SEMESTER 3

MAT 203: DISCRETE MATHEMATICAL STRUCTURES
Module – 1 (Fundamentals of Logic)
Mathematical logic - Basic connectives and truth table, Statements, Logical Connectives, Tautology, Contradiction. Logical Equivalence - The Laws of Logic, The Principle of duality, Substitution Rules . The implication - The Contrapositive, The Converse,The Inverse. Logical Implication - Rules of Inference. The use of Quantifiers - Open Statement, Quantifier. Logically Equivalent – Contrapositive, Converse , Inverse , Logical equivalences and implications for quantified statement, Implications , Negation .

Module - 2 (Fundamentals of Counting Theory)
The Rule of Sum – Extension of Sum Rule . The Rule of Product - Extension of Product Rule . Permutations. Combinations. The Binomial Theorem (without proof). Combination with Repetition. The Pigeon hole Principle. The Principle of Inclusion and Exclusion Theorem (Without Proof) - Generalization of the Principle. Derangements.

Module - 3 (Relations and Functions)
Cartesian Product - Binary Relation. Function – domain , range-one to one function, Image restriction. Properties of Relations- Reachability Relations, Reflexive Relations, Symmetric Relations, Transitive relations, Anti-symmetric Relations, Partial Order relations, Equivalence Relations, Irreflexive relations. Partially ordered Set – Hasse Diagram, Maximal-Minimal Element, Least upper bound (lub), Greatest Lower bound(glb) (Topological sorting Algorithm- excluded). Equivalence Relations and Partitions - Equivalence Class. Lattice - Dual Lattice , Sub lattice , Properties of glb and lub , Properties of Lattice , Special Lattice , Complete Lattice, Bounded Lattice, Completed Lattice , Distributive Lattice.

Module - 4 (Generating Functions and Recurrence Relations)
Generating Function - Definition and Examples , Calculation techniques, Exponential generating function. First order linear recurrence relations with constant coefficients – homogeneous, non-homogeneous Solution. Second order linear recurrence relations with constant coefficients, homogeneous, non-homogeneous Solution.

Module - 5 (Algebraic Structures)
Algebraic system-properties- Homomorphism and Isomorphism. Semi group and monoid – cyclic monoid , sub semi group and sub monoid, Homomorphism and Isomorphism of Semi group and monoids. Group- Elementary properties, subgroup, symmetric group on three symbols ,The direct product of two groups, Group Homomorphism, Isomorphism of groups, Cyclic group . Right cosets - Left cosets . Lagrange's Theorem

CST 201: DATA STRUCTURES
Module 1 (Basic Concepts of Data Structures)
System Life Cycle, Algorithms, Performance Analysis, Space Complexity, Time Complexity, Asymptotic Notation, Complexity Calculation of Simple Algorithms

Module 2 (Arrays and Searching)
Polynomial representation using Arrays, Sparse matrix, Stacks, Queues-Circular Queues, Priority Queues, Double Ended Queues, Evaluation of Expressions Linear Search and Binary Search

Module 3 (Linked List and Memory Management)
Self Referential Structures, Dynamic Memory Allocation, Singly Linked List-Operations on Linked List. Doubly Linked List, Circular Linked List, Stacks and Queues using Linked List, Polynomial representation using Linked List
Memory allocation and de-allocation-First-fit, Best-fit and Worst-fit allocation schemes

Module 4 (Trees and Graphs)
Trees, Binary Trees-Tree Operations, Binary Tree Representation, Tree Traversals, Binary Search Trees-Binary Search Tree Operations Graphs, Representation of Graphs, Depth First Search and Breadth First Search on Graphs, Applications of Graphs

Module 5 (Sorting and Hashing)
Sorting Techniques – Selection Sort, Insertion Sort, Quick Sort, Merge Sort and Heap Sort
Hashing- Hashing Techniques, Collision Resolution, Overflow handling, Hashing functions
Mid square, Division, Folding, Digit Analysis

CST 203: LOGIC SYSTEM DESIGN

Module I (Number systems, Operations & Codes)

Decimal, Binary, Octal and Hexadecimal Number Systems- Number Base Conversions. Addition, Subtraction, Multiplication and Division of binary numbers. Representation of negative numbers- Complements, Subtraction with complements. Addition and subtraction of BCD, Octal and Hexadecimal numbers. Binary codes- Decimal codes, Error detection codes, Reflected code, Character coding schemes – ASCII, EBCDIC.

Module II (Boolean Algebra)

Postulates of Boolean Algebra. Basic theorems and Properties of Boolean Algebra. Boolean Functions - Canonical and Standard forms. Simplification of Boolean Functions- Using Karnaugh- Map Method (upto five variables), Don't care conditions, Product of sums simplification, Tabulation Method. Digital Logic Gates- Implementation of Boolean functions using basic and universal gates.

Module III (Combinational Logic Circuits)

Design Procedure & Implementation of combinational logic circuits- Binary adders and subtractors, Binary Parallel adder, Carry look ahead adder, BCD adder, Code converter, Magnitude comparator, Decoder, Demultiplexer, Encoder, Multiplexer, Parity generator/ Checker.

Module IV (Sequential logic circuits)

Flip-flops- SR, JK, T and D. Triggering of flip-flops- Master slave flip- flops, Edge- triggered flip- flops. Excitation table and characteristic equation. Registers- register with parallel load. Counter design: Asynchronous counters- Binary and BCD counters, timing sequences and state diagrams. Synchronous counters- Binary Up- down counter, BCD counter.

Module V (Shift registers)

Shift registers – Serial In Serial Out, Serial In Parallel Out, Bidirectional Shift Register with Parallel load. Ring counter. Johnson counter- timing sequences and state diagrams.

CST 205: OBJECT ORIENTED PROGRAMMING USING JAVA

Module 1 (Introduction)

Approaches to Software Design - Functional Oriented Design, Object Oriented Design, Case Study of Automated Fire Alarm System.

Object Modeling Using Unified Modeling Language (UML) – Basic Object Oriented concepts, UML diagrams, Use case model, Class diagram, Interaction diagram, Activity diagram, State chart diagram.

Introduction to Java - Java programming Environment and Runtime Environment, Development Platforms - Standard, Enterprise. Java Virtual Machine (JVM), Java compiler, Bytecode, Java applet, Java Buzzwords, Java program structure, Comments, Garbage Collection, Lexical Issues.

Module 2 (Core Java Fundamentals)

Primitive Data types - Integers, Floating Point Types, Characters, Boolean. Literals, Type Conversion and Casting, Variables, Arrays, Strings, Vector class.

Operators - Arithmetic Operators, Bitwise Operators, Relational Operators, Boolean Logical Operators, Assignment Operator, Conditional (Ternary) Operator, Operator Precedence.

Control Statements - Selection Statements, Iteration Statements and Jump Statements.

Object Oriented Programming in Java - Class Fundamentals, Declaring Objects, Object Reference, Introduction to Methods, Constructors, *this* Keyword, Method Overloading, Using Objects as Parameters, Returning Objects, Recursion, Access Control, Static Members, Final Variables, Inner Classes, Command Line Arguments, Variable Length Arguments.

Inheritance - Super Class, Sub Class, The Keyword *super*, protected Members, Calling Order of Constructors, Method Overriding, the Object class, Abstract Classes and Methods, using *final* with Inheritance.

Module 3 (More features of Java)

Packages and Interfaces - Defining Package, CLASSPATH, Access Protection, Importing Packages, Interfaces. Exception Handling - Checked Exceptions, Unchecked Exceptions, *try* Block and *catch* Clause, Multiple *catch* Clauses, Nested *try* Statements, *throw*, *throws* and *finally*. Input/Output - I/O

Basics, Reading Console Input, Writing Console Output, PrintWriter Class, Object Streams and Serialization, Working with Files.

Module 4 (Advanced features of Java)

Java Library - String Handling – String Constructors, String Length, Special String Operations -Character Extraction, String Comparison, Searching Strings, Modifying Strings, using valueOf(), Comparison of StringBuffer and String.

Collections framework **-** Collections overview, Collections Interfaces- Collection Interface, List Interface. Collections Class – ArrayList class. Accessing a Collection via an Iterator.

Event handling **-** Event Handling Mechanisms, Delegation Event Model, Event Classes, Sources of Events, Event Listener Interfaces, Using the Delegation Model.

Multithreaded Programming - The Java Thread Model, The Main Thread, Creating Thread, Creating Multiple Threads, Synchronization, Suspending, Resuming and Stopping Threads.

Module 5 (Graphical User Interface and Database support of Java)

Swings fundamentals - Swing Key Features, Model View Controller (MVC), Swing Controls, Components and Containers, Swing Packages, Event Handling in Swings, Swing Layout Managers, Exploring Swings –JFrame, JLabel, The Swing Buttons, JTextField.

Java DataBase Connectivity **(**JDBC**)** **-** JDBC overview, Creating and Executing Queries – create table, delete, insert, select.

SEMESTER 4

MAT256: PROBABILITY AND STATISTICAL MODELLING

Module-1 (Discrete probability distributions)

Discrete random variables and their probability distributions, Expectation, mean and variance, Binomial distribution, Poisson distribution, Poisson approximation to the binomial distribution, Discrete bivariate distributions, marginal distributions, Independent random variables, Expectation ,multiple random variables.

Module - 2(Continuous probability distributions)

Continuous random variables and their probability distributions, Expectation, mean and variance, Uniform, exponential and normal distributions, Continuous bivariate distributions, marginal distributions, Independent random variables. Expectation-multiple random variables, independent and identically distributed (i.i.d) random variables and Central limit theorem (Proof not required).

Module - 3(Sampling Techniques)

Need for Sampling, Some Fundamental Definitions, Important Sampling Distributions, Sampling Theory, Sandler's A-test, Concept of Standard Error, Estimation, Estimating the Population Mean(μ), Estimating Population Proportion, Sample Size and its Determination, Determination of Artificial Intelligence and Data ScienceSample Size through the Approach Based on Precision Rate and Confidence Level, Determination of Sample Size through the Approach Based on Bayesian Statistics

Module- 4(Testing of Hypothesis)

Hypothesis and Test Procedures, Tests about a population mean, Tests concerning a population proportion, p-values, Single factor ANOVA, F-test, Multiple comparisons in ANOVA, Two factor ANOVA

Module - 5 (Correlation and Regression Analysis)

Simple Linear Regression Model, Estimating model parameters, Correlation, Non-Linear and multiple regression, Assessing Model Adequacy, Regression with transformed values, Polynomial Regression, Multiple Regression Analysis

CST202: COMPUTER ORGANISATION AND ARCHITECTURE

Module 1 (Basic Structure of computers)

functional units - basic operational concepts - bus structures. Memory locations and addresses - memory operations,Instructions and instruction sequencing , addressing modes.

Basic processing unit – fundamental concepts – instruction cycle – execution of a complete instruction - single bus and multiple bus organization

Module 2 (Register transfer logic)

inter register transfer – arithmetic, logic and shift micro operations. Processor logic design: - processor organization – Arithmetic logic unit - design of arithmetic circuit - design of logic circuit - Design of arithmetic logic unit - status register – design of shifter - processor unit – design of accumulator.

Module 3 (Arithmetic algorithms)

Algorithms for multiplication and division (restoring method) of binary numbers. Array multiplier , Booth's multiplication algorithm. Pipelining: Basic principles**,** classification of pipeline processors, instruction and arithmetic pipelines (Design examples not required), hazard detection and resolution.

Module 4 (Control Logic Design)

Control organization – Hard_wired control-microprogram control – control of processor unit - Microprogram sequencer,micro programmed CPU organization - horizontal and vertical micro instructions.

Module 5 (I/O organization)

accessing of I/O devices – interrupts, interrupt hardware -Direct memory access. Memory system: basic concepts – semiconductor RAMs. memory system considerations – ROMs, Content addressable memory, cache memories - mapping functions.

CST 204: DATABASE MANAGEMENT SYSTEMS

Module 1 (Introduction & Entity Relationship (ER) Model)

Concept & Overview of Database Management Systems (DBMS) - Characteristics of Database system, Database Users, structured, semi-structured and unstructured data. Data Models and Schema - Three Schema architecture. Database Languages, Database architectures and classification. ER model **-** Basic concepts, entity set & attributes, notations, Relationships and constraints, cardinality, participation, notations, weak entities,relationships of degree 3.

Module 2 (Relational Model)

Structure of Relational Databases - Integrity Constraints, Synthesizing ER diagram to relational schema Introduction to Relational Algebra - select, project, cartesian product operations, join - Equi-join, natural join. query examples, introduction to Structured Query Language (SQL), Data Definition Language (DDL), Table definitions and operations – CREATE, DROP, ALTER, INSERT, DELETE, UPDATE.

Module 3 (SQL DML (Data Manipulation Language))

Physical Data OrganizationSQL DML (Data Manipulation Language) - SQL queries on single and multiple tables, Nested queries (correlated and non-correlated), Aggregation and grouping, Views, assertions, Triggers, SQL data types. Physical Data Organization - Review of terms: physical and logical records, blocking factor, pinned and unpinned organization. Heap files, Indexing, Singe level indices, numerical examples, Multi-level-indices, numerical examples, B-Trees & B+-Trees (structure only, algorithms not required), Extendible Hashing, Indexing on multiple keys – grid files. Artificial Intelligence and Data Science

Module 4 (Normalization)

Different anomalies in designing a database, The idea of normalization, Functional dependency, Armstrong's Axioms (proofs not required), Closures and their computation, Equivalence of Functional Dependencies (FD), Minimal Cover (proofs not required). First Normal Form (1NF), Second Normal Form (2NF), Third Normal Form (3NF), Boyce Codd Normal Form (BCNF), Lossless join and dependency preserving decomposition, Algorithms for checking Lossless Join (LJ) and Dependency Preserving (DP) properties.

Module 5 (Transactions, Concurrency and Recovery, Recent Topics)

Transaction Processing Concepts - overview of concurrency control, Transaction Model, Significance of concurrency Control & Recovery, Transaction States, System Log, Desirable Properties of transactions. Serial schedules, Concurrent and Serializable Schedules, Conflict equivalence and conflict serializability, Recoverable and cascade-less schedules, Locking, Two-phase locking and its variations. Log-based recovery, Deferred database modification, check-pointing. Introduction to NoSQL Databases, Main characteristics of Key-value DB (examples from: Redis), Document DB (examples from: MongoDB) Main characteristics of Column - Family DB (examples from: Cassandra) and Graph DB (examples from : ArangoDB)

CST 206: OPERATING SYSTEMS

Module I

Operating system overview – Operations, Functions, Service – System calls, Types – Operating System structure - Simple structure, Layered approach, Microkernel, Modules
– System boot process.

Module II

Processes -Process states, Process control block, threads, scheduling, Operations on processes - process creation and termination – Inter-process communication - shared memory systems, Message passing systems.
Process Scheduling – Basic concepts- Scheduling criteria -scheduling algorithms- First come
First Served, Shortest Job Firs, Priority scheduling, Round robin scheduling

Module III
Process synchronization- Race conditions – Critical section problem – Peterson's solution, Synchronization hardware, Mutex Locks, Semaphores, Monitors – Synchronization problems - Producer Consumer, Dining Philosophers and Readers-Writers.
Deadlocks: Necessary conditions, Resource allocation graphs, Deadlock prevention, Deadlock avoidance – Banker's algorithms, Deadlock detection, Recovery from deadlock.

Module IV
Memory Management**:** Concept of address spaces, Swapping, Contiguous memory allocation, fixed and variable partitions, Segmentation, Paging. Virtual memory, Demand paging, Page replacement algorithms.

Module V
File System: File concept - Attributes, Operations, types, structure – Access methods, Protection. File-system implementation, Directory implementation. Allocation methods.
Storage Management: Magnetic disks, Solid-state disks, Disk Structure, Disk scheduling,
Disk formatting

SEMESTER 5

ADT301 FOUNDATIONS OF DATA SCIENCE
Module – 1 (Introduction to Data Science)
A brief introduction to data – structured, unstructured, semi-structured, data sets & patterns, Brief history of Data Science, Introduction to Data Science, Importance of Data Science, Differences between AI, ML, DL, Data Science & Data Analytics, Real world applications of data science, Steps in data science process
Simple case study based on real life applications such as - Market research case, tracking disease outbreaks, business predictions, (for example, Rating a product design) etc., Ethical and privacy implications of Data Science.
Tools and Skills Needed – brief introduction of platforms, tools, frameworks, languages, databases and libraries, Current trends & major research challenges in data science.

Module – 2 (Data Mining & Preprocessing)
Data Mining, Kinds of data - mining, Data Preprocessing. An Overview - Data Quality, Need to preprocess the data. Major Tasks in Data Preprocessing.
Data cleaning - Missing Values Noisy Data, Data Cleaning as a Process, Data Integration, Data Reduction, Data transformation and Data Discretization. Introduction to Data Visualization

Module - 3 (Classification Models)
Classification - Basic Concepts, Decision Tree Induction, Bayes Classification Methods- Naıve Bayesian Classification, Rule-Based Classification
Classification Advanced Methods - Bayesian Belief Networks, Classification by Back propagation, A Multilayer Feed-Forward Neural Network, Back propagation, Support Vector Machines, Lazy Learners, K-Nearest-Neighbour Classifiers, Case-Based Reasoning

Module - 4 (Association Mining and Cluster Analysis)
Mining Frequent Patterns, Associations, and Correlations. Basic Concepts Frequent Itemset Mining Methods, Apriori Algorithm, Generating Association Rules from Frequent Itemsets Cluster Analysis, Partitioning Methods, Hierarchical Methods, Agglomerative versus Divisive Hierarchical Clustering, Distance Measures in Algorithmic Methods. Density-Based Methods – DBSCAN

Module - 5 (Evaluation)
Evaluating model performance-Confusion matrices, Precision and recall, Sensitivity and specificity, F-measure, ROC curves, Cross validation, K-fold cross validation, Bootstrap sampling. Improving model performance - Bagging, Boosting, Random forests.

CST 303 COMPUTER NETWORKS
Module - 1 (Introduction and Physical Layer)
Introduction – Uses of computer networks, Network hardware, Network software. Reference models – The OSI reference model, The TCP/IP reference model, Comparison of OSI and TCP/IP reference models.

Physical Layer – Modes of communication, Physical topologies, Signal encoding, Repeaters and hub, Transmission media overview. Performance indicators – Bandwidth, Throughput, Latency, Queuing time, Bandwidth–Delay product.

Module - 2 (Data Link Layer)

Data link layer - Data link layer design issues, Error detection and correction, Sliding window protocols, High-Level Data Link Control(HDLC)protocol. Medium Access Control (MAC) sublayer –Channel allocation problem, Multiple access protocols, Ethernet, Wireless LANs - 802.11, Bridges & switches - Bridges from 802.x to 802.y, Repeaters, Hubs, Bridges, Switches, Routers and Gateways.

Module - 3 (Network Layer)

Network layer design issues. Routing algorithms - The Optimality Principle, Shortest path routing, Flooding, Distance Vector Routing, Link State Routing, Multicast routing, Routing for mobile hosts. Congestion control algorithms. Quality of Service (QoS) - requirements, Techniques for achieving good QoS.

Module - 4 (Network Layer in the Internet)

IP protocol, IP addresses, Internet Control Message Protocol (ICMP), Address Resolution Protocol (ARP), Reverse Address Resolution Protocol (RARP), Bootstrap Protocol (BOOTP), Dynamic Host Configuration Protocol (DHCP). Open Shortest Path First(OSPF) Protocol, Border Gateway Protocol (BGP), Internet multicasting, IPv6, ICMPv6.

Module – 5 (Transport Layer and Application Layer)

Transport service – Services provided to the upper layers, Transport service primitives. User Datagram Protocol (UDP). Transmission Control Protocol (TCP) – Overview of TCP, TCP segment header, Connection establishment &release, Connection management modeling, TCP retransmission policy, TCP congestion control.

Application Layer –File Transfer Protocol (FTP), Domain Name System (DNS), Electronic mail, Multipurpose Internet Mail Extension (MIME), Simple Network Management Protocol(SNMP), World Wide Web(WWW) – Architectural overview

AMT 305 INTRODUCTION TO MACHINE LEARNING

Module-1 (Overview of machine learning)

Introduction to Machine Learning, Machine learning paradigms-supervised, semi-supervised, unsupervised, reinforcement learning.

Supervised learning- Input representation, Hypothesis class, Version space, Vapnik-Chervonenk is (VC) Dimension, Probably Approximately Correct Learning (PAC), Noise, Learning Multiple classes, Model Selection and Generalization

Module-2 (Supervised Learning)

Dimensionality reduction – Subset selection, Principal Component Analysis.

Regression - Linear regression with one variable, Linear regression with multiple variables, solution using gradient descent algorithm and matrix method, basic idea of overfitting in regression. Linear Methods for Classification- Logistic regression, Naive Bayes, Decision tree algorithm ID3.

Case Study: Develop a classifier for face detection.

Module-3 (Classification Assessment and Neural Networks (NN))

Classification Performance measures - Precision, Recall, Accuracy, F-Measure, Receiver Operating Characteristic Curve(ROC), Area Under Curve AUC. Bootstrapping, Cross Validation.

Perceptron, Neural Network - Multilayer feed forward network, Activation functions (Sigmoid, ReLU, Tanh), Back propagation algorithm.

Module-4 (Parameter estimation & SVM Classifier)

Basics of parameter estimation - Maximum Likelihood Estimation(MLE) and Maximum a Posteriori estimation(MAP). Bias-Variance decomposition.

Support Vector Machines - Introduction, Maximum Margin hyperplanes, Mathematics behind Maximum Margin Classification, soft margin SVM classifier, non-linear SVM, Kernels for learning non-linear functions, polynomial kernel, Radial Basis Function(RBF), Kernel Trick

Module-5 (Unsupervised Learning)

Ensemble methods, Voting, Bagging, Boosting.

Unsupervised Learning - Clustering Methods -Similarity measures, K-means clustering, Expectation-Maximization for soft clustering, Hierarchical Clustering Methods , Density based clustering.

AIT307 INTRODUCTION TO ARTIFICIAL INTELLIGENCE

Module – 1 (Introduction)

Introduction – What is Artificial Intelligence(AI) ? The Foundations of AI, History of AI, Applications of AI. Intelligent Agents – Agents and Environments, Good behavior: The concept of rationality, Nature of Environments - Specifying the task environment, Properties of task environments. Structure of Agents - Agent programs, Basic kinds of agent programs.

Module – 2 (Problem Solving)

Solving Problems by searching-Problem solving Agents, Example problems, Searching for solutions, Uninformed search strategies, Informed search strategies, Heuristic functions.

Module - 3 (Search in Complex environments)

Adversarial search - Games, Optimal decisions in games, The Minimax algorithm, Alpha-Beta pruning. Constraint Satisfaction Problems – Defining CSP, Example Problems, Constraint Propagation- inference in CSPs, Backtracking search for CSPs, Structure of CSP problems.

Module - 4 (Knowledge Representation and Reasoning)

Logical Agents – Knowledge based agents, Logic, Propositional Logic, Propositional Theorem proving, Agents based on Propositional Logic. First Order Predicate Logic - Syntax and Semantics of First Order Logic, Using First Order Logic, Knowledge representation in First Order Logic. Inference in First Order Logic – Propositional Vs First Order inference, Unification and Lifting, Forward chaining, Backward chaining, Resolution. Classical Planning - Algorithms for planning state space search, Planning Graphs.

Module - 5 (Machine Learning)

Learning from Examples – Forms of Learning, Supervised Learning. Learning Decision TreesThe decision tree representation, Inducing decision trees from examples, Choosing attribute tests, Generaliztion and overfitting. Evaluating and choosing the best hypothesis, Regression and classification with Linear models.

CST 309 MANAGEMENT OF SOFTWARE SYSTEMS

Module 1 : Introduction to Software Engineering (7 hours)

Introduction to Software Engineering - Professional software development, Software engineering ethics. Software process models - The waterfall model, Incremental development. Process activities - Software specification, Software design and implementation, Software validation, Software evolution. Coping with change - Prototyping, Incremental delivery, Boehm's Spiral Model. Agile software development - Agile methods, agile manifesto - values and principles. Agile development techniques, Agile Project Management. Case studies : An insulin pump control system. Mentcare - a patient information system for mental health care.

Module 2 : Requirement Analysis and Design (8 hours)

Functional and non-functional requirements, Requirements engineering processes. Requirements elicitation, Requirements validation, Requirements change, Traceability Matrix. Developing use cases, Software Requirements Specification Template, Personas, Scenarios, User stories, Feature identification. Design concepts - Design within the context of software engineering, Design Process, Design concepts, Design Model. Architectural Design - Software Architecture, Architectural Styles, Architectural considerations, Architectural Design Component level design - What is a component?, Designing Class-Based Components, Conducting Component level design, Component level design for web-apps. Template of a Design Document as per "IEEE Std 1016-2009 IEEE Standard for Information Technology Systems Design Software Design Descriptions". Case study: The Ariane 5 launcher failure.

Module 3 : Implementation and Testing (9 hours)

Object-oriented design using the UML, Design patterns, Implementation issues, Open-source development - Open-source licensing - GPL, LGPL, BSD. Review Techniques - Cost impact of Software Defects, Code review and statistical analysis. Informal Review, Formal Technical Reviews, Post-mortem evaluations. Software testing strategies - Unit Testing, Integration Testing, Validation testing, System testing, Debugging, White box testing, Path testing, Control Structure testing, Black box testing, Testing Documentation and Help facilities. Test automation, Test-driven development, Security testing. Overview of DevOps and Code Management - Code management, DevOps automation, Continuous Integration, Delivery, and Deployment (CI/CD/CD). Software Evolution - Evolution processes, Software maintenance.

Module 4 : Software Project Management (6 hours)

Software Project Management - Risk management, Managing people, Teamwork. Project Planning, Software pricing, Plan-driven development, Project scheduling, Agile planning. Estimation techniques,

COCOMO cost modeling. Configuration management, Version management, System building, Change management, Release management, Agile software management - SCRUM framework. Kanban methodology and lean approaches.

Module 5 : Software Quality, Process Improvement and Technology trends (6 hours)
Software Quality, Software Quality Dilemma, Achieving Software Quality Elements of Software Quality Assurance, SQA Tasks , Software measurement and metrics. Software Process Improvement(SPI), SPI Process CMMI process improvement framework, ISO 9001:2000 for Software. Cloud-based Software - Virtualisation and containers, Everything as a service(IaaS, PaaS), Software as a service. Microservices Architecture - Microservices, Microservices architecture, Microservice deployment.

SEMESTER 6

ADT302 CONCEPTS IN BIG DATA ANALYTICS
Module – 1 (Introduction to Big Data)
Introduction to Big data, Conventional Data vs Big data, Big data architecture, Big data platforms, Nature of data, Analytic processes and tools, 5 V's of Big data, Big data analytical method, Intelligent data analysis, Big data analytics life cycle.

Module - 2 (Introduction to Stream Computing)
Introduction to stream concepts – Streaming data architecture, Stream data model, Sampling techniques for efficient stream processing, Filtering streams – Bloom filter, Count distinct problem – Flajolet martin algorithm, Estimating moments, Counting oneness in a window – DGIM Algorithm

Module - 3 (Hadoop Distributed File System)
History of Hadoop, Hadoop Ecosystem, Core Components, HDFS- Architecture, Using HDFS Files, HDFS Design, Blocks, Namenodes and Data nodes, Basic File system Operations, Hadoop Specific File Types, Anatomy of a file read, Anatomy of a file write. Data Processing with MapReduce: Execution Pipeline, Runtime Coordination and Task Management in MapReduce, Designing MapReduce implementations: Using MapReduce as a framework for parallel processing, Example-Road Enrichment.

Module - 4 (Pig, Hive, HBase)
Pig : Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators. Hive : Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, HiveQL, Tables, Querying Data and User Defined Functions. Hbase : HBasics, Concepts, Clients, Example, Hbase Versus RDBMS.

Module - 5 (Introduction to R programming)
Introduction to R – Overview of modern data analytic tools, Introduction to R, R Graphical User Interfaces - Features of R Language, Vectors, Filtering, Creating Matrices , Applying Functions to Matrix Rows and Columns, Lists , Creating List , General List Operations, Data Frames , Creating Data Frames , Matrix like Operations in Frames , Applying Functions to Data Frames ,Reading and Writing Files.

AIT304 ROBOTICS AND INTELLIGENT SYSTEM
Module – 1 (Introduction to robotics)
Introduction to robotics – Degrees of freedom, Robot types- Manipulators- Anatomy of a robotic manipulator-links, joints, actuators, sensors, controllers. Robot configurations-PPP, RPP, RRP, RRR. Mobile robots- wheeled, legged, aerial robots, underwater robots, surface water robots . Dynamic characteristics- speed of motion, load carrying capacity & speed of response. Introduction to End effectors - mechanical grippers, special tools, Magnetic grippers, Vacuum grippers, adhesive grippers, Active and Passive grippers. Ethics in robotics - 3 laws - applications of robots.

Module - 2(Sensors, Actuators and Control)
Sensor classification- touch, force, proximity, vision sensors. Internal sensors-Position sensors, velocity sensors, acceleration sensors, Force sensors; External sensors-contact type, non contact type; Digital Camera - CCD camera - CMOS camera - Omnidirectional cameras Sensor characteristics. Actuators - DC Motors - H-Bridge - Pulse Width Modulation - Stepper Motors – Servos, Hydraulic & pneumatic actuators. Control - On-Off Control - PID Control - Velocity Control and Position Control

Module – 3 (Robotic vision & Kinematics)

Robotic Vision: Sensing, Pre-processing, Segmentation, Description, Recognition, Interpretation, Feature extraction -Camera sensor hardware interfacing. Representation of Transformations - Representation of a Pure Translation - - Pure Rotation about an Axis - Combined Transformations - Transformations Relative to the Rotating Frame.

Basic understanding of Differential-Drive Wheeled Mobile Robot, Car-Like Wheeled Mobile Robot. Kinematic model of a differential drive and a steered mobile robot, Degree of freedom and manoeuvrability, Degree of steerability, Degree of mobility - different wheel configurations, holonomic and nonholonomic robots. Omnidirectional Wheeled Mobile Robots.

Module - 4 (Localization and Mapping)
Position and Orientation - Representing robot position. Basics of reactive navigation; Robot Localization, Challenges in localization - An error model for odometric position estimation

Map Representation - Continuous representations - Decomposition strategies - Current challenges in map representation. Probabilistic map-based localization (only Kalman method), Autonomous map building, Simultaneous localization and mapping (SLAM) - Mathematical definition of SLAM - Visual SLAM with a single camera - Graph-based SLAM - Particle filter SLAM - Open challenges in SLAM

Module - 5 (Path Planning and Navigation)
Path Planning- Graph search, deterministic graph search - , breadth first search - depth first search- Dijkstra's algorithm, A*, D* algorithms, Potential field based path planning. Obstacle avoidance - Bug algorithm - Vector Field Histogram - Dynamic window approaches. Navigation Architectures - Modularity for code reuse and sharing - Control localization - Techniques for decomposition. Alternatives for navigation - Neural networks - Processing the image - Training the neural network for navigation - Convolutional neural network robot control implementation

CST 306 ALGORITHM ANALYSIS AND DESIGN
Module-1 (Introduction to Algorithm Analysis)
Characteristics of Algorithms, Criteria for Analysing Algorithms, Time and Space Complexity - Best, Worst and Average Case Complexities, Asymptotic Notations - Big-Oh (O), Big- Omega (Ω), Big-Theta (Θ), Little-oh (o) and Little- Omega (ω) and their properties. Classifying functions by their asymptotic growth rate, Time and Space Complexity Calculation of simple algorithms.

Analysis of Recursive Algorithms: Recurrence Equations, Solving Recurrence Equations – Iteration Method, Recursion Tree Method, Substitution method and Master's Theorem (Proof not required).

Module–2 (Advanced Data Structures and Graph Algorithms)
Self Balancing Tree - AVL Trees (Insertion and deletion operations with all rotations in detail, algorithms not expected); Disjoint Sets- Disjoint set operations, Union and find algorithms.

DFS and BFS traversals - Analysis, Strongly Connected Components of a Directed graph, Topological Sorting.

Module–3 (Divide & Conquer and Greedy Strategy)
The Control Abstraction of Divide and Conquer- 2-way Merge sort, Strassen's Algorithm for Matrix Multiplication-Analysis. The Control Abstraction of Greedy Strategy- Fractional Knapsack Problem, Minimum Cost Spanning Tree Computation- Kruskal's Algorithms - Analysis, Single Source Shortest Path Algorithm - Dijkstra's Algorithm-Analysis.

Module-4 (Dynamic Programming, Back Tracking and Branch & Bound))
The Control Abstraction- The Optimality Principle- Matrix Chain Multiplication-Analysis, All Pairs Shortest Path Algorithm - Floyd-Warshall Algorithm-Analysis. The Control Abstraction of Back Tracking – The N Queen's Problem. Branch and Bound Algorithm for Travelling Salesman Problem.

Module-5 (Introduction to Complexity Theory)
Tractable and Intractable Problems, Complexity Classes – P, NP, NP- Hard and NP-Complete Classes- NP Completeness proof of Clique Problem and Vertex Cover Problem- Approximation algorithms- Bin Packing, Graph Coloring. Randomized Algorithms (Definitions of Monte Carlo and Las Vegas algorithms), Randomized version of Quick Sort algorithm with analysis.

AIT352 ARTIFICIAL NEURAL NETWORKS TECHNIQUES
Module – 1 (Basics of Artificial Neural Network and Learning Methods)
Characteristics of the human brain, Neurons, Introduction to Artificial Neural Networks, Terminology, Models of ANN, Topology, Network Architectures, Knowledge Representation, Learning Process, Learning

Tasks. Categories of learning - Hebbian learning, Perceptron Learning Rule, Delta Learning Rule, Generalized Delta Learning Rule, Competitive learning, Errorcorrection learning, Reinforcement learning, Stability and Convergence.

Module – 2(Basic ANN Models)

McCulloch-Pitts Neuron, Architecture, Algorithm and Applications. Biases and Thresholds, Linear Separability. Hebb Net - Algorithm, Applications. Perceptron - Architecture, Algorithm, Applications. Perceptron Learning Rule Convergence Theorem. Adaline - Architecture, Algorithm, Applications.

Module - 3 (Multilayer Perceptrons)

Multi-Layered network architecture, Back propagation Algorithm, Applications, XOR problem, Replacing and Modifying Back propagation Algorithms Using Heuristics.

Cover's Theorem on the Separability of patterns, The Interpolation Problem, Radial Basis Function Networks, Comparison of MLP and RBF Networks(Theory only).

Module – 4 (SOMs and ART Networks)

Self-organizing maps - Building, Training, Evaluating, Interpreting and Visualizing a Selforganizing Map. Applications of Self Organizing Maps.

Adaptive Resonance Theory -Stability Plasticity Dilemma, ART-1-Architeture, Algorithm, Applications. ART-2 – Architeture, Algorithm, Applications.

Module – 5 (Training Algorithms for Pattern Association)

Introduction, Hetero associative neural network- Architecture, Applications. Auto Associative Net - Architecture, Applications. Iterative Auto Associative Net – Architecture, Applications. Discrete Hopfield Network. Bidirectional Auto-associative Memory – Architecture, Applications.

AIT362 PROGRAMMING IN R

Module -1 (Introduction to R)

The R Environment - Command Line Interface and Batch processing, R Packages, Variables, Data Types, Vectors- vector operations and factor vectors, List- operations, Data Frames, Matrices and arrays, Control Statements- Branching and looping - For loops, While loops, Controlling loops. Functions- Function as arguments, Named arguments

Module -2(Reading and writing data)

Importing data from Text files and other software, Exporting data, importing data from databases- Database Connection packages, Missing Data - NA, NULL Combining data sets, Transformations, Binning Data, Subsets, summarizing functions. Data Cleaning, Finding and removing Duplicates, Sorting.

Module -3 (Statistics with R)

Analyzing Data, Summary statistics, Statistical Tests- Continuous Data, Discrete Data, Power tests, Common distributions- type arguments. Probability distributions, Normal distributions

Module -4(Data Visualization)

R Graphics- Overview, Customizing Charts, Graphical parameters, Basic Graphics functions, Lattice Graphics - Lattice functions, Customizing Lattice Graphics, Ggplot.

Module - 5 (Regression Models)

Building linear models - model fitting, Predict values using models, Analyzing the fit, Refining the model, Regression- types, Unusual observation and corrective measures, ARTIFICIAL INTELLIGENCE AND DATA SCIENCE Comparison of models, Generalized linear models - Logistic Regression, Poisson Regression, Nonlinear least squares

AIT322 CONCEPTS IN COMPUTER GRAPHICS AND IMAGE PROCESSING

Module – 1 (Basics of Computer graphics and Algorithms)

Basics of Computer Graphics and its applications. Video Display devices- Refresh Cathode Ray Tubes, Random Scan Displays and systems, Raster scan displays and systems. Line drawing algorithms- DDA, Bresenham's algorithm. Circle drawing algorithms- Midpoint Circle generation algorithm, Bresenham's algorithm.

Module – 2 (Filled Area Primitives and transformations)

Filled Area Primitives- Scan line polygon filling, Boundary filling and flood filling. Two dimensional transformations-Translation, Rotation, Scaling, Reflection and Shearing, Composite transformations, Matrix representations and homogeneous coordinates. Basic 3D transformations.

Module - 3 (Clipping and Projections)

Window to viewport transformation. Cohen Sutherland Line clipping algorithm.Sutherland Hodgeman Polygon clipping algorithm. Three-dimensional viewing pipeline. Projections-Parallel and Perspective projections. Visible surface detection algorithms- Depth buffer algorithm, Scan line algorithm.

Module - 4 (Fundamentals of Digital Image Processing)

Introduction to Image processing and applications. Image as 2D data. Image representation ingrayscale, Binary and Colour images. Fundamental steps in image processing. Components of image processing system.Coordinate conventions. Sampling and quantization. Spatial and Gray Level Resolution. Basic relationship between pixels– neighbourhood, adjacency, connectivity.

Module - 5 (Image Enhancement in Spatial Domain and Image Segmentation)

Basic gray level transformation functions- Log transformations, Power-Law transformations, Contrast stretching. Histogram equalization. Basics of spatial filtering - Smoothing spatial filterLinear and nonlinear filters, and Sharpening spatial filters-Gradient and Laplacian. Fundamentals of Image Segmentation.Thresholding-Basics of Intensity thresholding and Global Thresholding. Region based Approach- Region Growing, Region Splitting and Merging. Edge Detection - Edge Operators- Sobel and Prewitt.

CST 332 FOUNDATIONS OF SECURITY IN COMPUTING

Module-1 (Modular Arithmetic)

Integer arithmetic - Integer division, Divisibility, Greatest Common Divisor (GCD), Euclid's algorithm for GCD, Extended Euclid's algorithm, Linear Diophantine Equations. Modular ARTIFICIAL INTELLIGENCE AND DATA SCIENCE arithmetic - Operations, Properties. Algebraic structures - Groups, Rings, Fields, Finite fields, GF(p), GF (2n).

Module-2 (Prime Numbers and Factorization)

Prime numbers - Prime numbers and prime-power factorization, Fermat and Mersenne primes, Fermat's theorem, Applications, Euler's theorem, Euler's totient function, Applications. Primality testing – Deterministic algorithms and Probabilistic algorithms. Factorization - Fermat's factorization, Pollard p-1 method.

Module-3 (Linear Congruence, Primitive Roots and Elliptic Curve Arithmetic)

Linear congruence - Simultaneous linear congruence, Chinese Remainder Theorem (CRT). Congruence with a prime - Power modulus, Arithmetic modulo p, Pseudoprimes and Carmichael numbers, Solving congruence modulo prime powers. Primitive roots - Existence of primitive roots for primes, Discrete logarithms. Elliptic curve arithmetic – Prime curves, Binary curves, Addition of two points, Multiplication of a point by a constant.

Module-4 (Computer and Program Security)

Introduction to computer security – Threats, Vulnerabilities, Controls. Browser attack types, Web attacks targeting users, Email attack types. Introduction to program security - Non-malicious programming oversights, Malware.

Module-5 (Operating System and Database Security)

Operating system security – Security in operating system, Security in design of operating system. Database security – Security requirements of databases, Reliability and integrity, Database disclosure.

ADT342 DATA VISUALIZATION

Module 1 (Introduction to Data Visualization)

Introduction to Visualization – Need and purpose, External representation – Interactivity – Difficulty in Validation, Data Abstraction: Dataset types – Attribute types – Semantics, Task Abstraction – Analyze, Produce, Search, Query, Four levels of validation – Validation approaches – Validation examples. Marks and Channels. Data Visualization tools.

Module 2 (Arranging Spatial Data and Networks)

Arrange tables: Categorical regions – Spatial axis orientation – Spatial layout density, Arrange spatial data: Geometry – Scalar fields – Vector fields – Tensor fields. Arrange networks and trees: Connections, Matrix views – Containment, Map color: Color theory, Color maps and other channels.

Module 3 (Data Visualization using R)

Basic and Interactive Plots: scatter plot, interactive scatter plot, bar plot, line plot, interactive Gantt/timeline chart, Merging histograms, interactive bubble plot, waterfall plot, Heat Maps and Dendrograms: simple dendrogram, dendrograms with colors and labels, heat map, heat map with customized colors, three-

dimensional heat map and a ARTIFICIAL INTELLIGENCE AND DATA SCIENCE stereo map, tree map. Maps: regional maps, choropleth maps, contour maps, maps with bubbles, Integrating text with maps, shapefiles, cartograms, Pie Chart and Its Alternatives, Adding the Third Dimension: 3D scatter plot, 3D pie chart, 3D histogram, 3D contour plot.

Module 4 (Interactive Data Visualization using D3)
Drawing with data: Drawing divs, SVG's, Making a bar chart, scatterplot – Scales - Axes – Updates, Transition and Motion – Modernizing the bar chart, Updating data, transitions, Interactivity – Layouts – Geomapping – Framework – D3.js, tableau.

Module 5 (Security Data Visualization)
Port scan visualization - Vulnerability assessment and exploitation - Firewall log visualization - Intrusion detection log visualization - Attacking and defending visualization systems – Creating security visualization system.

SEMESTER 7

AIT 401: FOUNDATIONS OF DEEP LEARNING
Module 1: Introduction to Neural Networks and Deep learning
Introduction, The Basic Architecture of Neural Networks - Single Computational Layer: The Perceptron, Multilayer Neural Networks. Activation functions – Sign, Sigmoid, Tanh, ReLU, leaky ReLU, Hard Tanh, Softmax. Loss function. Training a Neural Network with Backpropagation. Practical issues in neural network training. Overfitting, Underfitting, Hyper parameters and Validation sets, Estimators -Bias and Variance.Introduction to deep learning, Deep feed forward network.

Module 2: Training deep models
Introduction, setup and initialization- Kaiming, Xavier weight intializations, Vanishing and exploding gradient problems, Optimization techniques - Gradient Descent (GD), Stochastic GD, GD with momentum, GD with Nesterov momentum, AdaGrad, RMSProp, Adam., Regularization Techniques - L1 and L2 regularization, Early stopping, Dataset augmentation, Parameter tying and sharing, Ensemble methods, Dropout, Batch normalization.

Module 3: Convolutional Neural Networks
Convolutional Neural Networks –Architecture, Convolution operation, Motivation, pooling .Variants of convolution functions, Structured outputs, Data types, Efficient convolution algorithms, Applications of Convolutional Networks, Pre-trained convolutional Architectures : AlexNet, ZFNet, VGGnet-19, ResNet-50.

Module 4: Recurrent Neural Networks
Recurrent neural networks – Computational graphs. RNN design. Encoder – decoder sequence to sequence architectures. Language modeling example of RNN. Deep recurrent networks. Recursive neural networks. Challenges of training Recurrent Networks. Gated RNNs LSTM and GRU. Case study: BERT, Social Media Sentiment Analysis.

Module 5: Auto-encoders and Generative models.
Autoencoders, *Variational Auto-Encoder*-under complete Auto-encoder, stochastic encoder, denoising encoder, Applications of Autoencoders. Generative models - Boltzmann machines, Deep Belief Networks, Generative Adversarial Networks.

AIT 413: ADVANCED CONCEPTS OF MICROPROCESSOR AND MICRO CONTROLLER
Module-1(Evolution of microprocessors):
8086 microprocessor – Architecture and signals,Stack structure of 8086, Physical Memory organization, Minimum and maximum mode of 8086 system and timings. Comparison of 8086 and 8088.

Module-2 (Addressing modes and instructions):
Addressing Modes of 8086. Instruction set – data copy /transfer instructions, arithmetic instructions, logical instructions, string manipulation instructions, branch instructions, unconditional and conditional branch instruction, flag manipulation and processor control instructions. Assembler Directives and operators. Basic Assembly Language Programming with 8086.Interrupts - Types of Interrupts and Interrupt

Service Routine- Handling Interrupts in 8086

Module- 3 (Interfacing chips): Programmable Interrupt Controller - 8259, Architecture (Just mention the control word, no need to memorize the control word). Programmable Peripheral Input/output port 8255 - Architecture and modes of operation- Programmable interval timer 8254- Architecture and modes of operation- DMA controller 8257 Architecture (Just mention the control word, no need to memorize the control word of 8254 and 8257).

Module- 4 (Advanced Microprocessors):
Introduction to 32-bit advanced microprocessors- Salient Features and comparison of 80286, 80386 and 80486. Introduction to Pentium Microprocessors-Salient features of 80586-System Architecture-Brach predication-Enhanced Instruction set of Pentium Journey to Pentium -Pro and Pentium-II.

Module- 5 (Microcontrollers):
8051 Architecture- Register Organization- Memory and I/O addressing- Interrupts and Stack- 8051 Addressing Modes- Instruction Set- data transfer instructions, arithmetic instructions, logical instructions, Boolean instructions, control transfer instructions Simple programs.

CST423 CLOUD COMPUTING
Module 1: Fundamental Cloud Computing
Traditional computing- Limitations. Overview of Computing Paradigms-Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing. NIST reference Model-Basic terminology and concepts. Cloud characteristics, benefits and challenges,Roles and Boundaries. Cloud delivery (service) models-Infrastructure-as-a-Service (IaaS), Platform-as-a Service(PaaS),Software-as-a-Service (SaaS), XaaS (Anything-as-a-service)-Cloud deployment models- Public cloud, Community cloud, Private cloud, Hybrid cloud.

Module 2: Virtualization
Introduction to virtualization-Virtualizing physical computing resources, Virtual Machines (Machine virtualization), non-virtualized v/s virtualized machine environments. Types of VMs process VM v/s system VM, Emulation, interpretation and binary translation. Hardware-level virtualization-Hypervisors/VMM. Types of Hypervisors. Full Virtualization, Para- Virtualization, Hardware-assisted virtualization, OS level virtualization. Basics of Network Virtualization, Storage Virtualization and Desktop Virtualization, Pros and cons of virtualization. Case Study Xen: Para-virtualization, VMware: full virtualization.

Module 3: Cloud-Enabling Technologies, Private cloud platforms and programming
Broadband networks and internet architecture- Internet Service Providers (ISPs), Data center technology, Web technology, Multitenant technology, Service technology. Resource provisioning techniques-static and dynamic provisioning.
Open-source software platforms for private cloud-OpenStack, CloudStack, Basics of Eucalyptus, Open Nebula, Nimbus. Cloud Programming- Parallel Computing and Programming Paradigms. Map Reduce – Hadoop Library from Apache, HDFS, Pig Latin High Level Languages, Apache Spark.

Module 4: Fundamental Cloud Security
Basic terms and concepts in security- Threat agents, Cloud security threats/risks, Trust. Operating system security-Virtual machine security- Security of virtualization- Security Risks Posed by Shared Images, Security Risks Posed by Management OS. Infrastructure security- Network Level Security, Host Level Security, Application level security, Security of the PhysicalSystems. Identity & Access Management-Access Control.

Module 5: Popular Cloud Platforms
Amazon Web Services(AWS):- AWS ecosystem- Computing services, Amazon machine images, Elastic Compute Cloud (EC2), Advanced compute services. Storage services-Simple Storage System (Amazon S3), Elastic Block Store (Amazon EBS), Database Services, Amazon CDN Services and Communication services. Google Cloud Platform:- IaaS Offerings: Compute Engine (GCE), Cloud Storage, PaaS Offerings: Google App Engine (GAE), Storage services, Application services, Compute services, Database Services, SaaS Offerings: Gmail, Docs, Google Drive.Microsoft Azure: Azure Platform Architecture, Hyper-V, Azure Virtual Machine, Compute services, Storage services.

CST433 SECURITY IN COMPUTING

Module-1 (Basics of Security and Traditional Cryptosystems)

OSI security architecture – Security attacks, Services, Mechanisms. Cryptography vs
Cryptanalysis. Classical encryption techniques – Symmetric cipher model. Substitution ciphers –
Monoalphabetic vs Polyalphabetic ciphers, Caesar cipher, Affine cipher, Playfair cipher, Vigenere cipher,
Hill cipher. Transposition ciphers – Keyless, Keyed, Double transposition.

Module-2 (Modern Symmetric Key Cryptosystems)

Symmetric key ciphers – Block vs Stream ciphers, Block cipher components, Product ciphers, Feistel and
Non-Feistel ciphers. Data Encryption Standard (DES) – Structure, Key generation, Design criteria,
Weaknesses, Double DES, Triple DES. Advanced Encryption Standard (AES) – Structure, Key expansion.
Block cipher modes of operation – Electronic Codebook Mode (ECB), Cipher Block Chaining Mode (CBC),
Cipher Feedback Mode (CFB), Output Feedback Mode (OFB), Counter Mode (CTR). Stream ciphers –
Structure, RC4.

Module-3 (Public Key Cryptosystems)

Introduction to public key cryptosystems – Principles, Applications, Requirements,
Conventional vs Public key cryptosystems. RSA cryptosystem – Algorithm, Security, Attacks. ElGamal
cryptosystem – Algorithm. Diffie-Hellman key exchange – Algorithm, Man-in-the middle attack. Elliptic
Curve Cryptography (ECC) – ElGamal ECC, Key exchange using ECC.

Module-4 (Message Integrity and Authentication)

Hash functions – Security requirements, Secure Hash Algorithm (SHA-512). Message
Authentication Code (MAC) – Requirements, Uses, Hash-based MAC (HMAC), Cipher-based MAC
(CMAC). Digital signatures – Attacks, Forgeries, Requirements, Direct vs Arbitrated digital signatures,
RSA digital signature, ElGamal digital signature, Digital Signature Standard (DSS).

Module-5 (Key Distribution and System Security)

Key management – Distribution of secret keys using symmetric and asymmetric encryption,
Distribution of public keys. System security – Intruders, Intrusion detection techniques,
Password management. Malicious software – Viruses, Related threats, Countermeasures.
Distributed Denial of Service (DDoS) attacks – Types, Countermeasures.

AIT 443 CONCEPTS IN COMPILER DESIGN

Module - 1 (Introduction to compilers and lexical analysis)

Analysis of the source program - Analysis and synthesis phases, Phases of a compiler. Compiler writing
tools.Lexical Analysis - Role of Lexical Analyser, Input Buffering, Specification of Tokens, Recognition of
Tokens.

Module - 2 (Introduction to Syntax Analysis)

Role of the Syntax Analyser- Introduction to Context Free Grammars -Parse Trees and
DerivationsAmbiguous grammar-Eliminating ambiguity, left recursion and Left factoring the
grammar. Top-Down Parsing - Recursive Descent parsing, First and Follow, Predictive Parsing table
constructor for LL(1) grammar.

Module - 3 (BottomUp Parsing)

Bottom-up parsing - Shift Reduce Parsing,LR parsing - algorithm and working, LR(0) Canonical items,
Constructing LR(0) and SLR Parsing Tables, LR(1) Canonical items ,Constructing Canonical and LALR
Parsing Tables.

Module - 4 (Syntax directed translation and Intermediate code generation)

Syntax directed translation - Syntax directed definitions, S-attributed definitions, L-attributed
definitions, Storage-allocation strategies. Intermediate Code Generation - Intermediate languages, Graphical
representations, Three-Address code, Quadruples, Triples.

Module 5 – (Code Optimization and Generation)

Code Optimization - Principal sources of optimization, Machine dependent and machine
independent optimizations, Basic Blocks and Program Flow Graph: with Examples, Local and global
optimizations. Code generation - Issues in the design of a code generator, A simple code generator.

ADT 453 INFORMATION EXTRACTION AND RETRIEVAL

Module – 1 (Introduction and Basic Concepts)

Introduction: Information versus Data Retrieval, IR: Past, present, and future. Basic concepts: The retrieval process, logical view of documents. Modeling: A Taxonomy of IR models, ad-hoc retrieval and filtering

Module – 2 (Classic IR Models and Retrieval Evaluation) Classic IR models, Alternative Set theoretic models, Alternative algebraic models, Alternative
probabilistic models, Structured text retrieval models, models for browsing. Retrieval evaluation: Performance evaluation of IR: Recall and Precision, other measures

Module – 3 (Reference Collections and Query Languages)
Reference Collections such as TREC, CACM, and ISI data sets. Query Languages: Keyword based queries, single word queries, context queries, Boolean Queries, Query protocols.

Module– 4 (Text and Multimedia Languages, Indexing, and Searching)
Text and Multimedia Languages and properties, Metadata, Text formats, Markup languages,
Multimedia data formats, Text Operations-Document preprocessing, Document
Clustering, Text Compression,Comparing text compression techniques. Indexing and
searching -Inverted files, other indices for text, Sequential se arching-Brute force,
knuth morris pratt, Pattern matching-string matching allowing errors.

Module 5 (Web based Information Extraction)
Web search basics - Background and history , Web characteristics, Advertising as the economic model, The search user experience, Index size and estimation, Near-duplicates and shingling Web crawling and indexes – Crawling, Distributing indexes, Connectivity servers
Link analysis - The Web as a graph, PageRank

CST463: WEB PROGRAMMING
Module – 1 (WWW, HTML)
Introduction to the Internet & WWW: Evolution of Internet & World Wide Web- Web Basics, URI's & URL-MIME. Introduction to HTML5: Structuring & editing an HTML5 document, Fundamentals of HTML - Headings-Hyper Links- Images - Special Characters & Horizontal Rules-Lists- Tables -Forms - Internal Linking- Meta Elements-HTML5 Form input types -Input and Data List Elements and autocomplete attribute- Page Structure Elements -Multimedia-HTML5 Audio & video elements..

Module -2 (CSS, JavaScript)
Introduction to Stylesheets : Introduction to CSS-Basic syntax and structure-Inline Styles,
Embedded Style Sheets, Conflict Resolution, Linking External Style Sheets-Exploring CSS
Selectors-Properties, values, Positioning Elements: Absolute Positioning, Relative Positioning -
Backgrounds-List Styles-Element Dimensions- Table Layouts-Box Model and Text Flow-div and span -
Basics of Responsive CSS, Media port & Media Queries.
Introduction to JavaScript : Introduction to Scripting- Programming fundamentals of JavaScript -Obtaining User Input with prompt Dialogs-Arithmetic-Decision Making -Control Statements - Functions -Arrays - Objects -Document Object Model (DOM) -Form processing

Module- 3 (PHP Basics)
PHP Language Structure: Introduction- **B**uilding blocks of PHP-Variables, Data Types -simple PHP
program-Converting between Data Types- Operators and Expressions -Flow Control functions - Control
statements- Working with Functions- Initialising and Manipulating Arrays-- Objects String Comparisons-
String processing with Regular Expression

Module -4 (PHP- MySQL, JSON)
Advanced PHP: Form processing and Business Logic-Cookies- Sessions & MySQL Integration Connecting to MySQL with PHP- Performing CREATE, DELETE, INSERT, SELECT and UPDATE operations on MySQL table -Working with MySQL data-Reading from Database Dynamic Content.

Module- 5 (JSON, Laravel)
JSON Data Interchange Format: Syntax, Data Types, Object, JSON Schema, Manipulating
JSON data with PHP Web Development Frameworks**:** Laravel Overview-Features of Laravel-Setting up a
Laravel Development Environment-Application structure of Laravel-Routing -Middleware-
Controllers Route Model Binding-Views-Redirections-Request and Responses.

CST473: NATURAL LANGUAGE PROCESSING
Module – 1 (Introduction to NLP)

NLP Tasks and Applications, Language-Building Blocks, Challenges of NLP, Machine Learning for NLP – Naïve Bayes Classifier, Logistic Regression, Support Vector Machines, Approaches to NLP-- Heuristics-Based NLP, Machine Learning-based NLP.

Module – 2 (Pre-processing and Representation Models)
NLP System Pipeline--Steps--Data Acquisition, Text Extraction and Clean-up, Pre-processing, Feature Engineering, Modelling, Evaluation, Post-Modelling Phases
Text Representation--Vector Space Models--Basic Vectorization Approaches--One-Hot Encoding, Bag of Words, Bag of N-Grams TF-IDF; Distributed Representations-- Word Embeddings, Doc2Vec.

Module - 3 (Classification and Information Extraction)
Text Classification--Text classification applications – Pipeline for building text classification systems, Naïve Bayes for Sentiment Classification – Naïve Bayes Classifier Training – Optimizing for Sentiment Analysis, Logistic Regression, Support Vector Machine for Text ClassificationInformation Extraction(IE)—IE Applications – The General Pipeline for IE - Named Entity Recognition(NER), Ambiguity in Named Entity Recognition – NER as Sequence Labeling – Evaluation of NER.

Module - 4 (Relation Detection and Information Retrieval)
Relation Detection and Classification – Supervised Learning Approaches to Relation Analysis – Lightly Supervised Approaches to Relation Analysis – Evaluation of Relation Analysis systems Information Retrieval – Term weighting and document scoring – Inverted Index – Evaluation of Information Retrieval Systems.

Module - 5 (QA Systems and Machine Translation)
Question-Answering Systems – Factoid Question Answering – Question Processing – Passage Retrieval – Answer Processing – Evaluation of Factoid Answers
Machine Translation – Why Machine Translation is Hard – Classical Machine Translation – Direct Translation – Transfer – Statistical Machine Translation- The Phrase based Translation model – Alignment in MT – Training Alignment Models – Symmetrizing Alignments for Phrase-based MT – Decoding for Phrase-based Statistical MT

CST415: INTRODUCTION TO MOBILE COMPUTING
Module-1 (Mobile Computing Architecture)
Introduction to mobile computing – Functions, Devices, Middleware and gateways, Applications and services, Limitations. Mobile computing architecture – Internet: The ubiquitous network, Three-tier architecture, Design considerations for mobile computing.

Module-2 (Communication Systems)
Mobile computing through telephony - Evolution of telephony, Multiple access procedures - Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), Code Division Multiple Access (CDMA), Space Division Multiple Access (SDMA). Satellite communication systems – Basics, Applications, Geostationary Earth Orbit (GEO), Low Earth Orbit (LEO), Medium Earth Orbit (MEO), Satellitephones. Mobile computing through telephone – Interactive Voice Response (IVR) architecture, Overview of voice software, Developing an IVR application. Global System for Mobile Communication (GSM) - Introduction, Architecture, Entities, Call routing, Mobility management, Frequency allocation, Authentication and security.

Module-3 (Short Messaging Service and General Packet Radio Service)
Short Message Service (SMS) – Strengths, Architecture, Value added services, Accessing the SMS bearer. General Packet Radio Service (GPRS) – Architecture, Network operations, Data services, Applications, Limitations, Billing and charging.

Module-4 (Wireless Local Area Networks)
Wireless Local Area Network (WLAN) - Advantages, Evolution, Applications, Architecture, Mobility, Security, Deploying WLAN. Wireless Local Loop (WLL) – Architecture. High Performance Radio Local Area Network (HIPERLAN). WiFi Vs 3G.

Module-5 (Mobile Security and Next Generation Networks)
Security issues in mobile computing - Information security, Security techniques and algorithms, Security protocols. Next generation networks – The Converged Scenario, Narrowband to broadband, Orthogonal Frequency Division Multiplexing (OFDM), Multi

Protocol Label Switching (MPLS), Wireless Asynchronous Transfer Mode (WATM), Multimedia broadcast services.

CST425 INTRODUCTION TO DEEP LEARNING

Module-1 (Introduction)
Key components - Data, models, objective functions, optimization algorithms, Learning algorithms. Supervised learning- regression, classification, tagging, web search, page ranking, recommender systems, sequence learning, Unsupervised learning, Reinforcement learning, Historical Trends in Deep Learning. Other Concepts - overfitting, underfitting , hyperparameters and validation sets, estimators, bias and variance.

Module- 2 (Optimization and Neural Networks)
Neural Networks –Perceptron, Gradient Descent solution for Perceptron, Multilayer perceptron, activation functions, architecture design, chain rule, back propagation, gradient based learning. Introduction to optimization– Gradient based optimization, linear least squares. Stochastic gradient descent, Building ML algorithms and challenges.

Module -3 (Convolutional Neural Network)
Convolutional Neural Networks – convolution operation, motivation, pooling, Convolution and Pooling as an infinitely strong prior, variants of convolution functions, structured outputs, data types, efficient convolution algorithms.

Module- 4 (Recurrent Neural Network)
Recurrent neural networks – Computational graphs, RNN design, encoder – decoder sequence to sequence architectures, deep recurrent networks, recursive neural networks, modern RNNs LSTM and GRU, Practical use cases for RNNs.

Module-5 (Application Areas)
Applications – computer vision, speech recognition, natural language processing. Research Areas – Autoencoders, Representation learning, Boltzmann Machines, Deep belief networks.

CST435 COMPUTER GRAPHICS

Module – 1(Basics of Computer graphics)
Basics of Computer Graphics and its applications. Video Display devices- Refresh Cathode Ray Tubes(CRT), Random Scan Displays and systems, Raster scan displays and systems, Color CRT displays, Flat panel display and its categories.

Module – 2 (Line drawing, Circle drawing and Filled Area Primitives)
Line drawing algorithms- DDA, Bresenham's algorithm. Circle drawing algorithms- Midpoint Circle generation algorithm, Bresenham's algorithm. Filled Area Primitives- Scan line polygon filling, Boundary filling and flood filling.

Module - 3 (Geometric transformations)
Two dimensional transformations-Translation, Rotation, Scaling, Reflection and Shearing, Composite transformations, Matrix representations and homogeneous coordinates. Basic 3D transformations.

Module - 4 (Clipping)
Window to viewport transformation. Cohen Sutherland and Midpoint subdivision line clipping algorithms, Sutherland Hodgeman and Weiler Atherton Polygon clipping algorithms.

Module - 5 (Three dimensional graphics)
Three dimensional viewing pipeline. Projections- Parallel and Perspective projections. Visible surface detection algorithms- Back face detection, Depth buffer algorithm, Scan line algorithm, A buffer algorithm

CST445 PYTHON FOR ENGINEERS

Module 1 (Basics of Python)
Getting Started with Python Programming - Running code in the interactive shell, Editing, Saving, and Running a script. Using editors - IDLE, Jupyter. Basic coding skills - Working with data types, Numeric data types and Character sets, Keywords, Variables and Assignment statement, Operators, Expressions, Working with numeric data, Type conversions, Comments in the program, Input Processing, and Output, Formatting output. How Python works. Detecting and correcting

syntax errors. Using built in functions and modules in math module. Controlstatements - Selection structure - if-else, if-elif-else. Iteration structure - for, while. Testing the control statements. Lazy evaluation.

Module 2 (Functions and Python Data Structures)

Functions - Hiding redundancy and complexity, Arguments and return values, Variable scopes and parameter passing, Named arguments, Main function, Working with recursion, Lambda functions. Strings - String function. Lists - Basic list Operations and functions, List of lists, Slicing, Searching and sorting list, List comprehension. Work with tuples. Sets. Dictionaries - Dictionary functions, dictionary literals, adding and removing keys, accessing and replacing values, traversing dictionaries, reverse lookup.

Module 3 (Object Oriented Programming)

Design with classes - Objects and Classes, Methods, Instance Variables, Constructor, Accessors and Mutators. Structuring classes with Inheritance and Polymorphism. Abstract Classes. Exceptions - Handle a single exception, Handle multiple exceptions.

Module 4 (Visualization and File handling)

Plotting - An Interactive Session with PyPlot, Basic Plotting, Logarithmic Plots, More Advanced Graphical Output, Plots with multiple axes, Mathematics and Greek symbols, The Structure of matplotlib, Contour and Vector Field Plots. File Processing - The os and sys modules, Introduction to file I/O, Reading and writing text files, Working with CSV files.

Module 5 (Scientific Computing)

Numerical Routines. SciPy and NumPy - Basics, Creating arrays, Arithmetic, Slicing, Matrix Operations, Special Functions, Random Numbers, Linear Algebra, Solving Nonlinear Equations, Numerical Integration, Solving ODEs. Data Manipulation and Analysis – Pandas : Reading Data from Files Using Pandas, Data Structures: Series and DataFrame, Extracting Information from a DataFrame, Grouping and Aggregation.

CST455 OBJECT ORIENTED CONCEPTS

Module – 1 (Object Orientation and Java basics)

Object Orientation Principles – Object and Class, Data abstraction and Encapsulation, Inheritance, Polymorphism, Dynamic binding, Message communication, Benefits of using Object orientation. Introduction to Java - Java programming Environment and Runtime Environment, Development Platforms -Standard, Enterprise. Java Virtual Machine (JVM), Java compiler, Bytecode, Java applet, Java Buzzwords, Java program structure, Comments, Garbage Collection, Lexical Issues. Primitive Data types - Integers, Floating Point Types, Characters, Boolean. Literals, Type Conversion and Casting, Variables, Arrays, Strings, Vector class.

Module – 2 (Core Java Fundamentals)

Operators - Arithmetic Operators, Bitwise Operators, Relational Operators, Boolean Logical Operators, Assignment Operator, Conditional (Ternary) Operator, Operator Precedence. Control Statements - Selection Statements, Iteration Statements and Jump Statements. Object Oriented Programming in Java - Class Fundamentals, Declaring Objects, Object Reference, Introduction to Methods, Constructors, *this* Keyword, Method Overloading, Using Objects as Parameters, Returning Objects, Recursion, Access Control, Static Members, Command-Line Arguments, Variable Length Arguments.

Module - 3 (More features of Java)

Inheritance - Super Class, Sub Class, The Keyword *super*, protected Members, Calling Order of Constructors, Method Overriding, the Object class, Abstract Classes and Methods, Using *final* with Inheritance. Packages and Interfaces - Defining Package, CLASSPATH, Access Protection, Importing Packages, Interfaces.Exception Handling - Checked Exceptions, Unchecked Exceptions, *try* Block and *catch* Clause, Multiple *catch* Clauses, Nested *try* Statements, *throw*, *throws* and *finally*.

Module - 4 (Advanced features of Java)

Input/Output - I/O Basics, Reading Console Input, Writing Console Output, PrintWriter Class, Reading and Writing Files. Java Library - String Handling – String Constructors, String Length, Special String Operations - Character Extraction, String Comparison, Searching Strings, Modifying Strings, Using valueOf(), Comparison of String Buffer and String.

Module - 5 (GUI Programming, Event Handling and Multithreaded Programming)

Multithreaded Programming - The Java Thread Model, The Main Thread, Creating Thread, Creating Multiple Threads, Suspending, Resuming and Stopping Threads.
Event Handling - Event Handling Mechanisms, Delegation Event Model, Event Classes, Sources of Events, Event Listener Interfaces, Using the Delegation Model.
Swing Fundamentals - Swing Key Features, Model View Controller (MVC), Swing Controls, Components and Containers, Exploring Swing - JFrame, JLabel, JButton, JTextField.

SEMESTER 8

ADT 402: BUSINESS ANALYTICS
Module – 1 (Introduction to Business Analytics)
Evolution and scope, resource alignment within organization. Applications of business analytics – finance, sensitivity analysis, human resource management, market share estimation, recovery management, risk management, portfolio stress testing, fraud detection and prediction. Decision models, types - descriptive, diagnostic, predictive, and prescriptive.
Data Modelling Approach - Data Organisation, Structured Vs Unstructured data, the 5 V's of Business Analytics, Data Analytics framework, Analytics Tools – licensed vs open source. Data cleaning, outliers and outlier's diagnostics.
Module - 2(Statistical Models)
Probability Distributions, Sampling and Sampling Distributions, Statistical Distributions - Normal, Binomial, Poisson. Measures of Central Tendency, Symmetry, and Correlation. Time Series analysis – definition, steps to analyse, importance, components, models and techniques.
Forecasting - Forecasting for Management Decisions, Data Patterns and Choice of Forecasting Techniques, Data Collection and Analysis in Forecasting, Forecasting with Smoothing Techniques, Forecasting with Regression.
Module - 3 (Data Modelling with Tableau)
Extracting data into Tableau – design flow, file types, data types, data sources, data preparations, dimensions, custom data view, extracting and editing data, transformation of variables, joining and blending data, tableau worksheets, tableau calculations, sort and filters, working with charts, exporting visualizations, formatting and forecasting.
Module - 4 (Web Analytics)
A|B Testing, Market Basket Analysis, Classification and Regression Tree, Monte Carlo Simulation.Click stream analytics, anonymous vs. registered user's analysis, Social Media Analytics - User generated content – Page tagging, Server log files, Data abstractions. Sentiment Analysis, Analytics in digital decoding consumer intent, decoding customer sentiments from comments, Text mining from opinion platforms.
Module - 5 (Data Science Toolkits for Business Analytics)
Clustering - K-Means, DBSCAN, Agglomerative and Hierarchical, Decision Tree – ID3, Factor Analysis, and Segmentation Analysis.
Build spread sheet models, analysis using spread sheets – What-if analysis, Break even analysis

AMT 414: GPU COMPUTING
Module 1 – (Introduction)
Introduction - GPUs as Parallel Computers- Architecture of a Modern GPU- Why More Speed or Parallelism? - Parallel Programming Languages and Models.
History of GPU Computing- Evolution of Graphics Pipelines - The Era of Fixed-Function Graphics Pipelines- Evolution of Programmable Real-Time Graphics- Unified Graphics and Computing Processors GPU Computing- Scalable GPUs
Module 2 – (CUDA Parallelism and Threads)
Introduction to CUDA- Data Parallelism- CUDA Program Structure- A Matrix–Matrix Multiplication Example - Device Memories and Data Transfer - Kernel Functions and Threading
CUDA Threads - CUDA Thread Organization- Using blockIdx and threadIdx - Synchronization and Transparent Scalability - Thread Assignment - Thread Scheduling and Latency Tolerance
Module 3 – (CUDA Memories and Performance Considerations)
CUDA Memories Importance of Memory Access Efficiency- CUDA Device Memory Types - A Strategy

for Reducing Global Memory Traffic- Memory as a Limiting Factor to ParallelismPerformance Considerations- More on Thread Execution- Global Memory Bandwidth - Dynamic Partitioning of SM Resources- Data Prefetching- Instruction Mix- Thread Granularity

Module 4 – (Floating Point Considerations and Parallel Thinking)
Floating Point Considerations- Floating-Point Format – Normalized Representation of M- Excess Encoding of E - Representable Numbers- Special Bit Patterns and Precision- Arithmetic Accuracy and Rounding - Algorithm Considerations Parallel Programming and Computational Thinking- Goals of Parallel Programming - Problem Decomposition - Algorithm Selection - Computational Thinking

Module 5 – (Case Studies)
Application Case Study: Advanced MRI Reconstruction Application Background - Iterative Reconstruction- Computing FHd- Determine the Kernel Parallelism Structure - Getting Around the Memory Bandwidth Limitation - Using Hardware Trigonometry Functions- Experimental Performance Tuning Application Case Study: Molecular Visualization and Analysis Application Background - A Simple Kernel Implementation - Instruction Execution Efficiency - Memory Coalescing - Additional Performance Comparisons - Using Multiple GPUs

CST424 PROGRAMMING PARADIGMS
Module – 1
Introduction – Role of Programming Languages, Programming Domains, Language Evaluation Criteria, Influence on Language Design, Language Design Trade-offs, Implementation Methods. Names, Bindings & Scope – Names, Variables, Concept of Binding, Scope and Lifetime, Referencing Environments.

Module - 2
Data Types – Primitive Data Types, Character String Types, User-Defined Ordinal Types, Array Types, Record Types, List Types, Pointer & Reference Types, Type Checking, Strong Typing, Type Equivalence. Expressions – Arithmetic Expressions, Overloaded Operators, Type Conversions, Relational and Boolean Expressions, Short-Circuit Evaluation. Assignment - Assignment Statements, Mixed-mode Assignment.

Module - 3
Statement-Level Control Structures – Selection Statements, Iterative Statements, Unconditional Branching, Guarded Commands. Subprograms – Design Issues of Subprograms, Local Referencing Environments, Parameter Passing Methods, Subprograms as Parameters, Overloaded Subprograms, Closures, Co-routines

Module - 4
Support for Object Oriented Programming – Inheritance, Dynamic Binding, Design Issues for Object Oriented Languages, Support for Object Oriented Programming in C++, Implementation of Object-oriented Constructs. Exception Handling – Basic Concepts, Design Issues.

Module - 5
Concurrency – Subprogram Level Concurrency, Semaphores, Monitors, Message Passing. Functional Programming Languages – Introduction to LISP and Scheme, Comparison ofFunctional and Imperative Languages. Logic Programming Languages – Basic Elements of Prolog, Applications of Logic Programming.

CST434 NETWORK SECURITY PROTOCOLS
Module-1 (Authentication Protocols)
Authentication Protocols – Mutual authentication, One way authentication. Kerberos – Kerberos Version 4, Kerberos Version 5. X.509 Authentication service. Public Key Infrastructure (PKI) – Trust models, Revocation.

Module-2 (E-mail Security)
Pretty Good Privacy (PGP) – Operational Description, Cryptographic keys and key rings, Message format, PGP message generation, PGP message reception, Public key management. S/MIME – Functionality, Messages, Certificate processing, Enhanced security services.

Module-3 (Network Layer Security and Web Security)
Internet Protocol Security (IPSec) – Overview, IP security architecture, Authentication Header (AH), Encapsulating Security Payload (ESP), Combining Security Associations, Key

management. Internet Key Exchange (IKE) - Phases. Web Security – Web security considerations. Secure Socket Layer and Transport Layer Security (SSL/TLS) – SSL Architecture, SSL protocols, Cryptographic computations, Transport layer security.**Module-4 (Real-time Security and Application Layer Security)**

Real-time communication security – Perfect Forward Secrecy (PFS), Denial-of-Service protection, Endpoint identifier hiding, Live partner reassurance. Hypertext Transfer Protocol Secure (HTTPS) – Connection initiation, Closure. Secure Shell (SSH) – Transport layer protocol, User authentication protocol, Connection protocol. Secure Electronic Transaction (SET) – Overview, Features, Participants, Dual signature, Payment processing.

Module-5 (System Security and Wireless Security)

Firewalls – Firewall characteristics, Types of Firewalls, Firewall configurations, Encrypted Tunnels, Trusted systems – Data access control, The concept of Trusted Systems, Trojanhorse defense. IEEE 802.11i wireless LAN security - Services, Phases of operation, Wired Equivalent Privacy (WEP), Wi-Fi Protected Access (WPA), WPA2.

CST444 SOFT COMPUTING

Module – 1 (Introduction to Soft Computing & Artificial Neural Network)

Introduction to Soft Computing. Difference between Hard Computing & Soft Computing. Applications of Soft Computing. Artificial Neurons Vs Biological Neurons. Basic models of artificial neural networks – Connections, Learning, Activation Functions. McCulloch and Pitts Neuron. Hebb network.

Module – 2 (Supervised Learning Network)

Perceptron Networks– Learning rule, Training and testing algorithm. Adaptive Linear Neuron– Architecture, Training and testing algorithm. Back propagation Network – Architecture, Training and testing algorithm.

Module - 3 (Fuzzy Logic & Defuzzification)

Fuzzy sets – properties, operations on fuzzy set. Fuzzy membership functions, Methods of membership value assignments – intuition, inference, Rank Ordering. Fuzzy relations– operations on fuzzy relation. Fuzzy Propositions. Fuzzy implications. Defuzzification– Lamda cuts, Defuzzification methods.

Module - 4 (Fuzzy Inference System & Genetic Algorithm)

Fuzzy Inference Systems - Mamdani and Sugeno types. Fuzzy Logic Controller. Concepts of genetic algorithm. Operators in genetic algorithm - coding, selection, cross over, mutation. Stopping condition for genetic algorithm.

Module - 5 (Multi Objective Optimization & Hybrid Systems)

Multi objective optimization problem. Principles of Multi- objective optimization, Dominance and pareto-optimality. Optimality conditions. Neuro-fuzzy hybrid systems. Genetic – neuro hybrid systems.

CST454 FUZZY SET THEORY AND APPLICATIONS

Module – 1 (Basic Fuzzy Set Theory)

The case for imprecision, Utility and Limitations of Fuzzy Systems, Fuzzy Sets and Membership, Classical Sets – Properties, Operations, Fuzzy Sets – Properties and Operations, Classical Relations – Cartesian Product, Operations and Properties of Crisp Relations, Composition, Fuzzy Relations – Cardinality, Operations, Properties, Fuzzy Cartesian Product and Composition.

Module – 2 (Fuzzy Membership Functions)

Tolerance and Equivalence Relations – Crisp and Fuzzy, Similarity Methods – Cosine, Min-max, Fuzzy Membership Functions – Features, Fuzzification, Defuzzification to Crisp Sets, λ-Cutsfor Fuzzy Relations, Linguistic Hedges.

Module - 3 (Fuzzification and Defuzzification Methods)

Development of Membership Functions –Intuition, Inference, Rank ordering, Inductive reasoning. Defuzzification to Scalars - Max membership principle, Centroid method, Weighted average method, Mean max membership, Center of sums, Center of largest area, First (or last) of maxima.

Module - 4 (Fuzzy Inference)

Classical Logic, Fuzzy Logic, Approximate Reasoning, Fuzzy (Rule-Based) Systems - Multiple

conjunctive antecedents, Multiple disjunctive antecedents, Aggregation of fuzzy rules, Graphical Techniques of Inference.

Module - 5 (Fuzzy Applications)

Applications of Fuzzy Systems - Fuzzy Classification, Fuzzy Pattern Recognition, Fuzzy Control Systems, Fuzzy Systems and Neural Networks, Fuzzy Clustering, Fuzzy Databases and Information retrieval systems.

CST464 EMBEDDED SYSTEMS

Module – 1 (Introduction to Embedded Systems)

Embedded Systems – Definitions, Embedded Systems vs. General Computing Systems, History, Classification, Application Areas, Purpose. Building Blocks of a Typical Embedded System – System Core (Microprocessors, Microcontrollers, DSP, ASICs, PLDs), Memory (Different ROMs and RAMs), Sensors and Actuators, I/O Subsystem Interface, Communication Interface, Embedded Firmware, Other System Components (Reset and Brown-out Protection Circuits,Oscillator Unit, Real-Time Clock, Watchdog Timer), Printed Circuit Board. Embedded System Design Process – Requirements, Specification, Architecture Design, Designing Hardware and Software Components, System Integration.

Module - 2 (System Modeling and Hardware Software Co-Design)

Computational Models in Embedded Design – Data Flow Graph, Control Data Flow Graph, State Machine Model, Sequential Program Model, Concurrent Process Model, Object-Oriented Model. Hardware Software Co-Design – Traditional Embedded Development Cycle, History, Advantages of the Co-Design Methodology, The Co-Design Process, Fundamental Issues in Hardware Software Co-Design. Hardware software trade-offs.

Module - 3 (Real-Time Embedded System Design)

Prerequisite Topics: Operating System – Basics, Types. Basics of Tasks, Process and Threads. Multiprocessing and Multitasking. Task Scheduling – Non-Preemptive (FIFO, LIFO, SJF) and Preemptive (SRT, RR, Priority-based, Rate-based).

Task Communication – Shared Memory, Message Passing, Remote Procedure Call and Sockets. Task Synchronization – Synchronization Issues – Race Condition, Deadlock, Priority Inversion, Priority Inheritance, Priority Ceiling. Synchronization Techniques – Spin Lock, Sleep & Wakeup, Semaphores. Selection of an RTOS for an Embedded Design – Functional and Non- Functional Requirements.

Module 4 – (Embedded Firmware Design and Development, and EDLC)

Embedded Firmware Design and Development – Firmware Design Approaches, Firmware Development Languages. Integration of Embedded Hardware and Firmware.

Embedded Product Development Life Cycle – Objectives, Different Phases, Modeling Techniques – Waterfall Model, Incremental Model, Evolutionary Model, Spiral Model.

Module 5 (Embedded System Industry – Case Studies and Applications)

Design Case Studies – Battery Operated Smart Card Reader, Automated Meter Reading System, Smart Watch. Automotive and Aerospace Systems – Networked Control Systemsin Cars and Airplanes, Vehicular Networks – CAN bus, Time-triggered Architecture, FlexRay and LIN.

Internet of Things Systems – IoT System Architectures - Use Cases (Smart Appliance, Monitoring and Control Systems). Networks for IoT – Networking concepts, Bluetooth, Bluetooth LowEnergy, 802.15.4, ZigBee and WiFi. Databases and Timewheels. Smart Home Example.

CST474 COMPUTER VISION

Module – 1 (Image Formation and Filtering)

Geometric Camera Models - Pinhole perspective, Intrinsic and Extrinsic Parameters, Geometric Camera Calibration. Linear Filters- Linear Filters and Convolution, Shift Invariant Linear Systems. Filters as Templates - Normalized Correlation and Finding Patterns.

Module - 2(Local Image Features and Stereo Vision)

Image Gradients - Computing the Image Gradient, Gradient Based Edge and Corner Detection. Stereopsis- Binocular Camera Geometry, Epipolar Constraint, Binocular Reconstruction, Local Methods for Binocular Fusion, Global Methods for Binocular Fusion.

Module - 3 (Segmentation)

Segmentation - Background subtraction, Interactive segmentation, Forming image regions. Segmentation by clustering - Watershed Algorithm. Motion Segmentation by Parameter Estimation Optical Flow and Motion, Flow Models, Motion Segmentation with Layers.

Module- 4 (Classification and Tracking)

Classification - Classification Basics, Two-class and Multiclass classifiers, Error, Overfitting and Regularization, Cross Validation, Classifying Images of Single Objects.
Tracking - Tracking Basics, Simple Tracking Strategies, Tracking by detection, Tracking Linear Dynamical models with Kalman filters.

Module - 5 (Finding Objects and other Applications)

Object detection - The Sliding Window Method. Object Recognition -Goals of Object Recognition System. Applications - Robot Navigation by stereo vision, Face detection, Face recognition, Activity Recognition, Tracking people.

AMT 416: HUMAN COMPUTER INTERACTION

Module -1(Introduction to HCI and Usability)

Introduction- - Components of Interaction – Ergonomics Designing Interactive systems – Understanding Users cognition and cognitive frameworks, User Centered approaches, Usability goals and measures, Universal Usability-Diverse Cognitive and Perceptual abilities, Personality differences, Cultural and International diversity, Users with disabilities- Older Adult users and Children. Guidelines, Principles and Theories.

Module -2 (Design Process and Interaction Styles)

HCI patterns, Design frameworks, Design methods, Prototyping. Understanding interaction styles - Direct Manipulation and Immersive environments, Fluid navigation - Navigation by Selection, Small Displays, Content Organization, Expressive Human and Command Languages-Speech Recognition, Traditional Command Languages, Communication and Collaboration-Models of Collaboration, Design considerations.

Module -3 (User Experience Design)

Frameworks for User Centric Computing, Computational models of users, Advancing the User Experience- Display Design, View (Window) Management, Animation, Webpage Design, Color. Timely user Experience-Models of System Response Time (SRT) Impacts, Frustrating Experiences, Information Search- Five Stage Search Framework, Data Visualization-Tasks in Data Visualization, Challenges

Module -4 (Cognitive Systems and Evaluation of HCI)

Cognitive Models- Goal and task hierarchies, GOMS Model. Introducing Evaluation Types of Evaluation, Other Issues to Consider When Doing Evaluation. Conducting Experiments. Usability testing – Heuristic evaluation and walkthroughs, Analytics and predictive models.

Module -5 (Contexts for Designing UX)

Designing apps and websites – Website and app development, The information architecture of apps and websites. Social media -Social Networking, Sharing with others. Collaborative environments- Issues for cooperative working, Technologies to support cooperative working, AI and Interface Agents, Ubiquitous computing -Blended Spaces. Mobile Computing – Designing for Mobiles. Wearable Computing- Smart Materials, Material Design.

AIT426 Mining of Massive Data Sets

Module -1(Data Mining)

Data Mining- Statistical Modeling, Machine Learning, Computational Approaches to Modeling, Summarization, Feature Extraction. Statistical Limits on Data Mining- Total Information Awareness, Bonferroni's Principle, Importance of Words in Documents, Hash Functions, Secondary Storage, The Base of Natural Logarithms, Power Laws.

Module -2(MapReduce and the New Software Stack)

Distributed File Systems, MapReduce-The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Details of MapReduce Execution, Algorithms Using MapReduce- Matrix-Vector Multiplication by MapReduce, If the Vector v Cannot Fit in Main

Memory, Relational-Algebra Operations, Computing Selections by MapReduce, Computing Projections by MapReduce, Union, Intersection, and Difference by MapReduce, Computing Natural Join by MapReduce, Grouping and Aggregation by MapReduce, Matrix Multiplication, Matrix Multiplication with One MapReduce Step, Extensions to MapReduce.

Module -3 (Mining Data Streams) The Stream Data Model, Sampling Data in a Stream, Filtering Streams, Counting Distinct Elements
in a Stream, Estimating Moments- Definition of Moments, The Alon-Matias-Szegedy Algorithm for Second Moments, Counting Ones in a Window.

Module -4(Clustering)
Introduction to Clustering Techniques-Points, Spaces, and Distances, Clustering Strategies, The Curse of Dimensionality, Hierarchical Clustering, K-means Algorithms, The CURE Algorithm, Clustering in Non-Euclidean Spaces, Clustering for Streams and Parallelism- The Stream Computing Model, A Stream-Clustering Algorithm, Initializing Buckets, Merging Buckets, Answering Queries, Clustering in a Parallel Environment

Module -5 (Advertising on the Web)
Issues in On-Line Advertising, On-Line Algorithms, The Matching Problem, The Adwords Problem, Adwords Implementation. Mining Social-Network Graphs:Social Networks as Graphs, Clustering of Social-Network Graphs.

CST436: PARALLEL COMPUTING
Module- 1 (Principles of Parallel Algorithm Design)
Basic Introduction to Parallel Processing platforms. Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models.

Module- 2 (Communication Operations)
Basic Communication Operations - One-to-All Broadcast and All-to-One Reduction, All-to-All Broadcast and Reduction, All-Reduce and Prefix-Sum Operations, Scatter and Gather, All-to-All Personalized Communication, Circular Shift, Improving the Speed of Some Communication Operation

Module-3 (Programming Using the Message Passing Paradigm)
Principles of Message-Passing Programming, The Building Blocks: Send and Receive Operations, MPI: The Message Passing Interface, Overlapping Communication with Computation, Collective Communication and Computation Operations, Groups and Communicators.

Module 4 (Programming Shared Address Space Platforms Thread Basics)
Thread Basics, Why Threads? The POSIX Thread Application Programme Interface, Synchronization Primitives in POSIX, Controlling Thread and Synchronization Attributes, Thread Cancellation, Composite Synchronization Constructs, OpenMP: a Standard for Directive Based Parallel Programming, Specifying Concurrent Tasks in OpenMP, Synchronization Constructs in OpenMP, Data Handling in OpenMP, OpenMP Library Functions, OpenMP Applications: Parallel algorithm development for Matrix multiplication

Module 5 (GPU Programming)
Heterogeneous Parallel Computing, Architecture of a Modern GPU, Speeding up Real Applications, Data parallel computing, CUDA C Program Structure, A Vector Addition Kernel, Device Global Memory and Data Transfer, Kernel Functions and Threading, Kernel Launch, CUDA Thread Organization, Mapping Threads to Multidimensional Data, Synchronization and Transparent Scalability, Resource Assignment, Querying Device Properties, Thread Scheduling and Latency Tolerance, Importance of Memory Access Efficiency, Cuda Memory Types, Tiling for Reduced Memory Traffic, Tiled Matrix Multiplication Kernel, Boundary Checks

CST446 DATA COMPRESSION TECHNIQUES
Module-1 (Modelling and types of compression)) 1
Introduction to Compression Techniques- Lossy compression & Lossless compression, Measures of Performance, Modeling and coding. Mathematical modelling for Lossless and lossy compression - Physical models and probability models.

Module – 2 (Basic Compression Methods)

Basic Compression Technique- Run length encoding, RLE Text compression. Statistical Methods Prefix Codes, Binary Huffman coding, non-binary Huffman Algorithms, Arithmetic Coding.

Module - 3 (Text & Image Compression)

Dictionary based Coding- LZ77, LZ78 and LZW compression.Image Compression- Image standards, JPEG image Compression- Baseline JPEG, JPEG-LS.

Module - 4 (Video Compression)

Video Compression- Analog video, Digital Video, Motion Compensation. MPEG standards MPEG 1, MPEG 4

Module - 5 (Audio Compression)

Audio Compression- Basics of Digital Audio, Basic Audio Compression Techniques, MPEG Audio Compression-Layer 1 coding, Layer 2 coding and Layer 3 coding.

AIT 456: INTODUCTION TO REINFORCEMENT LEARNING

Module 1: Review of Probability Concepts

Probability concepts review - Axioms of probability, concepts of random variables, probability mass function, probability density function, cumulative density functions, Expectation of random variables. Concepts of joint and multiple random variables, conditional and marginal distributions. Correlation and independence.

Module 2: Markov Decision Process

Introduction to Reinforcement Learning (RL) terminology - Examples of RL, Elements of RL, Limitations and Scope of RL. Finite Markov Decision Processes - The Agent–Environment Interface, Goals and Rewards, Returns and Episodes, Policies and Value Functions.

Module 3: Prediction and Control

Dynamic Programming - Policy Evaluation (Prediction), Policy Improvement, Policy Iteration, Value Iteration. Monte Carlo Prediction, MonteCarlo Estimation of Action Values, Monte Carlo Control, Monte Carlo Control without Exploring Starts, Off-policy Prediction via Importance Sampling.

Module 4: Temporal-Difference (TD) Methods for Model Free Prediction And Control

TD Methods - TD Prediction, Advantages of TD Prediction Methods, Optimality of TD(0), Sarsa: On policy TD Control, Q-learning: Off-policy TD Control, Expected Sarsa. n-step TD Prediction, n-step Sarsa, n-step Off-policy Learning. Off -policy Learning without Importance Sampling – The n step Tree Backup Algorithm

Module 5: Function Approximation Method

On-policy Prediction with Approximation - Value-function Approximation, The Prediction Objective, Stochastic-gradient Methods, Linear Methods.
Eligibility Traces - The λ-return, TD(λ), n-step Truncated λ-return Methods, Sarsa(λ).

CST466: DATA MINING

Module – 1 (Introduction to Data Mining and Data Warehousing)

Data warehouse-Differences between Operational Database Systems and Data Warehouses, Multidimensional data model- Warehouse schema, OLAP Operations, Data Warehouse Architecture, Data Warehousing to Data Mining, Data Mining Concepts and Applications, Knowledge Discovery in Database Vs Data mining, Architecture of typical data mining system, Data Mining Functionalities, Data Mining Issues.

Module - 2 (Data Preprocessing)

Data Preprocessing-Need of data preprocessing, Data Cleaning- Missing values, Noisy data, Data Integration and Transformation, Data Reduction-Data cube aggregation, Attribute subset selection, Dimensionality reduction, Numerosity reduction, Discretization and concept hierarchy generation.

Module - 3 (Advanced classification and Cluster analysis)

Classification- Introduction, Decision tree construction principle, Splitting indices -Information Gain, Gini indexDecision tree construction algorithms-ID3, Decision tree construction with presorting-SLIQ, Classification Accuracy-Precision, Recall.
Introduction to clustering-Clustering Paradigms, Partitioning Algorithm- PAM, Hierarchical Clustering-DBSCAN, Categorical Clustering-ROCK

Module 4: (Association Rule Analysis)

Association Rules-Introduction, Methods to discover Association rules, Apriori(Level-wise

algorithm), Partition Algorithm, Pincer Search Algorithm, Dynamic Itemset Counting Algorithm, FP-tree Growth Algorithm.

Module 5 (Advanced Data Mining Techniques)

Web Mining - Web Content Mining, Web Structure Mining- Page Rank, Clever, Web Usage Mining- Preprocessing, Data structures, Pattern Discovery, Pattern Analysis. Text Mining-Text Data Analysis and information Retrieval, Basic measures for Text retrieval, Text Retrieval methods, Text Indexing Techniques, Query Processing Techniques.

AIT 476: BIO-INSPIRED OPTIMIZATION TECHNIQUES

Module – 1 (Optimization Techniques)

Optimization Techniques: Understanding optimization process- Objective function, minima & maxima, convergence. Optimization methods- conventional methods, Gradient descent algorithm drawbacks. Introduction to Optimization Problems – classification- Single and Muti- objective Optimization – Classical Techniques – Overview of various Optimization methods . Bio inspired Computing (BIC): Motivation – Overview of BIC – usage of BIC – merits and demerits of BIC.

Module– 2(Evolutionary Computing)

Evolutionary Computing: Motivation, Genetic Algorithm and Genetic Programming: Basic concept – encoding – representation – fitness function – Population, Operators – Selection, Mutation, Crossover, Reproduction – Types of Evolutionary Algorithms, Differences between GA and Traditional optimization methods – Applications.

Module- 3 (Ant Colony Systems)

Swarm intelligent systems – Background. Ant colony systems – Biological systems, Development of the ant colony system- - Working of ACO Algorithm - Pheromone updating- Types of ant systems- ACO algorithms for TSP.

Module- 4 (Particle Swarm Optimization)

Foraging for food – Clustering of objects – Collective Prey retrieval –Scope of Swarm Robotics –Social Adaptation of Knowledge: Particle Swarm – Particle Swarm Optimization (PSO) – Particle Swarms for Dynamic Optimization Problems – Bee-inspired optimization, Artificial Bee Colony (ABC) Optimization , applications.

Module- 5 (Case Studies)

Other Swarm Intelligence algorithms: Fish Swarm – Bacteria foraging – Intelligent Water Drop Algorithms – Applications of biologically inspired algorithms in engineering. Case Studies: ACO for NP-hard problems – Routing problems – Assignment problems –Scheduling problems.

CST418: HIGH PERFORMANCE COMPUTING

Module-1 (Basics of Architecture)

Classes of Computers - Classes of Parallelism and Parallel Architectures – Defining Computer Architecture – Dependability – Quantitative Principles of Computer Design – Basics of Memory Hierarchies – Virtual Memory and Virtual Machines – Pipelining

Module-2 (Instruction-Level Parallelism)

Instruction-Level Parallelism: Concepts and Challenges – Basic Compiler Techniques for Exposing ILP – Reducing Branch Costs With Advanced Branch Prediction – Hardware-Based Speculation – Multithreading: Exploiting Thread-Level Parallelism to Improve Uniprocessor Throughput

Module-3 (Data-Level Parallelism)

Vector Architecture – SIMD Instruction Set Extensions for Multimedia – Graphics Processing Units – Detecting and Enhancing Loop-Level Parallelism

Module-4 (Thread Level Parallelism)

Multiprocessor Architecture: Issues and Approach – Centralized Shared-Memory Architectures – Performance of Symmetric Shared-Memory Multiprocessors– Distributed Shared-Memory and Directory-Based Coherence – Synchronization: The Basics – Introduction to Memory Consistency

Module-5 (GPU Architectures)

The CPU-GPU system as an accelerated computational platform – The GPU and the thread engine – Characteristics of GPU memory spaces – The PCI bus: CPU to GPU data transfer overhead –

Multi-GPU platforms – Potential benefits of GPU – accelerated platforms

CST428 BLOCKCHAIN TECHNOLOGIES
Module – 1 (Fundamentals of Cryptography)
Introduction to Cryptography, Symmetric cryptography – AES. Asymmetric cryptography – RSA. Elliptic curve cryptography, Digital signatures – RSA digital signature algorithms. Secure Hash Algorithms – SHA-256. Applications of cryptographic hash functions – Merkle trees, Distributed hash tables.
Module – 2 (Fundamentals of Blockchain Technology)
Blockchain – Definition, architecture, elements of blockchain, benefits and limitations, types of blockchain. Consensus – definition, types, consensus in blockchain.Decentralization – Decentralization using blockchain, Methods of decentralization, Routes to
decentralization, Blockchain and full ecosystem decentralization.
Module - 3 (Consensus Algorithms and Bitcoin)
Consensus Algorithms, Crash fault-tolerance (CFT) algorithms – Paxos, Raft. Byzantine fault tolerance (BFT) algorithms – Practical Byzantine Fault Tolerance (PBFT), Proof of work (PoW), Proof of stake (PoS), Types of PoS.
Bitcoin – Definition, Cryptographic keys – Private keys, public keys, addresses. Transactions – Lifecycle, coinbase transactions, transaction validation. Blockchain – The genesis block.
Mining – Tasks of miners, mining algorithm, hash rate. Wallets – Types of wallets.
Module - 4 (Smart Contracts and Use cases)
Smart Contracts – Definition, Smart contract templates, Oracles, Types of oracles, Deploying smart contracts. Decentralization terminology – Decentralized applications, Decentralized Autonomous Organizations.
Use cases of Blockchain technology – Government, Health care, Finance, Supply chain management.
Blockchain and allied technologies – Blockchain and Cloud Computing, Blockchain and Artificial Intelligence.
Module - 5 (Ethereum and Solidity)
Ethereum – The Ethereum network. Components of the Ethereum ecosystem – Keys and addresses, Accounts, Transactions and messages. The Ethereum Virtual Machine, Blocks and blockchain.
The Solidity language – The layout of a Solidity source code, Structure of a smart contract, variables, data types, control structures, events, inheritance, libraries, functions, error handling. Smart contracts Case study: Voting, Auction.

CST438 IMAGE PROCESSING TECHNIQUE
Module – 1 (Digital Image Fundamentals)
Elements of Visual Perception, A Simple Image Formation Model. Spatial and Intensity Resolution. Image Interpolation. Classification of Digital Images. Image Types. Image Storage Mechanisms. Arithmetic and Logical Operations. Geometric Spatial Transformations and Image Registration. Image File Formats. Colour Fundamentals and Colour Models.
Module - 2 (Image Transforms)
Basic concept of spatial domain and frequency domain, Unitary transform, Discrete Fourier Transform- 2D DFT, 4 order DFT Transform coefficients, Forward and inverse transform, Discrete Cosine Transform- 2D DCT, 4 order DCT Transform Coefficients(No derivation needed), Forward and Inverse DCT, Hadamard Transform.
Module - 3 (Image Enhancement in Spatial and Frequency Domain)
Point operations- Clipping and Thresholding, Digital Negative, Intensity Level Slicing, Bit Extraction, Range Compression. Spatial Operations- Fundamentals of spatial convolution andcorrelation, Spatial averaging and spatial Low pass filtering, Directional Smoothing, Median
Filtering, Unsharp masking and Crispening.
Basics of Filtering in Frequency Domain, Filters, Smoothing Frequency Domain Filters- Sharpening Frequency Domain Filters
Module - 4 (Image Restoration & Image Segmentation)

Image degradation model, Noise models, Mean Filters, Order Statistic filter, Adaptive filters. Edge Detection, gradient operators, Laplace operators and zero crossings. Thresholding, Basic Global Thresholding, Optimum global thresholding using Otsu method, Multiple thresholds, Variable thresholding, Multivariable thresholding. Region-Based Approach to Segmentation.

Module - 5 (Morphological Operations & Representation and Description)
Structuring Element, Dilation and Erosion, Opening and Closing, Hit or Miss Transformation. Boundary Following. Chain Codes. Polygonal Approximation. Boundary Descriptors. Regional Descriptors. Relational Descriptors.

CST448 INTERNET OF THINGS
Module- 1 (IoT Architecture)
What is IoT, Genesis of IoT, IoT and Digitization, IoT Impact, Convergence of IT and IoT, IoT Challenges, IoT Network Architecture and Design, Drivers Behind New Network Architectures, Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack, IoT Data Management and Compute Stack.

Module- 2 (Engineering IoT Networks)
Smart Objects: The "Things" in IoT, Sensors, Actuators, and Smart Objects, Sensor Networks, Connecting Smart Objects, Communications Criteria, IoT Access Technologies

Module- 3 (IoT Network Layer)
IP as the IoT Network Layer, The Business Case for IP, The need for Optimization, Optimizing IP for IoT, Profiles and Compliances, Application Protocols for IoT, The Transport Layer, IoT Application Transport Methods

Module 4 (Data Analytics for IoT)
Data and Analytics for IoT, An Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology, Edge Streaming Analytics, Network Analytics, Securing IoT, A Brief History of OT Security, Common Challenges in OT Security, Differences between IT and OT Security Practices and Systems, Formal Risk Analysis Structures: OCTAVE and FAIR.

Module 5 (Developing IoT Systems)
IoT Logical Design using Python, IoT Physical Devices and Endpoints - Raspberry Pi interfaces, Programming Raspberry Pi using Python, Other IoT devices, IoT Physical devices and Cloud offerings, Cloud Storage Models, WAMP - Autobahn for IoT, Django, Designing RESTful Web API, Cloud Web Services for IoT.

CST458 SOFTWARE TESTING
Module - 1 (Introduction to Software Testing)
Some Popular Errors – Ariane 5, Therac 25, Intel Pentium Bug. What is Software testing? Why should it be tested? Software Quality, Role of Testing. Testing Process - Level 0 thinking, Level 1 thinking, Level 2 thinking, Level 3 thinking, Level 4 thinking. Software Testing Terminologies - Verification, Validation and Testing, Faults, Error and Bug, Test cases, Coverage Criteria. Types of Testing- Unit testing,integration testing, System testing, Acceptance testing, Beta testing, Functional testing, Stress testing, Performance testing, Usability testing and Regression testing. Testing Methods - Black Box testing, WhiteBox testing, Grey Box testing.

Module - 2 (Unit Testing)
Concept of Unit testing. Static Unit testing. Dynamic Unit testing - Control Flow testing, Data Flow testing, Domain testing, Functional Program testing. Mutation testing - Mutation and Mutants, Mutation operators, Mutation score. Junit - Framework for Unit testing. Case Study - Mutation testing using Junitand Muclipse.

Module - 3 (Unit Testing - White Box Approaches)
Overview of Graph Coverage Criteria. Structural Graph Coverage Criteria - Node/vertex coverage, Edge coverage, Edge pair coverage, Path coverage, Complete path coverage, Prime path coverage, Complete round trip coverage, Simple round trip coverage. Data Flow Criteria - du paths, du pairs. Subsumption Relationships among Graph Coverage Criteria. Graph Coverage for Source Code - Control flow graphs for code, CFG: If statement, CFG: If statement with return, CFG: Switch-case, CFG: Loops, CFG: Exceptions (try-catch). Example program – Statistics. Graph Coverage for Design Elements - Call graphs and classes, Class inheritance testing: Coverage criteria, Coverage criteria on inheritance graph, Data flow at the design level, Inter-procedural DU pairs, Coupling du-pairs example. Example - Quadratic Root. Case Study - Graph

Based testing using JUnit Framework.

Module - 4 (Unit Testing - Black Box Approaches)

Domain Testing / Input Space Partitioning - Partitions of a set. Input domain modelling - Interface-based approach, Functionality-based approach. Identifying values. Multiple partitions of the input domain - All Combinations Coverage (ACoC), Each Choice Coverage (ECC), Pair-wise Coverage, T-wise Coverage, Base Choice Coverage, Multiple Base Choices Coverage. TriTyp example. Functional Testing - Functional Testing Concepts of Howden. Functional testing - Important Steps. Types of Functional testing - Equivalence

Class Partitioning, Boundary Value Analysis, Decision Tables, Random Testing. Case Study -Black Box testing approaches using JUnit.

Module - 5 (Grey Box Testing Approaches)

Introduction to Grey Box testing - Why Grey Box testing, Gray Box Methodology, Advantages and Disadvantages. Techniques of Grey Box Testing - Matrix Testing, Regression Testing, Orthogonal Array Testing or OAT, Pattern Testing. An Introduction to PEX - Parameterized Unit Testing, The Testing Problem. Symbolic Execution – Example, Symbolic execution tree. PEX application Case Study – PEX

CST468 BIOINFORMATICS

Module-1 (Introduction to bioinformatics)

Introduction to bioinformatics, Nature & Scope of Bioinformatics, DNA, RNA, and Protein: The Central Dogma, Messenger RNA, tRNA, rRNA, Genetic code, Gene Structure and Control, Transcription, translation

Module-2 (Introduction to bio sequences and analysis)

Introduction to Biological Databases, NCBI, Genbank, Bio sequence formats- FASTA, Sequence alignment- Global Alignment and Local Alignment, Dot Matrix Method, Dynamic Programming Method, Gap Penalties, Amino Acid Scoring Matrices - PAM and BLOSUM

Module-3 (Database Similarity Searching and genomics)

Database Similarity Searching, BLAST – Variants -BLASTN, BLASTP, BLASTX, Statistical Significance, Needleman and Wunsch and Smith–Waterman Method, Multiple Sequence Alignment, scoring function, Clustal, introduction to structure of prokaryotic and eukaryote gene

Module-4 (Proteomics)

Protein Structure, Ramachandran Plot, Hierarchies of Protein Structure, Determination of Protein three-dimensional structure, protein structure database-PDB, Protein structure visualization, introduction to Protein protein interaction, STRING database

Module-5 (Systems Biology)

Introduction to Systems Biology, Models and Modelling, Properties of models, Systems state and steady state, Variables, Parameters, and Constants in modelling, Purpose and Adequateness of Models, Advantages of Computational Modelling, Model Development, Network Versus Elements, Modularity, Robustness and Sensitivity, Data Integration

CST478 COMPUTATIONAL LINGUISTICS

Module- 1 (Preliminaries)

Introduction: Rationalist and Empiricist Approaches to Language-Questions that linguistics should answer-Noncategorical phenomena in language-Language and cognition as probabilistic phenomena The Ambiguity of Language: Why natural language processing is difficult-Lexical resources Word counts-Zipf's laws-Collocations-Concordances Linguistic Essentials: Parts of Speech and Morphology -Nouns and pronouns-Words that accompany nouns: Determiners and adjectives-Verbs-Other parts of speech-Phrase Structure-Phrase structure grammars -Semantics and Pragmatics-Corpus Based Work

Module -2 (Mathematical Essentials:)

Probability Theory-Probability spaces-Conditional probability and independence-Bayes' theorem-Random variables-Expectation and variance-Notation-Joint and conditional distributions-Standard distributions-Bayesian statistics Statistical Inference: n-gram Models over Sparse Data-Bins: Forming Equivalence Classes Reliability vs discrimination-n gram models Markov Models-Hidden Markov Models-Why use HMMs?-General form of an HMM Finding the probability of an observation-Finding the best state sequence

Module -3 (Word Sense Disambiguation)

Methodological Preliminaries- Supervised and unsupervised learning-Pseudowords-Upper
and lower bounds on performance-Supervised Disambiguation-Bayesian classification
Dictionary based Disambiguation-Disambiguation based on sense definitions-Thesaurus based
disambiguation Lexical Acquisition-Evaluation Measures-Verb Subcategorization
-Attachment Ambiguity-PP attachment- Selectional Preferences Semantic Similarity: Vector space
measures-Probabilistic measures

Module -4 (Grammar)

Part-of-Speech Tagging-The Information Sources in Tagging-Markov Model Taggers- Hidden
Markov Model Taggers-Applying HMMs to POS tagging-The effect of initialization on HMM
training-Transformation Based Learning of Tags Probabilistic Context Free Grammars-Some Features of
PCFGs-Questions for PCFGs -The Probability of a String -Using inside probabilities-Using outside
probabilities-Finding the most likely parse for a sentence-parsing for disambiguation-parsing model versus
language model

Module -5 (Language Processing with Python)

Introduction to NLTK, Text Wrangling and Text cleansing : Sentence Splitter, Tokenization,
Stemming, Lemmatization, Stop word removal , Rare word Removal, Spell Correction. Part
of Speech Tagging and NER. Parsing Structure in Text: Shallow versus deep parsing, different
types of parsers and dependency parsing