketing	6	9	i. Understand the concept of marketing the products and services digitally ii. Understand the definition and origin of Digital Marketing iii. Identify the benefits and difference of Digital Marketing vs. Traditional Marketing iv. Describe the phases and approaches in Digital Marketing
2. Search Engine Optimization (SEO)	6	9	i. Understand the concept of Search Engine Optimization ii. Describe the types of SEO iii. Understanding SEO Myth busters iv. Optimizing the site structure
3. Search Engine Marketing (SEM)	4	6	i. Understand the concept and importance of Search Engine Marketing ii. Learn Ad writing techniques iii. Identify and strategizing PPC (Pay-per-click) campaigns iv. Learn Link Building
4. Social Media Marketing (SMM)	6	9	i. Learn the concept and importance of Social Media Marketing (SMM) ii. Building successful Social Media Strategy iii. Setting SMM goals and bookmarking

			iv. Marketing on Social Media platforms such as Facebook, LinkedIn and Instagram v. Understanding Trends in Digital Marketing and Advertising
5. Content and E-mail Marketing	8	12	i. Learning Content writing techniques ii. Understanding the concept of Blogging, creating effective Blogs and Posts iii. Building blogging strategies powered by SEO iv. Micro-blogging using Koo and Twitter v. Creating Vlogs, Uploading on media streaming websites vi. Learning fundamentals and best practices of e-mail marketing vii. Developing e-mail strategies viii. Building and importing e-mail lists ix. Using segmentation strategy and segmentation lists
6. Affiliate Marketing	4	6	i. Understanding concept and importance of Affiliate Marketing ii. Understanding the difference between referral and Affiliate Marketing iii. Accessing and using Affiliate Marketing platforms
7. Web Analytics	6	9	i. Learning Web Analytics ii. Dashboard Preview& Customization iii. Real-Time Report

			iv. Audience Demographics v. UTM Parameters vi. Social Referrals and Referral Traffic vii. Google Search Console viii. Campaigns, Analysing Landing & Exit Pages ix. Event Tracking
8. Keyword Planning and Social Media Ad Campaigns	6	9	i. Define Keyword planning and its importance ii. Keyword Research iii. Learning Keyword Planning Tools, Goals and bidding Creating and running Social Media Ad Campaigns iv. Boosting techniques on social media channels v. Using Social Media Ad Campaign analytics vi. Online Reputation Management (ORM)
9. Lead Generation and Marketing Automation	2	3	i. Understanding Lead generation strategy ii. Capturing leads from sources iii. Understanding Marketing automation tools iv. Setting up email and SMS auto responders, Virtual Assistants
Total	48	72	

2.15.5. Detailed Syllabus

Fundamentals of Digital Marketing

Definition and origin of Digital Marketing; 4 P's; Evolution of Digital Marketing from Traditional to modern era; Role of Internet; Benefits of Digital Marketing and its scope; Digital Marketing Platforms, Basic terminologies in Digital Marketing, Building a digital presence for your business, Types of Digital Touch-points, Defining an online presence strategy, Understanding your business and brand, Understanding your consumer, Understanding your competition

Search Engine Optimization
Introduction of Search Engine Optimization (SEO); Need for SEO; SEO Techniques – White Hat, Black Hat and Grey Hat; Meta Tags and Meta Description; Search Engine Success Factors; Website Content Optimization; Back Link strategies; internal and external links; On Page and Off Page Optimization; SEO Tool Kit; Search Engine Result Pages (SERP); Page Rank and Myth Busters

Search Engine Marketing
Search Engine Marketing Overview; Pay-per-click overview; Strategizing PPC campaigns; Market Analysis; Ad writing Techniques; Campaign Management; Bid Management Plan; Performance Measurement and Matrices; Identifying Target Groups

Social Media Marketing (SMM)
Introduction to Social Media and Social Media Marketing (SMM); Need of SMM; Building successful SMM strategy; Goal setting and bookmarking; Customizing SMM campaign based on potential customers; Marketing on Social Media platforms such as Facebook, LinkedIn and Integra ; niche research; reverse engineering; Case study

Content and E-mail Marketing
Introduction of content writing techniques; concept of Blogging, creating effective Blogs and quality Posts; Building blogging strategies powered by SEO; Guest Blogging; Page clicks and impressions; Micro-blogging using Koo and Twitter; Creating Vlogs; Uploading on media streaming websites; Creating and managing Channels; Creating Video Libraries and Playlists; Monetizing contents; Channel Analytics

Email marketing an overview: Fundamentals of Email Marketing, Advanced Email Marketing, Email Best Practices and Myths, Bulk Email concept; Elements of marketing emails: Advantages of the different text formats (HTML or Plain Text), Permissions & E-permissions, Frequency & Ethics of Newsletters, Defining your Goals, Email Marketing Strategies; Build your email list: Building email list through a website subscribe form, Segmentation, Active Users; Measuring your email campaigns success: Open rates, click-through-rates, unsubscribe rates, conversion rates, and bounce rates

Affiliate Marketing
Affiliate Marketing basics and fundamentals; Difference between referral and affiliate marketing; Partnership with affiliate networks, Generating affiliate links, setting up website for promoting affiliate links; compensation methods; Customizing Affiliate campaigns; Strategy/planning & case studies; Ad Sense & Ad Words

Web Analytics
Introduction To Google Analytics, How Google Analytics works, Account Setup & Hierarchy, Dashboard Preview, Real-Time Report, Audience Demographics, Audience Behavior, UTM Parameters, Referral Traffic, Google Ads, Google Search

Console, Social Referrals, Campaigns, Analyzing Landing & Exit Pages, Analyzing Site Speed, Site Search, Event Tracking, Tracking Goals, Customizing Dashboard, Custom And Saved Reports, Setting Up Custom Alerts

Keyword Planning and Social Media Ad Campaigns
Discover new keywords related to your products, services, or website; Traffic Analysis on keywords; Determine cost and bidding on advertisement campaign; Select and organize keywords to fit into different categories related to your brand; Use of keyword plan to create new campaigns cantered on in-depth keyword research;
How to market on different social media channels; Content Marketing for social channels; Brand Building on Social Media; Social Media Advertising; Social Media Analytics; Managing a social media community; Online Reputation Management (ORM)

Lead Generation and Marketing Automation

Lead generation strategy, Lead and list management; CRM integration, sales integration, product integration; Capturing leads from sources; Lead source link building and lead tracking features; business reporting; web hooks and connector; Marketing Automation Tools; Email Auto responder; SMS Auto Responder; Virtual Assistants; Creating Landing Page; Landing Page –CTA; Website Widgets

2.15.6. Recommended Books

1. Digital Marketing, Second Edition by Seema Gupta, McGraw Hill
2. Fundamentals of Digital Marketing, Second Edition by Puneet Singh Bhatia, Pearson
3. Digital Marketing, by Vandana Ahuja, Oxford University Press

Reference Books
1. Marketing Without Money: An Essential Guide by Jessie Paul, Bloomsbury India
2. Social Media Marketing 2021 by Michael Branding, Notion Press

2.16.1. Introduction

This course provides an introduction to the process of designing models of existing or proposed real-world systems, and how to use the models to perform simulations that allow for predictions about the future behavior of the system. The system could be something as mundane as a cricket match, to something more complex, such as a communication network, or transportation system. Most systems of interest will require the development of one or more statistical models. Thus, modeling and simulation has a significant overlap with probability and statistics. The course topics will include a review of concepts from probability and statistics that are relevant to modeling and simulation, algorithms for random-variable sampling, modeling and analysis of basic queuing systems, variance-reduction techniques, statistical-validation techniques, Programming assignments will be provided throughout the semester. In addition, each student will complete an end-of-term project that centres on the modeling and simulation of a system of interest.

2.16.2. Objective

➢ Introduce computer simulation technologies and techniques, provides the foundations for the student to understand computer simulation needs, and to implement and test a variety of simulation and data analysis libraries and programs. This course focuses what is needed to build simulation software environments, and not just building simulations using pre-existing packages.

➢ Introduce concepts of modeling layers of society's critical infrastructure networks.

➢ Build tools to view and control simulations and their results.

2.16.3. Duration

120 Hours - (Theory: 48 hrs + Practical: 72 hrs)

2.16.4. Outline of Course

Module Unit	Duration(Theory) in Hours	Duration (Practical) in Hours	Learning Objectives(Learner will learn after completion of unit)
1. Introduction	10	15	i. Basics of simulations ii. Advantages & disadvantages

2. Statistical Models in Simulation	8	12	i.	Able to model deterministic systems and differentiate between nonlinear and linear models.
			ii.	Understand the numerically simulate ordinary differential equations and deterministic systems.
3. Random-Number Generation	8	12	i.	Numerical Techniques Sources and Propagation of Error
4. Input Modelling	8	12	Understanding of building model	
5. Estimation of Absolute Performance	6	9	Able to estimate and validate a model based upon input and output data.	
6. Measures of performance and their estimation 7. (Verification, Calibration and Validation)	8	12	Be able to model and simulate stochastic and discrete event systems. Able to estimate and validate a model based upon input and output data.	
Total				

2.16.5. Detailed Syllabus

Introduction:

Simulation Basics, When simulation is the appropriate tool and when it is not appropriate, Advantages and disadvantages of Simulation; Areas of application, Systems and system environment; Components of a system; Discrete and continuous systems, Model of a system; Types of Models, Discrete-Event System Simulation examples: Simulation of queuing systems. **General Principles, Simulation Software:** Concepts in Discrete-Event Simulation. The Event-Scheduling / Time-Advance Algorithm, Manual simulation Using Event Scheduling

Statistical Models in Simulation

Review of terminology and concepts, Useful statistical models, discrete distributions. Continuous distributions, Poisson process, Empirical distributions. **Dynamical,**

Finite State, and Complex Model Simulations: Graph or Network Transitions Based Simulations Actor Based Simulations Mesh Based Simulations Hybrid Simulations **Queuing Models:** Characteristics of queuing systems, Queuing notation, Long-run measures of performance of queuing systems, Long-run measures of performance of queuing systems cont…, Steady-state behaviour of M/G/1 queue, Networks of queues,

Random-Number Generation

Properties of random numbers; Generation of pseudo-random numbers, Techniques for generating random numbers, Tests for Random Numbers,

Random-Variant Generation: Inverse transforms technique Acceptance-Rejection technique.

Input Modelling:

Data Collection; Identifying the distribution with data, Parameter estimation, Goodness of Fit Tests, Fitting a non-stationary Poisson process, Selecting input models without data, Multivariate and Time-Series input models. Birth Death Process

Estimation of Absolute Performance:

Types of simulations with respect to output analysis, stochastic nature of output data, Measures of performance and their estimation, Coned... Measures of performance and their estimation, Output analysis for terminating simulations Continued.., Output analysis for steady-state simulations. Markov Process

Verification, Calibration and Validation:

Optimization: Model building, verification and validation, Verification of simulation models, Verification of simulation models, Calibration and validation of models, Optimization via Simulation. Simulations Results Analysis and Viewing Tools: Display Forms: Tables, Graphs, and Multidimensional Visualization, Terminals, X and MS Windows, and Web Interfaces, Validation of Model Results

2.16.6. Recommended Books

1. Jerry Banks, John S. Carson II, Barry L. Nelson, David M. Nicola: Discrete-Event System Simulation, 5th Edition, Pearson Education, 2010.

2. Lawrence M. Leemis, Stephen K. Park: Discrete – Event Simulation: A First Course, Pearson Education, 2006.

3. Averill M. Law: Simulation Modeling and Analysis, 4th Edition, Tata McGraw- Hill, 2007

4. Introduction to Dynamic Systems: Theory, Models, and Applications. D. G. Luenberger,   1979.

5. Numerical Analysis, R. L. Burden and J. D. Faires, 1993.

2.17. Module: B3.E3-R5- Distributed and Parallel Computing

2.17.1. Introduction

The purpose of Distributed and Parallel Computing is to design and develop hardware and software that helps to process large volume of data with high rate of performance. Different computing models are designed to meet this objective. Such computing models are Cloud, Grid, Parallel, Distributed and Edge. In this module, these computing models are covered.

The purpose of Cloud computing is the delivery of on-demand computing services over network to any end-user and the purpose of Grid computing is a group of networked computers which work together as a virtual supercomputer to perform large tasks.

The purpose of distributed computing is to make a network of computers that works as a single computer. Distributed systems have benefits over centralized system in terms of scalability and replication.

The purpose of parallel computing is to use multiple processing elements simultaneously to process data or to solve a problem. There are many advantages of use of parallel computing over conventional computing like time saving, solving large problem by splitting it, resource utilization etc.

Edge Computing brings computation and data storage closer to the sources of data, exploring topics such as developing scalable architectures, moving from closed systems to open systems, and ethical issues rising from data sensing, this timely book addresses both the challenges and opportunities that Edge computing presents. Contributions from leading IoT experts discuss federating Edge resources, middleware design issues, data management and predictive analysis, smart transportation and surveillance applications, and more. A coordinated and integrated presentation of topics helps readers gain thorough knowledge of the foundations, applications, and issues that are central to Edge computing.

2.17.2. Objectives

After completing the module, the incumbent will be able to:

➤ Understand the evolution and paradigm of Computing technologies

➤ Know the Architecture of Distributed and Parallel Computing systems

➤ Understand the components of Distributed and Parallel Computing and their working

➤ Understand the working of virtualization and its role in Cloud computing

➤ Understand the working of Grid computing

➤ Understand the working of Distributed and Parallel computing

> ➤ Understand the working of Edge computing and its benefits

2.17.3. Duration

120 Hours - (Theory: 48hrs + Practical/Tutorials: 72 hrs)

2.17.4. Outline of Module

Module/Unit	Duration (Theory) in Hours	Duration (Practical /Tutorials) in Hours	Learning Objectives
1. Introduction to Distributed and Parallel Computing Technologies	8	12	After completion of this unit of module, the Learner will be able to i. Know the basics of Distributed and Parallel Computing technologies. ii. Know the benefits of Distributed and Parallel Computing technologies.
2. Distributed Computing	20	30	After completion of this unit of module, the Learner will be able to ● Know the evolution of Distributed systems ● Know the Distributed File systems (DFS) ● Understand the role of transaction and concurrency controls in Distributed Systems ● Gain knowledge of mutual exclusion algorithms ● Know the basics of edge computing ● Know the Challenges in Federating Edge Resources ● Know the method Data Management in Edge Computing
3. Parallel Computing	20	30	After completion of this unit of module, the Learner will be able to

			● Know the parallel computing and its architecture ● Know working of OPENMP ● Know PRAM and its model
Total	48	72	

2.17.5. Marks Distribution

Module Unit	Written Marks (Max.)
1. Introduction to Distributed and Parallel Computing Technologies	20
2. Distributed Computing and Edge Computing	55
3. Parallel Computing	25
Total	100

2.17.6. Detailed Syllabus

(i) Introduction to Distributed and Parallel Computing Technologies

Introduction to Distributed and Parallel Computing Technologies: Introduction to Soft Computing, Introduction to Parallel Computing, Introduction to Ditributed Computing, Introduction to Edge Computing, benefits; Understanding Soft and HPC.

(ii) Distributed Computing

Evolution of Distributed Computing, various issues involved in designing a distributed system, the Challenges faced. Distributed computing models like Minicomputer, Workstation, Workstation-Server model, Processor – pool. Emerging trends in distributed systems

System models: Physical, Architectural and Fundamental models

Inter-process Communication (IPC): characteristics, group communication, Multicast Communication, Remote Procedure call, Network virtualization. Methods in IPC, Pipes, messaging queues, semaphores, shared memory, sockets

Distributed File System: File service architecture, Network file system

Transactional Concurrency Control:- Transactions, Nested transactions, Locks-Optimistic concurrency control

Distributed mutual exclusion – purpose of disrtibuted mutualexclusion, central server algorithm, ring based algorithm, Bully algorithm

Edge Computing

Introduction, Relevant Technologies, Advantages of FEC: SCALE, Hierarchy, Business Models, Opportunities and Challenges; Challenges: Networking, Management and Miscellaneous Challenges;

Edge Computing: Introduction, Relevant Technologies, Advantages of FEC: SCALE, Advantages: SCANC, Hierarchy, Business Models, Opportunities and Challenges.

Addressing the Challenges: Introduction, Networking Challenge, Management Challenge, Miscellaneous Challenges.

Middlewares: Introduction, Need, Design Goals, State-of-the-Art Middleware Infrastructures.

Data Management in Fog Computing: Introduction, Background, Data Management.

Case Studies: Big Data Analytics, Health Monitoring, Smart Transportation and IoT Applications.

(iii) **Parallel Computing**

Introduction to parallel Computing, parallel computing paradigm, parallel architecture, shared memory systems, cache coherence, distributed memory system

Shared address space system: OpenMP

Parallel random access machine (PRAM), PRAM Models, shared memory models

2.17.7. Recommended Books

1. Parallel & Distributed Computing by I. A. Dhotre, Technical Publications, 2021.
2. Introduction to Parallel Computing, Ananth Grama, Anshul Gupta, George Karypis and Vipin Kumar, Pearson Ed.

3. Fog and Edge Computing: Principles and Paradigms by Rajkumar Buyya, Satish Narayana Srirama, John Wiley & Sons, 2019.

2.18. Module: B3.E4-R5- Data Warehousing and Data Mining

2.18.1. Introduction

The main purpose of the course is to develop and gain an understanding of the principles, concepts, functions and uses of data warehouses, data modeling and data mining in business. In this course, students will study the various topics on Data warehousing and data mining are the essential components of decision support systems for the modern-day industry and business. These techniques `enable the knowledge worker (analysis, manager, executive) to make better and faster decisions. The objective of this course is to introduce the student to various Data Warehousing and Data Mining concepts and Techniques. A database perspective must be used throughout the course to introduce principles, algorithm, architecture, design and implementation of data mining and data warehousing techniques.

2.18.2. Objectives

After completing the module, the incumbent will be able to:

➢ Design a Data warehouse system

➢ Implement the designed model of the warehouse system

➢ Data Modeling as per requirements of a business

➢ Design and implementation of several Data Mining algorithms

➢ Evaluate a warehouse system using Data Mining algorithms.

➢ Describe the mining of web and Spatial data

2.18.3. Duration

120 Hours - (Theory: 48 hrs + Practical/Tutorial: 72 hrs)

2.18.4. Outline of Module

Module Unit	Duration (Theory) in Hours	Duration (Practical/ Tutorial) in Hours	Learning Objectives
1. Introduction	4	6	After completion of this unit, the Learner will be able to uunderstand the basics

			concept of Dara warehouse and Data mining
2. Data Warehousing	6	9	Familiarize with the Data warehouse, multidimensional database and Building steps of a Data Warehouse etc.
3. ETL processes	6	9	Implement the building of warehouse and possible process of ETL
4. Data Mining Primitives	4	6	Familiarize with the basis of data mining and Knowledge Discovery Database
5. OLAP engines and OLAP operations	6	9	Familiarize with the OLAP Engines and Develop use cases on Data Modeling using OLAP operations
6. Supervised and un-supervised techniques	4	6	Development of applications using Supervised techniques - Classification techniques
7. Association algorithms	4	6	Development of applications using Association Analysis, A priori algorithme etc.
8. Un-supervised algorithms	4	6	Development of applications using Un-supervised algorithms- Clustering Techniques etc.
9. Advanced Mining Concepts	4	6	Familiarize with the Data Mining attributes, and other topics- object oriented databases, spatial databases and multimedia databases, time series databases, Graph mining
10. Applications	6	9	Understand the advanced Topic- i. Exploration of related applications. ii. Mining-Pattern, opinion, Social media and crowd-sourcing data mining iii. Uses of data mining packages iv. Web content Mining, Bioinformatics

Module Unit	Written Marks (Max.)
1. Introduction	06
2. Data Warehousing	10
3. ETL processes	15
4. Data Mining Primitives	10
5. OLAP engines and OLAP operations	15
6. Supervised and un-supervised techniques	10
7. Association algorithms	10
8. Un-supervised algorithms	08
9. Advanced Mining Concepts	06
10. Applications	10
Total	100

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			v. Temporal and Spatial Data Mining:

2.18.5. Marks Distribution

2.18.6. Detailed Syllabus

Introduction
An introduction to multidisciplinary filed of Dara warehouse, Data mining. Issues in Dara warehousing and Data mining, Stress on important of its application potential etc.

Data Warehousing
Concepts of Data warehouse, deference between operational database system and data Ware house, Multidimensional Data Model: data cube, Stars – Snowflakes – Fact Schemas for multidimensional database, measures, concept hierarchies

Building of a Data Warehouse, Fact and dimension tables, Data Marts, Metadata, data quality problems

ETL processes
Extraction, Loading, Transformation techniques, Error event table, change data capture, Data-cubes, dimensions, and measures.ETL and ELT processes.

Data Mining Primitives
Data Preprocessing including Data cleaning - Data integration - Data transformation, Discretization and concept Hierarchy generation, Definition and Specification of a generic data miming task, Description of Data mining query language with few example queries. Knowledge Discovery Database (KDD)

OLAP engines and OLAP operations

Multi-dimensional data model, OLAP Engines, Data Modeling (Cube), Operation on multidimensional Data Model, Data Warehouse architecture, Types of OLAP (MOLAP and ROLAP) servers, Life cycle of data warehouse implementation, Relationship between data warehouse and data mining. Concept of non-structure Databases, operations using NoSQL

Supervised and un-supervised techniques

Supervised -Classification techniques, Decision trees, Bayesian classifier and Predictions, Issues regarding classification and predication, Different classification methods in cluding Decision tree induction – Bayesian Classification, Neural network technology, K- Nearest Neighbor Classifier- Case-based Reasoning - Fuzzy set theory - genetic algorithm, Prediction: Linear and Multiple Regression – Nonlinear Regression – Other Regression Models, Classifier Accuracy etc.

Association Algorithms

Association Analysis, A priori algorithme, Association rule mining, Mining Single Dimensional Boolean Association rule in truncation database, mining multilevel association rule, Discussion on few associations rule algorithm such as Apriority, frequent pattern growth, etc.., From Association rule to correlation analysis.

Un-supervised algorithms

Clustering Techniques: Hierarchical and partitioned clustering. K-means, Cluster Analysis- Types of data in cluster analysis, Partition based Clustering, Hierarchical Clustering, Density based Clustering, Grid based Clustering, Model based Clustering, Discussion on scalability of clustering algorithm, Outlier analysis, Parallel approaches to clustering. Introduction to CLARA, CLARANS, Hierarchical -DBSCAN, BIRCH, CURE, Categorical-STIRR, ROCK, CACTUS etc.

Advanced Mining Concepts

Data Mining attributes, Result Data Presentation, Data Preprocessing process, Dispersion of data.
Essential of Graph mining, FP-tree construction, sample of text mining.
Data mining issues in object-oriented databases, spatial databases, and multimedia
Data bases, time series databases, text databases, web mining: web usage mining – web Content mining – web log attribute.

Applications of Data Warehousing and Data Mining

Exploration of web sites on data warehousing and data mining application including bibliography databases, Corporate Houses and Research labs.

Mining-Pattern, opinion, Social media and crowd-sourcing data mining
Use of data mining packages and data warehousing packages, e.g. SAS, IBM, excel miner tools.

Web content Mining, Web structure Mining, Web usage Mining, Text Mining
Temporal and Spatial Data Mining: Basic concepts of temporal data Mining, Introduction to the GSP algorithm, SPADE, SPIRIT, WUM

2.18.7. Recommended Books

1. Hobbs, Lillian, et al. Oracle 9iR2 data warehousing Boston, MA: Digital Press, 2003.
2. Kimball, Ralph. The data warehouse ETL toolkit practical techniques for extracting, cleaning, conforming, and delivering data Indianapolis, Ind. : Wiley, c2004
3. Kimball, Ralph. The data warehouse toolkit the complete guide to dimensional modeling, second edition New York: Wiley, c2002.
4. Data Mining: Concepts and Techniques, Second Edition (The Morgan Kaufmann
5. Series in Data Management Systems) Jiawei Han and Micheline Kamber, ISBN-10:
6. 1558609016 ISBN-13: 978-1558609013; 2005
7. Arun K Pujari, "Data Mining Techniques" Universities Press.
8. M. Jarke, M. Lenzerni, Y. Vassiliou, and P. Vassiladis, "Fundamentals of Data
9. Warehouses, SpringerVerlag New York, Inc. Secaucus, NJ, USA.
10. Margaret Dunham, "Data mining: Introductory and Advanced Topics", Prentice Hall;

2.19.1. Introduction

In this course, students will study the various topics relevant to Software testing and quality assurance practices. It will provide understanding documents used in Pre- testing and post testing. The course will prepare the student for software testing and debugging. It will further lay the foundation for advanced topics -agile software Testing and Test Pyramid.

2.19.2. Objectives

After completing the module, the incumbent will be able to:

- ➢ To provide knowledge on life cycle models of a software and Industry practices
- ➢ To provide understanding documents used in Pre- testing and post testing
- ➢ To explore the Testing Techniques and Strategies
- ➢ To develop the Test Cases and Plans
- ➢ To conduct the test and produce reports
- ➢ To analyze applicable Quality Assurance and Standards
- ➢ To impart knowledge on Agile Software development practices and Agile Testing
- ➢ To provide knowledge on Version Management practices

2.19.3. Duration

120 Hours - (Theory: 47hrs + Practical/Tutorial: 73hrs)

2.19.4. Outline of Module

Module Unit	Duration (Theory) in Hours	Duration (Practical/Tutorial) in Hours	Learning Objectives
1. Introduction	2	3	After completion of this unit the Learner will be able to understand the concept of Software testing and quality assurance practices
2. Industry practices and Software Quality	4	6	Familiarize with the Industry practices and Software Quality

3. Understandin g Pre- testing documents	4	6	Understands the Pre- testing documents and its purposes
4. Testing Techniques and Strategies	8	12	i. Familiarize with Testing Terminologies, activities in Testing and designing the Test ii. Practice the Unit Testing process iii. Practice the other Integration, system, acceptance testing etc.
5. Building Test Cases and Plans	8	12	Developed Test Cases, Plans, and require reports
6. Verification, Validation and Debugging Technique and Tools	6	9	Familiarize with the Requirement verification, Coding standards, Walk through etc. and Debugging Technique and Tools, debugging, tracing
7. Quality Assurance and Standards	4	6	Familiarize the Software Quality Assurance and related standards
8. Post testing activities and documents	4	6	Understands the Post testing documents and its purposes
9. Agile Software development practices and Agile Testing	4	6	Familiarize with advance testing topics- Agile testing, test pyramid etc.
10. Version Control	4	6	Understand the practices of version Management, Changed management
Total	48	72	

2.19.5. Marks Distribution

Module Unit	Written Marks (Max.)
1. Introduction	05

2.	Industry practices and Software Quality	06
3.	Understanding Pre- testing documents	06
4.	Testing Techniques and Strategies	20
5.	Building Test Cases and Plans	20
6.	Verification, Validation and Debugging Technique and Tools	15
7.	Quality Assurance and Standards	10
8.	Post testing activities and documents	08
9.	Agile Software development practices and Agile Testing	05
10.	Version Control	05
	Total	100

2.19.6. Detailed Syllabus

Introduction
Software program and its objective, Life Cycle of a Software, Software development techniques, and top-down verses bottom-up approach, modular and structures programming. A brief introduction about object-oriented approach. Software testing and its importance, software development life cycle verses software testing life cycle, Deliverables, version, and error control

Industry practices and Software Quality
Industry practices- extreme Programming, Agile practices, Scrum
Software Quality Models-Hierarchical Quality Model, Quality Attributes, McCall's Quality Model, Quality Assurance: Planning and Reviewing, Quality in extreme Programming, Quality System and Standards, Capability Maturity Model (CMMI)

Understanding Pre- testing documents
Business Requirements Document, Purpose, Business Rules, Assumptions, Product Requirements, Functional Requirements, Mandatory Requirements etc.
Statement of Work-Objectives, Business Case, Scope of Effort, Management Approach, Quality Approach, Technical Approach, Phases of Design, Coding or construction, Test, Implementation, Roles, Responsibilities, Time, Cost, Risk, delivery dates etc.

Technical Detailed Design Specifications, Technical Architecture, Code Specifications, Components and layouts -Programs, Mock screen etc.

High Level Design Document-System Architecture, Detailed Design, Process Flow and Database and Files, sample layouts of Mockup Screen, Report and Templates etc.

Testing Techniques and Strategies
Life of a Bug, Validation, verification, Testing Terminologies-Test Case, Test
Criteria, Test Design, Test Strategy, Test Stub, Test Driver, Test Suite, Test
Script, Test Model etc.

Activities in Testing and Test Design Methods

Unit Testing process -Data Inputs and Data Outputs, Test cases, Expected
Results, Actual Result, Test Result Analysisetc

White-Box testing, testing -path, condition multiple condition, mutation.
Integration testing, System testing, Acceptance testing..Flow Graph notation,
Cyclamate Complexity, Graph matrices, control structure and loop testing.
Black-Box testing: Equivalence partitioning, Boundary Value Analysis,
Orthogonal Array testing. Testing UI/UX apps

Other testing type- accessibility, performance, mobile apps, script less apps,
security testing-dynamic and static applications etc

Building Test Cases and Plans
Format of test cases, and other data paths, Test data selection, branch
coverage, and statement coverage, pre-condition and post-condition, Test
schedule and check pointing, suitable exercises for creating test cases for each
type of techniques mentioned.

Verification, Validation and Debugging Technique and Tools
Requirement verification, Coding standards, Walk through, Formal Inspection,
Design validation and verification, Function test, Design metrics, correctness
proof and its requirement.

Debugging Technique and Tools-Integrated development environment,
debugging, tracing, data inspection, exception errors, code and data
redundancy, unreachable code.

Quality Assurance and Standards
Basic software quality parameters and its metrics, Software Configuration
Change and typesof errors, Quality management models: ISO, SPICE, IEEE,
CMM.

Post testing activities and document
Requirements Traceability Matrix [RTM], Requirement Functionality, Code
Module or File, Test Cases and References

Concept on Agile Software development practices and Agile Testing

Fundamentals of Agile Software and the Agile Manifesto, Role and Skills of the team
Agile Software Testing Techniques, Agile Testing Methods, Techniques, and Tools
The Test Pyramid, Testing Quadrants, Test Levels, and Testing Types

Version Control
Configuration Management, Change Management, tools, Roles and Responsibilities

2.19.7. Recommended Books

1. Desikan S, Ramesh G, "Software Testing", Pearson Education
2. Tamres L, "Introducing Software Testing", Pearson Education
3. Mathura A.P, "Fundamentals of Software Testing", Pearson Education
4. Testing Object Oriented Systems, Robert V. Binder, Addison Wesley
5. G. J. Myers, The Art of Software Testing
6. Beizer, Boris. Software Testing Techniques, 2nd Ed. Van Nostrand Reinhold, New York.
7. Pfleeger, L. Shari. Software Engineering-Theory and Practice. Prentice-Hall.
8. Brian Marick, "The Craft of Software Testing", Pearson Education, 2008.
9. Rajani & Oak, "Software Testing: Methodology, Tools and Processes" Tata McGraw-Hill, 2007.
10. R. Pressman, "Software Engineering", 6th Edition, Tata McGraw-Hill.
11. IEEE PMBOK
12. PRINCE2 materials

2.20.1. Introduction

This course Explain why the ability to perform digital processing of radiographic images is a Significant advantage. It Cover the basic theory and algorithms that are widely used in digital Image processing and Expose students to current technologies and issues that are specific to image processing systems. It gives to students the fundamentals of digital image processing, covering some topics from the following list: inverse problems in imaging; imageenhan cement; edge detection; feature extraction; and geometric diffusion. Describe the general relationship between image contrast and pixel values. It introduces the Virtual Reality and Augmented Reality practices.

2.20.2. Objectives

After completing the module, the incumbent will be able to:

➢   Explore the different aspect of Image processing and its applications

➢   Implement the designed model of Image Digitization, Image Enhancement, Image   Restoration, Image Compression, and Image Segmentation etc.

➢   Design and implementation of process of Image Transformations

➢   implementation of algorithms of Object detection

➢   Explore the different concepts on Virtual Reality and Augmented Reality

2.20.3. Duration

120 Hours - (Theory: 48 hrs + Practical/Tutorial: 72   hrs)

2.20.4. Outline of Module

Module Unit	Duration (Theory) in Hours	Duration (Practical/ Tutorial) in Hours	Learning Objectives
1. Introduction	4	6	After completion of this unit, the Learner will be able to uunderstand the basics concept of Image processing and its applications
2. Image Digitization	6	9	Familiarize with the Image Digitization process.
3. Image Enhancement	4	6	Implement the process of Image enhancement techniques

4. Image Restoration	4	6	Implement the process of Image Restoration techniques
5. Image Compression	4	6	Implement the process of Image Compression techniques
6. Image Segmentation	6	9	Implement the process of Image Segmentation techniques
7. Image registration and Multi-valued Image Processing	4	6	Familiarize with concept on Image registration and Multi-valued Image Processing
8. Image Transformations	4	6	Implement the process of Image Transformations
9. Object detection process	6	9	Implement the process of Object detection process
10. Introduction to Virtual Reality and Augmented Reality	6	9	Understand the advanced Topic- Introduction to Virtual Reality and Augmented Reality
Total	48	72	

2.20.5. Marks Distribution

Module Unit	Written Marks (Max.)
1. Introduction	08
2. Image Digitization	10
3. Image Enhancement	09
4. Image Restoration	10
5. Image Compression	10
6. Image Segmentation	08
7. Image registration and Multi-valued Image Processing	10
8. Image Transformations	10
9. Object detection process	15

10. Introduction to Virtual Reality and Augmented Reality	10
Total	100

2.20.6. Detailed Syllabus

Introduction
Introduction of Image, Image Processing with its applications, Components of Image processing system, Fundamentals of Image Processing: Image Acquisition, Image Model, Sampling, Quantization, Image Formation model.

Image Digitization
Image digitization process, Image representation schemes like, GIF, TIFF, BMP, JPEG etc. Resolution, Image size, File formats -bitmap and vector.

Image Enhancement
Introduction of Image enhancement, Image enhancement techniques: Contrast intensification by Linear stretching, Non-Linear stretching, Exponential stretching, Noise cleaning or Smoothing by Image averaging, Special filters like Mean filter, Median Filter, Max filter, Mean filter and Image sharpening and Christening. Cleaning process of the background of image and a video.

Image Restoration
Minimum Mean-square Error restoration, Least-square error restoration, Restoration by Singular Value Decomposition, Restoration by Maximum Posterior Estimation, Restoration by Homomorphism Filtering

Image Compression
Introduction, Error Criterion, Stages of Image compression, Difference between Lossy Compression techniques and Loss less image compression techniques, Compression techniques like Huffman coding, Run Length Encoding, Lempel-Ziv-Welch (LZW) coding, JPEG, Transform compression, Block Truncation compression, example of compression algorithms.

Image Segmentation
Definition of segmentation, Characteristics of Segmentation, Detection of Discontinuities, Thresholding. Pixel Based Segmentation Method. Region Based Segmentation Methods, Segmentation by Pixel Aggregation, Segmentation by Sub Region Aggregation, Histogram Based Segmentation, Spilt and Merge Technique, Segmentation of moving objects.

Image registration and Multi-valued Image Processing
Introduction of image registration, Geometric transformation, Plane to plane Transformation, Mapping, Stereo imaging, Multi-modal and Multi-spectral image processing, Pseudo and False colouring, Image fusion. Colour Models

Image Transformations
A Detail Discussion on Fourier Transform, DFT, FFT, and Properties of Fourier transform, Enhancement, Smoothening Filters

Object detection process
Image Classification, Object Localization, Object Detection, Object detection algorithms

Introduction to Virtual Reality and Augmented Reality
Evolution and Immersive Experience and application areas.
Visual presentation of objects through Transformation like zooming, panning, clipping, rotation and Rendering.
Basics of Animation like frame animation, Morphing, sample of Dynamic and responsive AR/VR – Applications, Languages and Tools.
Introduction to Unity SDK for implementing AR/VR, A-Frame, Browsers.
Introduction to Entity component System, JavaScript, Events
Introduction to Tools like three.js, 3D Models, Visual Inspector and Dev Tools
Case study on related Met averse

2.20.7. Recommended Books

1. Rafael C. Gonzalez& Richard E. Woods: Digital Image Processing, Addision-Wesley

2. Chanda, D. Dutta Majumder: Digital Image Processing and Analysis, PHI, 2000.

3. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins: "Digital Image Processing using MATLAB", Parsons Education Asia, 2004

4. Nick Afford: Know the basics of edge computing

5. Know the Challenges in Federating Edge Resources

6. Know the method Data Management in Edge Computing age Processing, Addison-Wesley Publishing Company, 2000.

7. Scott E Umbaugh: Computer Vision and Image Processing, PHI, 1998.

2.21.1. Introduction

Every person performs some kind of economic activity. A worker daily works and get wages and he spends to buy goods, cloths and some part of earnings saves for future. A business man purchases goods and sales it. He incurred various expenses like salaries, rent etc. A partner in firm contributes towards capital in the firm which carries on business may be trading in goods. Similarly, companies, Governments are also carries on some financial 3 activities. All are carrying some kind of economic activities. Such economic activities are performed through transactions and / or events. Thus the business transactions include purchase, sale of goods, rendering various services, receipts and payments for such transactions. In a business concerns the transactions are numerous. The details of all transactions cannot be remembered by the business man. Therefore, it is necessary to keep written records of all such transactions. The records of written transaction will help business to settle disputes and also possible to provide valuable information to the owner of business. Book-keeping disciple has been developed to serve this purpose. The aim of Book-keeping is to provide the information needed by the businessmen and also it helps him to take decisions.

2.21.2. Objectives

After completing the module, the incumbent will be able to:

➢ To keep a systematic record of financial transactions

➢ To help the users to understand the day to day transactions in a systematic manner so as to gain knowledge about overall business

➢ To reveal the profits and losses of the business and provide a true and fair view of the business which is aimed at safeguarding the interest of various stakeholders internal as well as external which are connected to the business.

➢ To explain the basic accounting procedures and financial management processes.

➢ To focus on the computerized implementation of the various accounting principles discussed at different levels.

2.21.3. Duration

120 Hours - (Theory: 48hrs + Practical: 72 hrs)

2.21.4. Outline of Module

Module Unit	Duration (Theory) in Hours	Duration (Practical) in Hours	Learning Objectives
Basic Accounting System	6	9	After completion of this unit of module, the Learner will be able to understand Accounting and its Functions, Scope of Accounting, Emerging Role of Accounting, Accounting as an Information System, Role and Activities of an Accountant, Accounting Personnel, Nature of Accounting Function, Organization Chart for Accounting and Finance
Accounting Concepts and Standards	8	12	After completion of this unit of module, the Learner will be able to understand Accounting Framework Accounting Concepts, Accounting Standards, Changing Nature of Generally Accepted, Accounting Principles (GAAP),Attempts towards Standardization, Accounting Standards in India
Preparation of Profit & Loss & Balance Sheet	6	9	After completion of this unit of module, the Learner will be able to understand i. Accounting Equation ii. Classification of Accounts Definitions of Journal and Ledger iii. Journalizing Process Ledger Posting iv. Balancing an Account

			v. Trial Balance vi. Objectives of Preparing Trial Balance vii. Preparation of Profit & Loss and Balance Sheet. Ledger Posting and Trial Balance. viii. Use of any Financial Accounting software either Licensed or Open source
Financial Management	8	12	After completion of this unit of module, the Learner will be able to understand, Cash and Treasury Management, Treasury Risk `Management, Functions of Treasury Department, Facets of Cash Management, Motives for Holding Cash, Cash Planning, Determining the Optimum Cash Balance, Methods of Cash Flow Budgeting, Investing Surplus Cash Collection and Disbursements. Budgeting and Budgetary Control.
Inventory & Receivables Management	8	12	After completion of this unit of module, the Learner will be able to understand, Reasons for Holding Inventory, Objectives of Inventory Management, Techniques of Inventory Control. Various techniques of receivable management
Portfolio Management and IT applications	6	9	After completion of this unit of module, the Learner will be able to understand, what is portfolio management, Portfolio management methods Design and implementation of portfolio management, Risk Management,

			Disaster Management, Portfolio management issues and challenges, Tools and techniques
Social, Ethical and Legal Aspects	6	9	After completion of this unit of module, the Learner will be able to understand Society in information age, Moral dimensions and information age, Technology trends and ethical issues, Ethical principal and dilemma, Responsibility, accountability and liability Information right and acts
Total	48	72	

2.21.5. Marks Distribution

Module Unit	Written Marks (Max.)
1. Unit 1	30
2. Unit 1I	30
3. Unit 1II	25
4. Unit 1V	15
Total	100

2.21.6. Detailed Syllabus

Unit 1

Basic Accounting System

Accounting and its Functions ,Scope of Accounting, Emerging Role of Accounting, Accounting as an Information System, Role and Activities of an Accountant, Accounting Personnel, Nature of Accounting Function, Organization Chart for Accounting and Finance

Accounting Concepts and Standards

Accounting Framework Accounting Concepts, Accounting Standards, Changing Nature of Generally Accepted, Accounting Principles (GAAP),Attempts towards Standardization, Accounting Standards in India

Preparation of Profit & Loss & Balance Sheet

Accounting Equation, Classification of Accounts Definitions of Journal and Ledger, Journalizing Process Ledger Posting, Balancing an Account, Trial Balance, Objectives of Preparing Trial Balance, Preparation of Profit & Loss and Balance Sheet. Ledger Posting and Trial Balance.

Use of any Financial Accounting software either Licensed or Open source

Unit II

Financial Management
Cash and Treasury Management, Treasury Risk `Management, Functions of Treasury Department, Facets of Cash Management, Motives for Holding Cash, Cash Planning, Determining the Optimum Cash Balance, Methods of Cash Flow Budgeting, In
vesting Surplus Cash Collection and Disbursements. Budgeting and Budgetary Control.

Inventory & Receivables Management
Reasons for Holding Inventory, Objectives of Inventory Management, Techniques of Inventory Control. Various techniques of receivable management

Unit III

Portfolio Management and IT applications
What is portfolio management, Portfolio management methods Design and implementation of portfolio management, Risk Management, Disaster Management, Portfolio management issues, Tools and techniques?

Unit IV

Social, Ethical and Legal Aspects

Society in information age, Moral dimensions and information age, Technology trends and ethical issues,
Ethical principal and dilemma, Responsibility, accountability and liability Information right and acts

2.21.7. Recommended Books

1. R.Narayanaswamy: Financial Accounting: A Managerial Perspective, PHI

2. MN Arora: Copst and Management Accounting, Vikas Publications

3. Prasanna Chandra, "Financial Management: Theory and Practices, 5th Edition, 2001, Tata McGraw Hill.

4. Robert N. Anthony and James s. Reece : Accounting Principles

5. S.N. Mahesweri : Advanced Accountancy

6. M.Y. Khan and P.K. Jain, "Management: Accounting", Second Edition, 1995 (Tata McGraw Hill Publishing Co. Ltd, New Delhi.

7. R.L. Gupta and M. Radhaswamy : Advanced Accountancy

8. Horngran, C.T., Foster G and Sales, S.M., "Cost Accounting: A Managerial Emphasis, 10th Edition, 2000, Prentice Hall of India.

9. Paresh Shah, Management Accounting, OUP

10. Ravi M. Kishore, Cost and Management Accounting, Taxmann

11. Pandey I.M., "Financial Manager, 7th Edition, 2002 Vikas Publishing Pvt.Ltd.

12. Ravi M. Kishore, Financial Management : Problems and Solutions, Taxman

2.22.1. Introduction

This course introduces students to the fundamentals of wireless and mobile communication concepts. This subject is framed to set the required background in wireless communication. Being the backbone for all the IT based developments; Wireless Technology has seen tremendous growth in the past decade. There are new techniques and protocols emerging from time-to-time to cater the requirements of this rapidly growing area. The subject will cover from rf fundamentals to the topics like cellular, WiFi, WPN and WSN technologies. The treatment would look at current and upcoming wireless communications technologies for various wireless accesses.

2.22.2. Objective

At the end of the course the students will be able understand

- ➢ Basic concept of Radio frequency & characteristics of a wireless communication channel.
- ➢ Basic concepts of cellular communication
- ➢ Different methods of improving coverage and increasing the capacity of cellular systems.
- ➢ Types of hand-off mechanism and spread spectrum techniques
- ➢ The architecture of modern and emerging cellular standards – 3G, 4G, 5G, CDMA, LTE, UMTS
- ➢ Wireless LAN and its applications
- ➢ Technologies used for building the Wireless Sensor Network and Wireless personal area networks
- ➢ To enable students to acquire in-depth knowledge in the field of wireless communication technology with an ability to integrate existing and new knowledge with the advancement of the technology.

2.22.3. Duration

120 Hours - (Theory: 48 hrs + Practical: 72 hrs)

2.22.4. Outline of Module

Module Unit	Duration in Hours (Theory)	Duration in Hours (Practical)	Learning Objectives(Learner will learn after completion of unit)
1. Wireless Communication Fundamentals	12	18	i. Radio frequency fundamentals ii. Modulation Techniques for Wireless and Mobile communication. iii. Wireless Frequency Spectrum
2. Cellular & Mobile technologies	12	18	Basic cellular system concept Cellular standards and generations
3. Wireless LAN Technologies	12	18	i. Wireless LAN overview ii. WiFi standards iii. WiFi security
4. WSN and WPAN Technologies	12	18	i. Wireless Sensor Network basics ii. WSN Topology iii. WSN standards iv. WPAN standards & Applications
Total	48	72	

2.22.5. Marks Distribution

Module Unit	Written Marks (Max.)
1. Wireless Communication Fundamentals	25
2. Cellular & Mobile Technologies	25
3. Wireless LAN technologies	25
4. WSN and WPAN Technologies	25
Total	**100**

2.22.6. Detailed Syllabus

Wireless Communication Fundamentals

RF Basics: Radio Frequency (RF) Fundamentals: Introduction to RF & Wireless Communications Systems,, Units of RF measurements, Analog & Digital Modulatio techniques for Mobile communication, Multiple access techniques , Wireless Antenna basics, OFDM, MIMO

Cellular & Mobile technologies

Types of wireless communication, The modern wireless communication system, The cellular concept - system design issues, Cellular carriers and Frequencies, Channel allocation, Cell coverage, Cell Splitting,

Microcells, Picocells, Handoff and outage, Improving coverage and system capacity, Cellular Systems (1G, 2G, 3G, 4G, 5G and beyond 5G), AMPS, GSM, IS-95 & CDMA, Mobile IP, GPRS, EDGE, UMTS,
NBIoT. (3gpp standards), LTEM, optical high speed backend networks, 6G overview, Software Defined Networking (SDN) , Virtual RAN & Open RAN (VRAN & ORAN)

Wireless LAN Technologies

Wi-Fi Organizations and Standards: Regulatory Bodies, IEEE, Wi-Fi Alliance, WLAN Connectivity, WLAN QoS & Power-Save, IEEE 802.11 Standards,802.11-2007,802.11a/b/g, 802.11e/h/I,802.11n, 802.11AC.

Wi-Fi Hardware & Software: Access Points, WLAN Routers, WLAN Bridges, WLAN Repeaters, WLAN Controllers/Switches, Wireless Topologies, PoE Infrastructure, Wireless signaling.WiFi6, WiFi Security standards

WSN and WPAN Technologies

Wireless Sensor Network (WSN) & Wireless Personal Area Network(WPAN): Introduction to WSN, WSN IEEE standards, WSN Topologies, routing protocols for WSN, Wireless Adhoc Networks, Zigbee, Zwave, Thread, Bluetooth 1.0 to 6.0, LoRA & LoRA WAN, WiMaX, 6lowPAN,sigfox

2.22.7. Recommended Books

1. Theodore S. Rappaport, "Wireless Communications: Principles and Practice", Second Edition, 2002, Pearson Education Asia.

2. David Tse and Pramod Viswanath, Fundamentals of wireless communications, Cambridge University Press, First Edition, 2012

3. Henrik Schulz And Christian L¨uders, Theory and Applications of OFDM and CDMA Wideband Wireless Communications, , John Wily & Sons, First Edition, 2005

4. Bluetooth Revealed; By: Miller, Brent A, Bisdikian, Chatschik; Addison Wesley Longman Pte Ltd., Delhi

5. Wilson , "Sensor Technology hand book," Elsevier publications 2005.

6. Andrea Goldsmith, "Wireless Communications," Cambridge University Press, 2005

7. Mobile and Personal Communications Services and Systems; 1 st Edition; By: Raj Pandya; PHI, New Delhi

8. Mobile Communications; By: Schiller, Jochen H; Addison Wesley Longman Pte Ltd., Delhi

9. 3G Networks: Architecture, protocols and procedures based on 3GPP specifications for UMTS WCDMA networks, By Kasera, Sumit, Narang, and Nishit, TATA MGH, New Delhi 8. Wireless Sensor Networks: information processing by approach, ZHAO, FENG, GUIBAS and LEONIDAS J, ELSEVIER, New Delhi 9. Holger Karl and Andreas Wiilig, "Protocols and Architectures for Wireless Sensor Networks" John Wiley & Sons Limited 2008

10. Wireless Communications and Networking,Vijay Garg, Elsevier

11. Wireless digital communication, Kamilo Feher, PHI

12. Mobile Communications Engineering, William C. Y. Lee, Mc Graw Hill Publications

13. Wireless Communications-T.L.Singh-TMH 7 Adhoc Mobile Wireless network, C.K.Toh Pearson.

14. L.Hanzo,M.Munster, B.J.Choi and T.Keller, OFDM and MC-CDMA for Broadband Multi-user Communications, WLANs and Broadcasting, John Wiley & Sons

15. Andreas.F. Molisch, "Wireless Communications", John Wiley – India, 2006.

16. Simon Haykin & Michael Moher, "Modern Wireless Communications", Pearson Education, 2007.

17. Clint Smith. P.E., and Daniel Collins, "3G Wireless Networks", 2nd Edition, Tata McGraw Hill, 2007.

18. Kaveth Pahlavan,. K. Prashanth Krishnamuorthy, "Principles of Wireless Networks", Prentice Hall of India, 2006.

19. Sumit Kasera and Nishit Narang, "3G Networks – Architecture, Protocols and Procedures", Tata McGraw Hill, 2007.

2.23. Module: B3.E9-R5- Blockchain Technology

2.23.1. Introduction

The main purpose of the course is to develop and gain an understanding of the principles, concepts of Blockchain technologies. The course structure has been designed to provide the participants a sound theoretical knowledge as well as hands-on practical experience on formulating and developing Blockchain-based Daps. The course will help

To solve some real-life problems being faced today the technology has attracted huge interest from both academia as well as the industries that spread from crypto currencies to various other domains, including business process management, smart contracts, IoT, and so on.

2.23.2. Objectives

After completing the module, the incumbent will:

➢ Learn the concept of crypto currencies, predominantly Bitcoin, and Blockchain structure along with cryptography and consensus mechanisms.

➢ Learn about Ethereal and the process to use Blockchain technologies to create decentralized applications with the help of Smart Contracts.

➢ Learn Hyperledger and possess to develop an enterprise-grade and open-source distributed ledger framework. You will be taught about the Hyperledger architecture and its consensus mechanism

➢ Help to develop a DApp service and deploy it on a local test Blockchain

2.23.3. Duration

120 Hours - (Theory: 48 hrs + Practical/Tutorial: 72h rs)

2.23.4. Outline of Module

Module Unit	Duration (Theory) in Hours	Duration (Practical/Tutorial) in Hrs.	Learning Objectives
1. Introduction	4	6	After completion of this unit, the Learner will be able to understand the objectives, and importance of the course

2. Fundamentals of Blockchain Technology	2	3	Familiarize with Properties of Blockchain, Types of Systems, possible application areas and concept of the smart contracts, etc.
3. Consensus Mechanism	4	6	Familiarize with the consensus Mechanisms, Proof-of-Work, Mining and Incentives, Proof-of-Authority, Proof-of-Stake, Practical Byzantine Fault Tolerance (PBFT),etc
4. Encryption & Decryption Algorithm	4	6	Implement of Encryption & Decryption algorithms- RSA, Ceaser Cipher, Rijndael algorithm logic, Message Authentication Code
5. Crypto currencies and Bitcoin	2	3	Familiarize with crypto currencies, crypto currencies, Digital cash, Wallets, and Altcoins, etc
6. Types of Blockchain	6	9	Development of applications using Public Blockchain: (Ethereal), Ethereal Virtual Machine (EVM),
7. Private Blockchain	8	12	Development of applications using Hyperledger, uPort, SlockIt, Crypto-kitties, Augur, etc.

8. Implementation/Case studies	8	12	Development of
			  i. Private application son the Ethereal Blockchain platform.
			  ii. Smart Contracts,
			  iii. DApp Development environment

9. Standards and possible attacks	4	6	Familiarize with the Development Tools and libraries, Front End Technologies, Attacks on Smart Contracts, etc.
10. Use Case	6	9	Developing a use case and implementation as a mini project
Total	48	72	

2.23.5. Marks Distribution

Module Unit		Written Marks (Max.)
1.	Introduction	6
2.	Fundamentals of Blockchain Technology	6
3.	Consensus Mechanism	10

4.	Encryption & Decryption Algorithm	10
5.	Crypto currencies and Bitcoin	8
6.	Types of Blockchain	10
7.	Private Blockchain	10
8.	Implementation/Case studies	15
9.	Standards and possible attacks	10
10.	Use Case	15
Total		100

2.23.6. Detailed Syllabus

Introduction
Providing an intuition, objectives, and importance of the course. Introduction to Cryptography, Security goals (CIA Triad), Security services and mechanism, Prime Numbers, Modular Division, Encryption and Decryption, Types of Ciphers(Substitution, Transportation, Stream, and Block)

Group, Fields, and Rings, Symmetric and Asymmetric Cryptography, Public Key Infrastructure, Brief introduction to AES and DES, RSA Algorithm

Hashing and Digital Signature: Properties of hash functions, Message Authentication Code, Secure Hash Algorithm(SHA 256), Digital Signatures, Need for Digital Signatures, Elliptic Curve Digital Signature Algorithm (ECDSA)

Fundamentals of Blockchain Technologies
Definition of Blockchain, Properties of Blockchain, Types of System (Centralized, Distributed, Peer-to-Peer, Decentralized), CAP Theorem, Distributed Ledgers & Blockchain, Components of Blockchain (Blocks, Block Header, Block Pointer), Types of Blockchain, in brief, Identifying the need for Blockchain, Applications of Blockchain Technology (FinTech, IoT, Agriculture). Smart Contracts.

Consensus Mechanism
Need for having a consensus mechanism, 3 Generals Problem, Impossibility Theorem, Types of consensus mechanism, (Challenge-Response Based, Voting Based), Proof-of-Work, Mining and Incentives, Proof-of-Authority, Proof-of-Stake, Practical Byzantine Fault Tolerance (PBFT).
Attack Models on Consensus Mechanism.

Encryption & Decryption Algorithm
Encryption & Decryption using DES Algorithm. Encryption & Decryption using RSA Algorithm. Creaser Cipher Algorithms, Rijndael algorithm logic, Implement Message Authentication Code

Crypto currencies and Bitcoin

Definition of crypto currencies, crypto currencies v/s digital cash, History of Bitcoin, Properties of Bitcoin, Economics of Bitcoin, Roles of Bitcoin Exchanges, Wallets, and its types(Hot, Cold, and Paper), Wallet Security, Bitcoin v/s Altcoins

Types of Blockchain
a. Platforms
b. Public Blockchain: (Ethereum): Introduction to Ethereum Blockchain, State Transition Model
c. Ethereum Virtual Machine (EVM), Accounts, Concept of Gas, Gas Price, Gas Limit, Ethereum, Test Nets (Rinkeby, Kovan), Ethereum Main Net, Ethash, clique, Casper Ethereum PoS, Difference between Ethereum and Bitcoin, Application of Ethereum beyond crypto currencies

Private Blockchain
a. Hyperledger: Introduction to Hyperledger projects in brief.
b. Consortium Blockchain (R3 Corda): Introduction to R3 project in brief
c. Use Cases of Ethereum Blockchain: (uPort, SlockIt, Crypto-kitties, Augur, etc.)

Implementation/Case studies
a. Setting up a private, permission Blockchain network on the Ethereum Blockchain platform.
b. Smart Contracts: Introduction to Solidity: Background of Solidity, variables, storage, memory, messages, etc. Stack operations, mappings other basic constructs, etc.
c. DApp Development: Formulating the problem for the DApp project with proper Flowcharts and diagrams following software engineering principles.

Standards and possible attacks

Development Tools and libraries: Remix IDE, Ganache, Metamask, web3.js.

Learning Front End Technologies required for the project (React, HTML, JS, etc)

Attacks on Smart Contracts: DAO Attack and Parity Hack. Best Practices while writing smart contracts.

Use Case

Developing a use case and its implementation

3. Hardware Requirement

Minimum Computer Configuration Recommended

Desktop/Laptop/PC

Processor	:	1 GHz or higher
RAM	:	4 GB or higher
HDD	:	100 GB or higher free space
Monitor	:	SVGA or of latest technology
Mouse	:	Operating System compatible
Keyboard	:	Standard
NIC	:	Standard
Optical Drive	:	Standard
Speaker, Mic, Webcam	:	Standard
Printer	:	Standard
Projector	:	Standard
Modem/DSL	:	Standard
Scanner	:	Standard

Sufficient number of computers are standard networking are part of satisfying criteria for accreditation.

Networking

NIC	:	Standar
RJ-45 Connector	:	Standard
Crimping Tools	:	Standard
UTP/STP/Coaxial Fiber Optic	:	
Cables and their connectors	:	Standard
8/16 port Switch	:	Standard
Wi-Fi Router	:	Standard

Others

Arduino UNO or equivalent board sensors and motors

4.   Software Requirement

Sr. No.	Particular/ Module	Software
1.	Operating System	Linux /Ubuntu 16 or higher
2.	NOS	Linux
3.	Software Package	Any relevant word processing/spreadsheet/ presentation like Libre Office 6.0,
4.	Complier/Interpreter	Python, C, C++, Java
5.	Antivirus	Standard
6.	Internet and Web Publishing Tools	Standard Browser and publishing tools
7.	IoT	Arduino IDE, Any open source Tool
8.	Databases	MariaDB, MySQL
9.	Framework	Spring,
10.	IDE	Netbeans, eclipse, RStudio

5. Faculty Requirement

Faculty & Support / Lab Instructor:

Faculty:

MCA/ B.E. / B. Tech with minimum 4 years of experience in IT/ Computer Science.

Lab Instructor:

BCA/ BSc. IT/ NSQF-5 in IT-ITeS Sector with minimum 1 years of experience in IT/ Computer Science.