B.Tech.

Sem.: 4th

Discrete Mathematics (PCCS-103)
Algebraic Structures and Morphism: Algebraic structures with one binary operation, Properties of an operation, Congruence relation, Semi groups, Monoids, Groups, Substructures, Cyclic groups, Cosets, Normal subgroups, Dihedral groups, Permutation Groups. Homomorphism and isomorphism of groups, Applications of groups. Algebraic structures with two binary operations, Rings – Introduction, Abelian ring, Ring with unity, Multiplicative inverse, Subrings, Homomorphism of rings. Integral Domain, Ideals. Boolean Algebra: Boolean algebra, Boolean sub-algebra, Boolean rings, Application of Boolean algebra (Logic implications, Logic gates, Karnaugh-map). Graphs and Trees: Graphs – Definition, degree, Connectivity, path, cycle, Directed and undirected, Sub Graph, Bi-connected component and Articulation points. Eulerian chains and cycles, Hamiltonian chains and cycles, shortest paths algorithms – Dijkstra's algorithm, Warshall's algorithm. Rooted trees, Spanning tree algorithms – Kruskal's algorithm, Prim's algorithm. Graph coloring, Map Coloring, Chromatic number, Planar graphs, Euler's formula, Isomorphism and homomorphism of graphs, Applications of graph theory.

Computer Architecture & Microprocessor (PCCS-104)
Central Processing Unit and Input-Output Organization: General register organization, Stack organization, Addressing modes, RISC and CISC architecture, I/O interface, Asynchronous data transfer, Modes of transfer, Priority interrupt, DMA, I/O processor, Microprocessor Architecture: Introduction to microprocessors, 8085 microprocessor architecture – Bus structure, Register organization. Programming with 8085: Addressing modes, Instruction classification, Instruction formats, Data transfer operations, Arithmetic operations, Logical operations, Branch operations, Stack and subroutine operations, looping, counting and indexing operations. Interfacing: Memory and I/O mapped I/O, Programmable interfaces – 8255 programmable peripheral interface, 8259 interrupt controller, and 8237 DMA controller. Microprocessor Applications: Interfacing of keyboards and seven segment LED display, Study of traffic light system, stepper motor controller.

Operating System (PCCS-105)
Inter-process Communication: Critical Section, Race Conditions, Mutual Exclusion, Hardware Solution, Strict Alternation, Peterson's Solution, The Producer\ Consumer Problem, Semaphore Deadlocks: Introduction to deadlocks, Conditions for deadlock, Resource allocation graphs, Deadlock prevention and avoidance, Deadlock detection and recovery.

Memory Management: Basic concept, Logical and Physical address map, Memory allocation: Contiguous Memory allocation – Fixed and variable partition–Internal and External fragmentation and Compaction; Paging: Principle of operation – Page allocation – Hardware support for paging, Protection and sharing, Disadvantages of paging, Segmentation.

File Management: Concept of File, Access methods, File types, File operation, Directory structure, Allocation methods (contiguous, linked, indexed), Free-space management (bit vector, linked list, grouping), directory implementation (linear list, hash table), efficiency and performance.

Secondary Storage: Disk structure, Disk scheduling – FCFS, SSTF, SCAN, C-SCAN, LOOK, C- LOOK, Disk Management, Disk Formatting, Boot blocks, Bad blocks.

Data Structure (PCCS-106)

Trees: Basic terminology, Sequential and linked representations of trees, Different types of TreesBinary Tree, Binary search tree, Threaded binary tree, AVL tree and B-tree. Operations on each of the trees. Application of Binary Trees.

Graphs: Basic terminology, Representation of graphs – Adjacency matrix, Adjacency list. Operations on graph, Traversal of a graph – Breadth first search, Depth first search. Shortest path algorithms – Dijkstra's and Floyd. Minimum spanning tree – Prim and Kruskal. Applications of graphs.

Heaps: Representing a heap in memory, Operations on heaps, Application of heap in implementing priority queue and Heap sort algorithm.

Hashing and Hash Tables: Introduction to hash table, Hash functions, Concept of collision and its resolution using open addressing and separate chaining, Double hashing, Rehashing.

Searching and Sorting: Linear and binary search techniques, Sorting methods – Bubble sort, Selection sort, Insertion sort, Quick sort, Merge sort, Shell sort and radix sort. Complexities of searching and sorting algorithms.

Software Engineering (PCCS-107)

PERT charts, Critical path method, Manpower management, Risk management- Identification, Analysis, Planning and Monitoring.

Software Design: Modular design– Coupling, Cohesion and abstraction, Function oriented design– Data flow diagrams, Structure chart, Object oriented design–Objects and object classes, Relationships between classes, User interface design

Coding & Testing: Coding standards and code reviews, Testing – Need of testing, Unit testing, Integration testing, System testing, White-Box testing, Black-box testing, Alpha, Beta and acceptance testing, Smoke testing, Sanity testing, Regression testing, Cyclometric Complexity. Verification and validation.

Maintenance and Re-engineering: Software maintenance, Software re-engineering, Reverse engineering, Forward engineering, PSP and Six sigma.

Environmental Sciences (MCCS-101)
Biodiversity and its conservation: Introduction- Definition- genetics, species and ecosystem diversity, Biogeographical classification of India, Value of biodiversity- competitive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, national and local level, India as a mega diversity nation, Hot spots of biodiversity, Threats to biodiversity- habitat loss, poaching of wildlife, man wildlife conflicts, Endangered and endemic species of India, Conservation of biodiversity- in-situ and ex situ conservation of biodiversity.
Environmental Pollution: Definition, causes, effects and control measures of – Air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution, nuclear hazards, Solid waste management- Causes, effects and control measures of urban and industrial wastes, Role of an individual in prevention of pollution, case studies.
Social issues and the Environment: From unsustainable to sustainable development, Water conservation, rain water harvesting, water shed management, Resettlement and rehabilitation of people- its problems and concerns, case studies, Environmental Ethics- issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies, Environmental protection act, Air (prevention and control of pollution) act, Water (prevention and control of pollution) act, Wildlife protection act, Forest conservation act.
Human population and the Environment: Population growth and variation among nations, Population explosion- family welfare program, Environment and human health, Human rights, value education, HIV/AIDS, Women and child welfare.

Sem.: 6th

Computer Graphics (PCCS-113)
2-D Transformations: Geometric and coordinate transformations. Geometric transformations – Scaling, Rotation, Translation, Reflection, Shear. Matrix representations, Homogeneous coordinates, Composite transformations.
2D Viewing and Clipping: The viewing pipeline, Window-to-viewport transformation, Point clipping, Line clipping algorithms – Cohen-Sutherland, Liang-Barsky, Nicholl-Lee-Nicholl. Polygon clipping algorithms –Sutherland-Hodgeman, Weiler-Atherton. Curve and text clipping.
3D Transformations and Viewing: 3D geometric transformations – Scaling, Rotation, Translation, Reflection, Shear. Composite transformations, 3D viewing, Viewing pipeline, Parallel projections, perspective projections, classifications of projections.
Visible-Surface Detection: Classification of visible-surface detection algorithms. Techniques for efficient visible-surface algorithms–Back face detection, Depth-buffer method, A-buffer method, Scanline method, Depth sorting method, BSP tree Method, Area-subdivision method, Octree Methods, Raycasting method.
Surface Rendering: Light sources, Surface lighting effects, Illumination models, Polygon rendering methods – Constant-intensity shading, Gouraud shading, Phong shading, Fast Phong shading.

Machine Learning (PCCS-114)

Artificial Neural Networks: Introduction, Neural network representation, appropriate problems for neural network learning, perceptron, gradient descent and the delta rule, Adaline, Multilayer networks, Derivation of Back propagation rule, back propagation algorithm, Initialization, Training & Validation.

Bayesian Learning: Introduction, Bayes theorem and concept learning, Maximum likelihood and least squared error hypothesis for predicting probabilities, minimum description length principle, Bayes optimal classifier, Naive Bayes classifier, Bayesian belief networks.

Genetic Algorithms: Motivation, Genetic algorithms, an illustrative example, hypothesis space search, genetic programming, models of evolution and learning.

Design and Analysis of Algorithms: Study of factors and responses related with experimentation, Hypothesis testing, performance analysis, Evaluation measures-bootstrapping & cross-validation, ROC curve

Cyber Security (PCCS-115)

E-commerce Security: Familiarization: Online Banking Security, Mobile Banking Security of Debit and Credit Card, UPI Security.

Micro ATM, e-wallet and POS Security: Security of Micro ATMs, e-wallet Security Guidelines, Security Guidelines for Point of Sales (POS), Cyber Security Exercise, Cyber Security Incident Handling, Cyber Security Assurance.

Social Engineering, Threat Landscape and Techniques: Social Engineering, Types of Social Engineering, How Cyber Criminal Works, How to prevent for being a victim of Cyber Crime, Cyber Security Threat Landscape, Emerging Cyber Security Threats, Cyber Security Techniques, Firewall.

Information Recovery Tools: Recovering from Information Loss, Destroying Sensitive Information, CCleaner for Windows, Various Case Studies.

Cloud Computing-I (OECS-113)

Virtual Servers, Content Delivery and Virtual Storage: Virtual Servers: Amazon Elastic Compute Cloud (Amazon EC2), Domain Name, Domain Name System (DNS), Amazon Simple Storage Service (S3) bucket, Amazon Route 53, Javascript Object Notation (JSON), Dynamic website, Static website. Content Delivery: Amazon CloudFront, AWS Direct Connect, Caching, Content Delivery Network (CDN), Distribution. 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)

Databases and Load Balancing: Databases: Relational database, Amazon Relational Database Service (Amazon RDS), Amazon DynamoDB, Nonrelational database, Amazon Redshift, Online Transaction Processing (OLTP), Online Analytic Processing (OLAP), Amazon Aurora, MySQL. Load balancing: Load balancer, Amazon ElastiCache, Data caching, Elastic Load

Balancing, Random Access Memory (RAM)

Elastic Beanstalk, CloudFormation, Billing and Support: AWS Elastic Beanstalk, AWS CloudFormation, Stack. Billing and Support: AWS simple monthly calculator, AWS support plan, Consolidated billing, Technical Account Manager (TAM)

Emerging Technologies in Cloud and Cloud Optimization: Machine Learning (ML), Artificial Intelligence (AI), Amazon SageMaker, Deep Learning, AWS DeepRacer, AWS DeepLens, Neural network, Blockchain technology. Cloud optimization using AWS Cloud Development Kit (CDK).

Software Testing & Quality Assurance (PECS-102)

Quality Assurance: The software quality challenge, Meaning of software quality, Software quality factors , Software Quality Lessons Learned, The components of the software quality assurance system, Pre-project software quality components: Contract Review, Development and quality plans, SQA components in the project life cycle: Integrating quality activities in the project life cycle, Assuring the quality of software maintenance components, Assuring the quality of external participants' contributions, CASE tools, Software quality infrastructure components, Pareto Principles, Total Quality Management, Ishikawa's Seven Basic Tools
 Software Quality Assurance Management: Management components of software quality: Project progress control, Software quality metrics, Costs of software quality, Standards, certification and assessment: Quality management standards, SQA project process standards – IEEE software engineering standards, Management and its role in software quality assurance, The SQA unit and other actors in the SQA system, Inspection as an Up-Front Quality Technique, Software Audit Methods, Software Safety and Its Relation to Software Quality Assurance, SQA for Small Projects, Development Quality Assurance, Quality Management in IT, Introduction to ITIL, Software Quality Assurance Metrics, Software Benchmarks and Baselines.

Network Security & Cryptography (PECS-108)

Modern Symmetric-key Ciphers: Modern Block cipher, components of block cipher, two classes of product cipher, Feistal structure, Data Encryption Standard (DES). Modern stream ciphers, Advanced Encryption Standard (AES), Stream ciphers – RC4.
 Public Key Cryptography and RSA: Symmetric – Key vs Asymmetric-key cryptosystems, Principles of public key cryptosystems, RSA algorithm and its attacks, Diffie Hellman Key Exchange.
Data Integrity and Authentication: Message: Hash function (SHA-I), Message Authentication (MD5), Digital Signature: services, attacks on digital signature, RSA Digital signature scheme.
Internet Security Protocols: General structure of Secure Socket Layer (SSL) and Transport Layer Security (TLS), Secure Electronic Transaction (SET), Email Security: Pretty Good Privacy (PGP), IP Security – Overview, IP security architecture modes, security protocols: Authentication header(AH) and Encapsulation security payload (ESP).

Advanced Database Management System (PECS-114)

Distributed Databases and Client-Server Architectures: Distributed Database Concepts, Data Fragmentation, Replication, and Allocation techniques for Distributed Database Design. Types of Distributed Database Systems, Query Processing in Distributed Databases, Overview of Concurrency Control and Recovery in Distributed Databases.

Overview of Data Warehousing and OLAP: Introduction, Characteristics of Data Warehouses, Data Modeling for Data Warehouses, Building a Data Warehouse, Typical Functionality of a Data Warehouse, Data Warehouse versus Views, Problems and Open Issues in Data Warehouses.

Data Mining Concepts: Overview of Data Mining Technology, Association rules, Classification, Clustering, Approaches to Other Data Mining Problems, Application of Data Mining, Commercial Data Mining Tools.

Emerging Database Technologies and Applications: Mobile Databases, Multimedia Databases, Geographical Information Systems (GIS), Genome Data Management.

Natural Language Processing (PECS-120)

Syntactic Analysis: Introduction to parsing, Basic parsing strategies, Top-down parsing, Bottom-up parsing, Dynamic programming – CYK parser, Issues in basic parsing methods, Earley algorithm, Parsing using Probabilistic Context Free Grammars.

Semantic Analysis: Lexical semantics, Lexemes, Relations among lexemes and their senses, WordNet, Word Sense Disambiguation – Supervised and Un-supervised approaches. Information Extraction – Introduction to Named Entity Recognition and Relation Extraction.

Pragmatics: Discourse, Discourse structure. Dialogue – Acts, structure, conversational agents. Language generation, Architecture for generation.

Applications: Different application areas of natural language processing – Machine translation, Machine learning, Text categorisation and summarisation, Speech synthesis, Speech recognition, Optical character recognition, Database access, etc.

Java Programming (PECS-126)

Exception Handling: Concepts of exception handling, Exception types, Using try, catch, throw, throws and finally, Java's built in exceptions, Creating own exception subclasses.

Multithreading: Java thread life cycle, Creating threads, Using isAlive() and join(), Synchronization, Interthread communication, Suspending, resuming,stopping threads.

Event Handling: Delegation event model, Event classes, Sources of events, Event listeners, Handling mouse and keyboard events, Adapter classes, Inner classes. The AWT class hierarchy, User interface components – Labels, Button, Canvas, Scrollbars, Text components, Check box, Check box groups, Choices. Lists panels – Scrollpane, Dialogs, Menubar, Graphics. Understanding layout managers – Flow Layout, BorderLayout, GridLayout and CardLayout.

Applets: Basics of applets, Differences between applets and applications, Life cycle of an applet, Types of applets, The HTML applet tag, Creating applets, Passing parameters to applets

Compiler Design (PCCS-112)
Bottom-up parsing – Shift reduce parsing, LR parsers, SLR parser. Canonical LR parser, LALR parser, Introduction to The Parser Generator Yacc.   Syntax-Directed Translation: Syntax-Directed Definitions, Evaluation Orders for SDD's, Applications of Syntax-Directed Translation, Syntax-Directed Translation Schemes, Implementing L-Attributed SDD's.   Intermediate Code Generation: Variants of Syntax Trees, Three-Address Code, Types and Declarations, Translation of Expressions, Type Checking, Control Flow, Backpatching, Switch-Statements, Intermediate Code for Procedures.   Code Generation: Issues in the Design of a Code Generator, The Target Language, Addresses in the Target Code , Basic Blocks and Flow Graphs, Optimization of Basic Blocks, A Simple Code Generator, Peephole Optimization , Register Allocation and Assignment.   Machine-Independent Optimizations: The Principal Sources of Optimization, Introduction to Data-Flow Analysis, Foundations of Data-Flow Analysis, Constant Propagation, Partial-Redundancy Elimination, Loops in Flow Graphs

Sem.: 8th

Software Metrics (PECS-105)
Component-based system: Metrics for object-oriented systems, Object-oriented analysis and design and its characteristics.   MOOD metrics: Component-based metrics and its characteristics and various component-based suites.   Dynamic Metrics: Runtime Software Metrics, Extent of Class Usage, Dynamic Coupling, Dynamic Cohesion, and Data Structure Metrics.   Software Quality: Concepts of software quality, software quality control and software quality assurance, evolution of SQA, major SQA activities and issues, zero defect software. Software Quality Assurance: SQA techniques; Management review process, technical review process, walkthrough, software inspection process, configuration audits, and document verification.

Block Chain Technology (PECS-113)
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.   Distributed Consensus II: Consensus Algorithms: Proof of Work, Proof of Stake, Delegated Proof of Stake, Proof of Activity, Comparison among them.   Ethereum: Public consortium blockchain: Introduction of Ethereum, Ethereum account, Ethereum network, Ethereum client, Ethereum gas, Ethereum virtual machine, Ethereum block,

header, Ether, smart contracts.
 Blockchain use cases: Applications in finance: settlements, KYC, capital markets, insurance; supply chain: provenance of goods, visibility, trade supply chain finance, invoice management discounting; government: digital identity, land registration; medical information systems.

Big Data (PECS-118)

Big Data Management: In-database Analytics – Introduction to NoSQL– Aggregate data models, Graph databases, Graph-less databases, Distribution models, Introduction to HBase, MongoDB, and Cassandra, Introduction to Hive and Spark.
Business Analytics: Decision making in business analytics, Business analytics in practice – Financial analytics, Healthcare analytics, Sport and web analytics. Categorization of analytics methods and models – Descriptive analytics, Predictive analytics, Perspective analytics.
Analytical Methods and Case studies: Linear regression, Logistic regression, K-Means clustering, Decision tree classification. Case studies: Social data analytics, Recommendation engines, Customer analytics.

Cloud Computing-II (OECS-114)

Automatic scaling in cloud environments, Auto scaling groups, Fleet, Launch template, Scale-out and Scale-in.
Dynamic Web Servers, Lambda and CloudFormation: Static website, Dynamic website, Amazon CloudFront, Content delivery network (CDN), Edge location, Origin, Distribution, Time to live (TTL), AWS Lambda, CloudFormation template, Infrastructure as code (IaC)
 Artificial Intelligence (AI) and Machine Learning (ML): Introduction to AI and ML, AWS DeepLens, AI services from AWS platform: Amazon Comprehend, Amazon Forecast, Amazon Lex, Amazon Personalize, Amazon Polly, Amazon Rekognition, Amazon Textract, Amazon Translate, Amazon Transcribe. Impact of AI, Deep learning, Reinforcement learning, Supervised learning, Unsupervised learning, Forecasting, Neural network, AWS machine learning applications.
 Internet of Things (IoT) and Big Data: Introduction to IoT and Big data, AWS IoT services, Apache Hadoop, Big data processing cycle, Data analytics, AWS Big data applications and services.
Blockchain and Cryptocurrency: Introduction to blockchain technology, Cryptocurrency, Cryptocurrency mining, Decentralized database, Hash, Immutable transactions, Smart contract, AWS blockchain products.

Component Based Development (PECS-107)

The Management of Component-Based Software Systems: Measurement and Metrics for Software Components, The Practical Reuse of Software Components, Selecting the Right COTS Software: Why Requirements are Important, Software Component Project Management Processes, The Trouble with Testing Software Components, configuration Management and Component Libraries, The Evolution, Maintenance and Management of Component-Based Systems.

Component Technologies: Overview of the CORBA Component Model, Transactional COM+: Designing Scalable Applications, The Enterprise JavaBeans Component Model, Choosing Between COM+, EJB, and CCM, Software Agents as Next Generation Software Components.

Internet of Things (PECS-112)

IoT & M2M: Lightweight M2M Communication Protocol, Domain model - information model, functional model, communication model.

Design Principles for Web Connectivity: Constrained Application Protocol, JSON (Java Script Object Notation) Format, Tag Length Value Format, MIME (Multipurpose Internet Mail Extension) Type, Message Communication Protocols for Connected Devices, Web Connectivity for Connected Devices Network.

Domain specific applications of IoT: Home automation, Industry applications, Surveillance applications, Environmental and Agriculture applications, Other IoT applications.

Developing IoT solutions: Data Aggregation for the IoT in Smart Cities

Data Science (PECS-119)

Data Exploration: Introduction and purpose of EDA (Exploratory Data Analysis), Descriptive statistics: mean, median and mode, variance and measures of variance: standard deviation, range, skewness, correlation, correlation. Handling anomalous values, missing values and outliers.

Data Visualization: Purpose and techniques of Data visualization: Histograms, Box Plots, Scatterplots. Normal Distribution: meaning and its characteristics, concept of transformations, transformation functions: Power function, Exponential function, Polynomial function, Model building and variable selection, Dimensionality, Feature selection methods: forward selection and backward selection procedure, stepwise selection procedure. Concepts of overfitting and under-fitting. Model validation and comparison: Confusion matrix: accuracy, precision and recall, ROC Curve.

Mobile Application Development (PECS-130)

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.

Android User Interface Design Essentials: User Interface Screen elements, Designing User Interfaces with Layouts, Drawing and Working with Animation, Testing Android applications, Publishing Android application, Using Android preferences, Managing Application resources in a hierarchy, working with different types of resources.

Using Common Android APIs: Using Android Data and Storage APIs, managing data using Sqlite, Sharing Data between Applications with Content Providers, Using Android Networking APIs.

iOS: Introduction to iOS, XCode and Swift, Architecture of Swift, Conditional Statement & Operators, Loops.

React Native: Introduction to React and React Native, Architecture of React Native, Working with content, Navigation, Statement Management in React Components

Parallel and Distributed Algorithms (PECS-129)

Synchronous Parallel Processing: Introduction, Example-SIMD Architecture and Programming Principles, SIMD Parallel Algorithms, Data Mapping and scheduling in array processors.

Distributed Algorithms: Definition, Issues, Goals, Types of distributed systems, Distributed System Models and complexity measures, Distributed Graph algorithms, Safety, liveness, termination, logical time and event ordering, Global state and snapshot algorithms, Mutual exclusion.

Synchronization: Clock Synchronization, Logical Clocks, Election Algorithms, Mutual Exclusion, Distributed Mutual Exclusion-Classification of mutual Exclusion Algorithm, Requirements of Mutual Exclusion Algorithms, Performance measure, Non Token based Algorithms: Lamport Algorithm, RicartAgrawala's Algorithm, Maekawa's Algorithm, Token Based Algorithms: Suzuki-Kasami's Broadcast Algorithms, Singhal's Heurastic Algorithm, Raymond's Tree based Algorithm, Comparative Performance Analysis.

M.Tech.

Sem:2nd

Advance Algorithms (MCS-103)

Greedy Algorithms: Introduction to greedy algorithms, Elements of greedy strategy, Prim's and Kruskal's algorithm for minimum spanning tree, Introduction to Matroids.

Flow Networks and Matching: Definitions of Flow networks and flows, Ford-Fulkerson method to compute maximum flow, Max-flow min-cut theorem, Edmonds-Karp algorithm, Maximum bipartite matching problem, Push-relabel algorithm.

String Matching: Naive string matching algorithm, Rabin-Karp algorithm, Longest Common

Subsequence (LCS), Knuth-Morris-Pratt pattern searching algorithm, String matching with finite automata.

NP-Completeness and Approximation Algorithms: Introduction to NP, NP- hard and NP complete problems, polynomial-time verification, proof of NP-completeness. Vertex-cover problem and Traveling-Salesman problem.

Case study: Case study on recent trends in problem solving paradigms using searching and sorting by applying data structures.

Soft Computing (MCS-104)

Fuzzy Logic: Concept of fuzziness, Fuzzy vs crisp, Crisp sets, Operations on crisp sets, Properties of crisp sets, Fuzzy sets, Features of fuzzy sets, Basic fuzzy set operations, Properties of fuzzy sets, Fuzzy relations, Fuzzy membership functions, linguistic hedges, Fuzzy rule-based system, De-fuzzification methods, Fuzzy extension principle.

Genetic Algorithms and Multi-objective Optimization: Concept of natural evolution, Generation of population, Encoding, Fitness Function, Reproduction, Crossover, Mutation, probability of crossover and probability of mutation, convergence. Concept of multi-objective optimization problems (MOOPs), Multi-Objective Evolutionary Algorithm (MOEA), Non-Pareto approaches to solve MOOPs, Pareto-based approaches to solve MOOPs, Some applications with MOEAs.

Software Testing and Quality Assurance (MCS-136)

Quality Metrics And Software Quality Assurance: Testing Software System Security - SixSigma, TQM - Complexity Metrics and Models, Quality Management Metrics, Availability Metrics, Defect Removal Effectiveness, FMEA, Quality Function Deployment, Taguchi Quality Loss Function, Cost of Quality. SQA basics, Components of the Software Quality Assurance System, software quality in business context, planning for software quality assurance, product quality and process quality, software process models, QC Tools and Modern Tools.

Quality Assurance Models: Models for Quality Assurance, ISO-9000 series, CMM, CMMI, Test Maturity Models, SPICE, Malcolm Baldrige Model- P-CMM.

Natural Language Processing (MCS-143)

Morphology and Phonology: Morphological parsing, Finite State transducers, N- gram language models, phonetics, fundamentals, phoneme and phonological rules, machine learning of phonology, phonological aspects of prosody and speech synthesis.

Part-of-Speech Tagging and Parsing: Word Classes, Part of speech tagging, Tagsets, Rule based, Stochastic and Transformation based POS tagging. Basic parsing strategies, top down parsing, bottom up parsing, parsing with context free grammars, a basic top down parser, Earley parser, CYK parser, Finite state parsing methods, Unification of feature structures.

Semantic Analysis and Pragmatics: Lexical Semantics, Lexemes, Relations among lexemes and their senses, WordNet, Internal structure of words, metaphor and metonymy & their computational approaches, Word Sense Disambiguation. Discourse, Reference resolution, syntactic and semantic constraints on coreference, pronoun resolution reference, text coherence, discourse structure, Dialogue- Acts, structure, conversational agents, Introduction to language

generation, architecture, discourse planning.