Guru Nanak Dev Engineering College, Ludhiana
Department of Computer Science and Engineering
Syllabus of MSE-I
Jan-May'2024

B.Tech.

Sem.: 4th

Discrete Mathematics (PCCS-103)
Fundamentals of Sets, Relations and Functions: Sets - Operations on sets, Subsets, Types of sets, Ordered pairs, Proofs of general identities of sets, Classes of sets and partitions, Countable and uncountable sets. Relations -Representations of relations, Types of relations, Composition of relations, Closure properties of relations, Equivalence relations, Compatibility relations, Partial order relations. Functions- Introduction and types of functions, Sum and product of functions, Hashing functions, Recursively defined functions. Prepositional and Predicate Logic: Prepositions and compound prepositions, Logical connectives, Truth tables, Logical implication and logical equivalence, Normal forms-Conjunctive and Disjunctive, Validity of well-formed formula, Propositional inference rules-Modus ponens and modus tollens. Predicate logic. Universal and existential quantification, Limitations of propositional and predicate logic. Combinatorial Mathematics: Basic counting principles, Permutations and combinations, Pigeonhole principle, Inclusion and exclusion principle, Recurrence relations-Solving homogeneous and non- homogeneous recurrence relations, Sequences, Generating function.
Computer Architecture & Microprocessor (PCCS-104)
Data Representation: Data types, Complements, Fixed point representation, Floating point representation, Error detection and correction. Register Transfer and Micro-operations: Addition, Subtraction, Multiplication and division algorithms and hardware, Register transfer language and operations, Arithmetic micro-operations, Logic micro-operations, Shift micro-operations, Arithmetic logic shift unit. Computer Organization and Design: Instruction codes, Computer registers, Computer instructions, Timing and control, Instruction cycle, Memory reference instructions, Input/ Output and interrupts, Design and working of a complete basic computer, Control functions, Design of accumulator logic. Memory Organization: Memory hierarchy, Main memory, Auxiliary memory, Associative memory, Cache memory, Virtual memory, Memory management hardware.
Operating System (PCCS-105)
Introduction: Concept of Operating Systems, Generations of Operating systems, Types of

Operating Systems, OS Services, System Calls, Structure of an OS-Layered, Monolithic, Microkernel Operating Systems, Case study on UNIX and WINDOWS Operating System

Process management: Concept of processes and threads, Definition, Process and Program, Different states of a Process, Process State transitions, Process Control Block (PCB), Context switching Thread: Definition, Various states, Benefits of threads.

Process Scheduling: Foundation and Scheduling objectives, Types of Schedulers, Scheduling criteria: CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time; Scheduling algorithms: Pre-emptive and Non pre-emptive, FCFS, SJF, RR; Multiprocessor scheduling: Real Time scheduling.

Data Structure (PCCS-106)

Basic concepts: Concept of data type, Linear and non-linear data structures, Data structures versus data types, Operations on data structures, Algorithm complexity and Asymptotic notations.

Arrays: Linear and multi-dimensional arrays and their representation, Operations on arrays, Sparse matrices and their storage.

Stacks: Sequential representation of stacks, Operations on stacks, Application of stacks - parenthesis checker, Evaluation of postfix expressions, Conversion from infix to postfix, Conversion from infix to prefix representation, Tower of Hanoi problem, implementing recursive functions.

Queues: Sequential representation of queue, Types of queue- Linear Queue, Circular Queue, Deque, Priority Queue, Operations on each types of Queues and their algorithms, Applications of Queues.

Linked List: Definition and representation of Linked list, Types of Linked list- Linear linked list, Doubly linked list, Circular linked list and Header linked list and their operations, Application of linked lists, Garbage collection and compaction, Linked representation of Stack and Queues and their algorithm

Software Engineering (PCCS-107)

Introduction: Evolution and impact of software engineering, Software myths, Software application domains, Software crisis-Problem and causes.

Software Process Models: Software process, Software process models- Waterfall model, Prototype model, Spiral model, Evolutionary model, RAD model, V-model and Component based model.

Requirements Engineering: Feasibility study, Problem analysis, Requirement elicitation and specification, Functional and non-functional requirements, Software requirements specification

document, Requirement validation and management.

Project Management and Risk Analysis: Project planning, Cost estimation techniques- Size metrics, Empirical estimation, Heuristic estimation and analytical estimation, Project monitoring and control- Work breakdown structure, Activity chart, Gantt charts
structure, Activity chart, Gantt charts

Environmental Sciences (MCCS-101)

Natural resources: Renewable and non-renewable resources, Natural resources and associated problems, Forest resources- Use and over-exploitation, deforestation, case studies, Timber extraction, mining, dams and their effects on forests and tribal people.

Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dam's benefits and problems, Food resources- World food problems, changes caused by agriculture and over gazing, effects of modern agriculture, Fertilizers- pesticides problems, water logging, sanity, case studies, Energy Resources- Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies, Land Resources- Land as a resource, land degradation, man induce landslides, soil erosion and desertification.

Eco systems: Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers, decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, Food webs and ecological pyramids, Introduction, types, characteristic features, structure and function of the following ecosystems- Forest ecosystem, Grass land ecosystem, Desert ecosystem, Aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries.

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Sem.: 6th

Computer Graphics (PCCS-113)
Introduction: Overview of computer graphics, Computer graphics applications, Different I/O devices with specialized graphics features, Elements of graphics. Graphic systems " Video display devices, Raster scan systems, Random scan systems. Video basics " Video controller, Raster-scan display processor. 2D Primitives: Scan conversion basics, Algorithm for scan converting a point, Scan converting a line "Digital differential analyser algorithm, Bresenham's line algorithm. Scan converting circle - Bresenham's circle drawing algorithm, Midpoint circle drawing algorithm. Scan converting ellipse - Midpoint ellipse algorithm. Filling Techniques - Scan line polygon fill algorithm, Boundary-fill, Flood-fill. Anti-aliasing.
Machine Learning (PCCS-114)
Introduction: Well defined learning problems, defining a learning system, perspectives and issues in machine learning, the concept learning task, concept learning as search, Find-S: finding a maximally specific hypothesis, version spaces and the candidate elimination algorithm, Inductive bias, probability theory. Supervised Learning: Basic methods: Distance based methods, Nearest- Neighbors, Decision Trees, Naive Bayes, and Linear models: Linear regression, Logistic Regression, Generalized Linear Models, Support Vector Machines, Nonlinearity and kernel Methods. Unsupervised Learning: Clustering: k-means/ kernel k-means, Dimensionality Reduction: PCA and kernel PCA, Matrix Factorization and Matrix Completion, Generative models (mixture models and latent factor models). Decision Tree Learning: Introduction, decision tree representation, appropriate problems for decision tree learning, the basic decision tree learning algorithm, hypothesis space search in decision tree learning, Inductive bias in decision tree learning, Ensemble methods- Bagging, Gradient Boosting, Random Forest.
Cyber Security (PCCS-115)
Introduction to Cyber Space: History of cyber space, Cyber Crime, Information Security, Computer Ethics and Security for users, Familiarization with secure web browser and guidelines to choose, Role of Antivirus, Guidelines for Secure password, Two-steps authentication, Introduction to Password Manager, Wi-Fi Security. Secure Social Media usage and security: Best practices for safer Social Networking, Basic

Security for Windows, User Account Password Smartphone Security, Android Security, IOS Security.

Cloud Computing-I (OECS-113)

Introduction to Amazon Web Services (AWS) Cloud: Global infrastructure of AWS cloud, Cloud Services: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS), Cloud storage. Structure of Cloud: Availability Zone, Edge Location, Origin, Latency, Region. Introduction to AWS Console.

Virtual Servers, Content Delivery and Virtual Storage: Virtual Servers: Amazon Elastic Compute Cloud (Amazon EC2), Amazon Simple Storage Service (S3) bucket, Virtual Storage: Amazon Simple Storage Service (Amazon S3), Amazon Elastic Block Store (Amazon EBS), Hard Disk Drive (HDD),Solid State Drive (SDD), Input / Output Operations Per second (IOPS)

Cloud Security and Monitoring the Cloud: Cloud Security: AWS Identity and Access Management (IAM), Role, User, Security group, Policy, Amazon Inspector, Root User, Credential, Multi-Factor Authentication (MFA), AWS shield, AWS Web Application Firewall (WAF), Distributed Denial of Service (DDoS), AWS Artifact. Monitoring the Cloud: Amazon CloudWatch, AWS CloudTrail, AWS Config, Amazon Simple Notification Service (Amazon SNS)

Software Testing & Quality Assurance (PECS-102)

Introduction: Overview of Software Engineering, Software Process, Process Models, Overview of
Project Management Process and its Phases.

Testing principles and basic concepts: Testing Concepts: Purpose of Software Testing, Testing Principles, Goals of Testing, Testing aspects: Requirements, Test Scenarios, Test cases, Test scripts/procedures, Strategies for Software Testing, Testing Activities, Mistakes, Faults & Failures, Planning for Verification and Validation, Software Inspections, Automated Static Analysis, Verification and Formal Methods, Levels of Testing White-Box Testing: Test Adequacy Criteria, Static Testing, Structural Testing, Code Complexity Testing, Mutation Testing, Data Flow Testing Black-Box Testing: Test Case Design Criteria, Requirement Based Testing, Positive and Negative Testing, Boundary Value Analysis, Equivalence Partitioning State Based Testing, Domain Testing.

Test planning and Execution: Test Plan, Test Management, Test Execution and Reporting, Test Specialist Skills, Tester's Workbench and Tool Categories, Test Maturity Model and Test Process Assessment, Debugging & Root Cause Analysis, Software Items, Component & Units, Test Bed, Traceability and Testability, Attributes of Testable Requirements, Test Matrix, Types

of Testing Documentation, Verification Testing, Validation Testing, Integration Testing, System and Acceptance Testing, GUI Testing, Regression Testing, Selection, Minimization and Prioritization of Test Cases for Regression Testing, Creating Test Cases from Requirements and Use cases, Software Defects: Origins of Defects, Defect Classes, Defect Repository / Test Design, Defect Repository.

Network Security & Cryptography (PECS-108)

Introduction to Security: Essentials of network security, Architecture, Security goals, cryptographic attacks: cryptanalytic, non-cryptanalytic attacks, active attack and passive attack, security Services and security mechanism, Fundamental Security design principles, Network security model, standards.

Number Theory: Integer Arithmetic, Euclidean Algorithm, Extended Euclidean Algorithm, Modular Arithmetic, Matrices, Linear Congruence, Prime numbers, Fermatâ€˜s and Eularâ€˜s Theorem, Factorization, Chinese Remainder Theorem.

Classical Encryption Techniques: Encryption, Decryption, Plaintext, Cipher text, Key range and Size, Symmetric cipher model, Substitution techniques: Mono-alphabetic ciphers (additive, Caesar,Multiplicative, affine), polyalphabetic cipher (autokey, playfair, Hill Cipher) Transposition techniques (keyless, keyed, combined approaches)

Advanced Database Management System (PECS-114)

Introduction to SQL Programming Techniques: Database Programming: Issues and Techniques, Embedded SQL, Dynamic SQL, Database Programming: Data Types, Variables, Constraints, Operators, Conditions, Loops, Strings, Arrays, Procedures, Functions, Cursors, Records, Exceptions, Triggers, Packages, Database Stored Procedures.

Transaction Processing and Optimization: Transaction Processing Concepts, Concurrency Control Techniques, Timestamp ordering, Multiversion Concurrency Control Techniques, Validation (Optimistic) Concurrency Control Techniques, Granularity of Data Items and Multiple Granularity Locking.

Query Processing and Optimization: Query Processing, Syntax Analyzer, Query decomposition, Query Optimization, Heuristic Query Optimization, Algorithms for SELECT and JOIN Operations, Algorithms for PROJECT and Set Operations, Implementing Aggregate Operations and OUTER JOINS. Using Selectivity and Cost Estimation in Query Optimization. Semantic Query Optimization.

Object-Oriented DBMS: Introduction Advanced Database Applications, Weakness of RDBMS, Storing Objects in Relational Database. Next- Generation Database Systems, OODBMS Perspectives, Persistence, Issues in OODBMS, Advantages and Disadvantages of OODBMS, Object- Oriented Database Design, Comparison of ORDBMS and OODBMS.

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Natural Language Processing (PECS-120)

Introduction: Introduction to natural language and speech processing, Steps for processing natural languages, Issues and challenges for processing of natural languages, Elements of information theory, Brief history of natural language processing.

Morphological Analysis: Inflectional and Derivational morphology, Morphological parsing, Lexicon and Morphotactics, Finite state transducers, N-gram language models, N-gram smoothing, Entropy.

Part-of-Speech Tagging: Word classes, Part-of-speech tagging, Tagsets, POS tagging Techniques - Rule- based, Stochastic, Transformation-based.

Java Programming (PECS-126)

Introduction: History of Java, Importance of Java to the internet, Java's Magic – The Byte code features of Java, Overview of Java

Java Basics: Data-types, Variables, Arrays, Operators, Expressions, Control statements, Type conversion, Concepts of classes and objects, Constructors, Methods, Access control, this keyword, Garbage collection, Overloading methods and constructors, Parameter passing, Recursion, Understanding static, Introducing nested and inner classes, Using command line arguments, Introduction to string handling

Inheritance: Basics of inheritance, Types of inheritance, Member access rules, Using super, Using final with inheritance, Method overriding, Dynamic method dispatch, Using abstract classes.

Packages and Interfaces: Defining a package, Accessing a package, Understanding CLASSPATH, Importing packages, Differences between classes and interfaces, defining an interface, implementing interface, Variables in interface, Extending interfaces.

Compiler Design (PCCS-112)

Introduction to Compiler: Language Processors, The Structure of a Compiler, The Grouping of Phases into Passes, Applications of Compiler Technology, Programming Language Basics.

Lexical Analysis: Role of lexical analyzer, Tokens, Patterns, and Lexemes, Attributes for Tokens, Lexical Errors, Input Buffering, Sentinels, Specification of Tokens, Recognition of Tokens, The Lexical-Analyzer Generator Lex, Finite Automata.

Syntax Analysis: Introduction, Role of the parser, Context-Free Grammars (CFG), Writing a Grammar, Writing a Grammar, Top down parsing - Backtracking, LL (1),

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Sem.: 8th

Software Metrics (PECS-105)
Software Metrics: Measurement in software engineering, software metrics, Metrics data collection and analysis. Complexity Metrics and Models: Lines of Code, Halstead's Software Science, Cyclomatic Complexity Syntactic Metrics, and An Example of Module Design Metrics in Practice. Object Oriented Projects: Object Oriented Concepts and Constructs, Productivity Metrics, Quality Management Metrics. Estimate internal product attributes: Aspects of software size, length, functionality, and complexity, measuring structure, types of structural measures, control-flow structure, and modularity and information flow attributes, data structures. Estimate external product attributes: Modeling software quality, software reliability, software reliability problem, parametric reliability growth models, predictive accuracy, importance of operational environment, and wider aspects of software reliability.
Block Chain Technology (PECS-113)
Introduction to Cryptography: Need of Cryptography, Traditional and Modern techniques, Hash function, Distributed Hash Table, Digital Signatures, Symmetric and Asymmetric Key Cryptography, Zero Knowledge Proof, Double Spending problem. Introduction to Blockchain: Distributed Database, shortcomings of current transaction systems, distributed network, difference between blockchain and traditional database, evolution of blockchain. Bitcoin's Architecture, Blockchain Architecture: merkle root tree, gas limit, transactions and fee, nonce value, anonymity, reward, chain policy, miners, validators, types (private and public blockchains), Challenges to Blockchain Implementation, Features of Blockchain Network, Soft & Hard Fork. Distributed Consensus I: The mining mechanism, Two Generals Problem, Byzantine General problem and Fault Tolerance, Nakamoto consensus, Evaluation aspects Blockchain consensus protocols: Scalability, Throughput (TPS), Latency, Security, Fault Tolerance Rate, Energy Department of Computer Science and Engineering Consumption.
Big Data (PECS-118)
Introduction to Big Data: Big data overview, V's of big data, Data structures, State of the practice in analytics, Current analytical architecture, Drivers of big data, Big data ecosystem and a New Approach to Analytics, Key roles for the new big data ecosystem, Data at rest v/s data at motion, Examples of big data analytics tools.

Apache Hadoop: Understanding distributed system and Hadoop, Comparing SQL databases and Hadoop, MapReduce building blocks of Hadoop –Name node, Data node, Secondary name node, Job- Tracker, Task-Tracker, Introducing and configuring Hadoop cluster – Local, Pseudo distributed mode, Fully distributed mode, Handling web-based Cluster, and Configuring XML files.

Working with Hadoop: Interacting with HDFS, Steps to read and write into HDFS. Anatomy of MapReduce Program – Hadoop data type, Mapper and Reducer, Partitioner, Combiner, Reading and writing format, Word count with predefined Mapper and reducer.

Cloud Computing-II (OECS-114)

Amazon Web Services (AWS) Shared Security Model: Introduction to AWS security model for cloud services, Identity and access management (IAM), Principle of least privilege (PoLP), Denial of service (DoS), Distributed denial of service (DDoS), Watering hole attack, Multi-factor authentication (MFA), Amazon inspector, AWS trusted advisor, Amazon simple storage service (Amazon S3), Amazon elastic block store (Amazon EBS), Amazon relational database service (Amazon RDS)

Cloud Services, Instance States and Auto Scaling in Cloud Environments: Cloud service models: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). Amazon elastic compute cloud (Amazon EC2), EC2 instance states, AWS instance lifecycle, Instance store volumes, Amazon machine image (AMI), IPv4 address and IPv6 address, Elastic IP address, Automatic scaling in cloud environments, Auto scaling groups, Fleet, Launch template, Scale-out and Scale-in.

Component Based Development (PECS-107)

Component Definition: Definition of Software Component and its Elements. Component Models and Component Services: Concepts and Principles, COTS Myths and Other Lessons Learned in ComponentBased Software Development, Roles for Component-Based Development, Common High-Risk Mistakes in Component-Based Software Engineering, CBSE Success Factors: Integrating Architecture, Process, and Organization.

Software Engineering Practices: The Practice of Software Engineering, From Subroutines to Subsystems: Component-Based Software Development. The Design of Software Component Infrastructures: Software Components and the UML, Placing Software Components in Context, Business Components, Components and Connectors: Catalysis Techniques for Defining Component Infrastructures, An Open Process for Component-Based Development, Designing Models of Modularity, and Integration.

Internet of Things (PECS-112)

Introduction to Internet of Things (IoT): IoT Definition, IoT Vision, Smart and Hyper-connected Devices, Conceptual Framework, Architectural View, Technology behind IoT, Major

Components of IoT System, Sources of IoT, Examples of IoT.

IoT & M2M: Difference between IoT and Machine to Machine, M2M Architecture, SNMP protocol, IoT reference model, Lightweight M2M Communication Protocol, Domain model - information model, functional model, communication model.

Data Science (PECS-119)

Introduction to Data Science, Introduction to Big Data, Relationship between Big Data and Data Science, Benefits and uses of Data science and Big data. Data Structure: Structured vs Unstructured Data. Drivers of big data, Data Growth-issues and challenges, Data Science vs Business Intelligence.

Data Collection and Data Science Process: Sources of Data, Data collection and APIs, Data Science Process: Goal setting, retrieving data, data preparation, data cleansing and transformation, exploratory data analysis, data visualization, Model building and performance evaluation, presentation.

Data Representation: Various Forms of data, Text data, Graph-based data. Modern databases-text files, spreadsheets, SQL databases, NoSQL databases, Distributed databases, Live data streams, Image, Sensor and Network data. Dataset Terminology: Observations and variables, Discrete and Continuous variables, Quantitative and Qualitative variables, Dependent and Independent variables.

Mobile Application Development (PECS-130)

Introduction: Introduction to mobile applications, Market and business drivers for mobile applications, Publishing and delivery of mobile applications, Requirements gathering and validation for mobile applications, Different types of Mobile Applications – Native Application Development and Hybrid Mobile Application Development.

Android: The Android Platform, Android SDK, Eclipse Installation, Android Installation, Building you First Android application, Understanding Anatomy of Android Application, Android Manifest file.

Android Application Design Essentials: Anatomy of an Android applications, Android terminologies, Application Context, Activities, Services, Intents, Receiving and Broadcasting Intents, Android Manifest File and its common settings, Using Intent Filter, Permissions.

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M.Tech.

Sem:2nd

Advance Algorithms (MCS-103)
Introduction to analysis of algorithms: Review of various sorting algorithms, Asymptotic Notation, Performance analysis, space and time complexity. Fundamental Techniques: Divide and Conquer, Greedy Method, Dynamic Programming. Graphs: Definitions and Elementary Algorithms- Shortest path by Breadth First Search, Depth First Search and computation of strongly connected components, shortest path in edge weighted case (Dijkstra's Algorithm), correctness proof of Dijkstra's algorithm, Directed Acyclic Graphs - Topological sorting. Dynamic Programming: Elements of dynamic programming, Applications of dynamic programming – Rod cutting problem, Bellman-Ford algorithm and Floyd-Warshall algorithm for shortest path in graphs. Greedy Algorithms: Introduction to greedy algorithms, Elements of greedy strategy, Prim's and Kruskal's algorithm for minimum spanning tree, Introduction to Matroids.
Soft Computing (MCS-104)
Introduction: Introduction to Soft Computing, Historical Development, Definitions, advantages and disadvantages, Hard computing vs soft computing, Applications of soft computing. Neural Networks: Model of an artificial neuron, Comparison of artificial neural network and biological neural network, Neural network architectures, Learning methods, Activation functions, Perceptron, Hopfield network, Back-propagation network, Radial basis function network.
Software Testing and Quality Assurance (MCS-136)
Software Testing Basics And Testing Techniques: Basic definitions, Testing as a process, Role of process in software quality Software testing principles, The tester's role in a software development organization, Origins of defects, Defect classes, The defect repository and test design, Defect examples, Developer / Tester support for developing a defect repository. Using White Box Approach to Test design - Static Testing Vs. Structural Testing, Code Functional Testing, Coverage and Control Flow Graphs, Using Black Box Approaches to Test Case Design, Random Testing, Requirements based testing, Decision tables, State-based testing, Cause-effect graphing, Error guessing, Compatibility testing. Levels Of Testing And Software Test Automation: Levels of Testing -Unit Testing, Integration Testing, Defect Bash Elimination. System Testing - Usability and Accessibility Testing, Configuration Testing, Compatibility Testing. Software Test Automation, Scope of Automation, Design and Architecture for Automation, Requirements for a Test Tool, Challenges in Automation, Tracking the Bug, Debugging.

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Natural Language Processing (MCS-143)
Introduction: Need for processing of natural languages, Language processing levels, Issues and challenges in NLP, History, Classical approaches to NLP with knowledge bases and linguistic rules. Introduction to formal languages, finite state automata and regular expressions. Applications of NLP. Morphology and Phonology: Morphology fundamentals, Inflectional and Derivational morphology, Morphological parsing, Finite State transducers, N- gram language models.