DEPARTMENT OF INFORMATION TECHNOLOGY
SYLLABUS OF 2ND TO 4TH YEAR OF THE
UNDERGRADUATE ENGINEERING DEGREE PROGRAMME

2nd Year 1st Semester								
Subject Code	**Subject Name**	**Category**	**Type**	**Contact**			**Credit**	**Marks**
				L	**T**	**P**		
IT/PC/B/T/211	Data Structures and Algorithms	PC	Basic	3	0	0	3	100
IT/BS/B/T/212	Mathematics for IT-I	BS	Basic	3	0	0	3	100
IT/PC/B/T/213	Database Management Systems	PC	Basic	3	0	0	3	100
IT/PC/B/T/214	Object Oriented Programming	PC	Basic	3	0	0	3	100
IT/PC/B/T/215	Computer Organization and Architecture	PC	Basic	3	0	0	3	100
IT/PC/B/S/211	Data Structures and Algorithms Lab	PC	Basic	0	0	3	1.5	100
IT/PC/B/S/212	Database Management Systems Lab	PC	Basic	0	0	3	1.5	100
IT/PC/B/S/213	Object Oriented Programming Lab	PC	Basic	0	0	3	1.5	100
IT/PC/B/S/214	Assembly and Machine Language Lab	PC	Basic	0	1	3	2.5	100
			Sub-Total	15	1	12		
			Total	28			22	900

(IT/PC/B/T/211) Data Structures & Algorithms

Introduction: Algorithms, Order Notation: Time and Space Analysis of Algorithms

Sequential Representations of lists: Arrays and Lists, Linked Representation - Linear linked lists. Circular linked lists. Doubly linked lists. Operations on all types of lists. Applications.

Special Lists: Stacks, Queues and their applications.

Recursion: Design of recursive algorithms, Recursion vs. Iteration, Removal of Recursion

Trees - Binary Trees, Traversals of binary trees, Structural properties of binary trees. Representation of binary trees in terms of pointers and arrays. General trees

Binary Search Trees: Search, Insertion and Deletion algorithms, Structural properties. Threaded Binary trees.

Balanced Binary Search Trees: AVL tree, B-trees, B+- trees.

Graphs: Representations, Breadth-first and Depth-first Traversals, Shortest Path algorithms, Minimal Spanning Tree Algorithms

Sorting and Searching Algorithms: Bubble sort, Selection Sort, Insertion Sort, Quick sort, Merge Sort, Heap sort and Radix Sort, Binary Search, Interpolation Search.

Hashing: Hashing Functions, Collision Resolution Techniques.

(IT/BS/B/T/212) Mathematics for IT-I

Vector Algebra:

Basics of vector algebra; Dot and Cross products of two vectors; Products of three or more vectors; Volume of tetrahedron; Work done by a force, Moment of a force about a point .

Vector calculus:

Vector Calculus: Differentiation of a vector point function, Tangent and normal vectors, Directional derivatives, Gradient Divergence and Curl, Green's, Gauss' and Stokes' Theorems (statement only) with applications.

Ordinary Differential Equation:

Ordinary differential equations of the 1st order, exactness and integrating factors, variation of parameters, Picard's iteration method. Ordinary linear differential equation of n-th order, solutions of homogeneous and non-homogeneous equations. Operator method, Methods of undetermined coefficients and variations of parameters, systems of differential equations, Phase plane, Critical points, Stability.

Linear programming:

General structure of Linear programming model, application areas of Linear programming, solution by graphical method, simplex method (including two phase and Big-M method), duality in Linear programming.

Transportation Problem:

Mathematical model of Transportation Problem, methods for finding initial solution: North-West Corner Method, Least Cost Method, Vogel's Approximation Method, test for optimality, variations in Transportation Problem.

Assignment Problem:

Mathematical model of Assignment Problem, solution of Assignment Problem, variations in Assignment Problem.

(IT/PC/B/T/213) Database Management Systems

Introduction: History of Evolution of DBMS and advantages over traditional file system, Three-schema architecture of DBMS and Data Independence. Introduction to DDL and DML. Ideas about different kind of users of DBMS and available databases in market.

Data Model: Introduction to Relational data model and object oriented data model; Keys, Entity-Relationship Model, Relational Algebra , Tuple and Domain Relational Calculus

Database Design: Conceptual database design, Different types of dependencies, Theory of normalization, preservation of dependencies, Lossless decomposition, Armstrong's axioms, Views, Database security,

SQL: Introduction to SQL, Stored Procedures and Triggers, Application development using SQL and embedded SQL programming

Data Storage and Querying: Physical data structure ,Evaluation of Relational Algebra expressions; Query equivalence and Query Optimization, Join algorithm(s)

Transaction Management: Transaction Processing, Concurrency control and Recovery management ,Transaction Model Properties and State , Serializability, Lock-based and Time-stamped based Protocols, Two-phase Locking

Advanced Topics: Brief introduction to Distributed database systems, Temporal databases, Object oriented and object-relational database, Data warehousing, Data mining

(IT/PC/B/T/214) Object Oriented Programming

Basic Concepts: Background, OOP features (Encapsulation, Abstraction, Polymorphism, Inheritance), advantages, disadvantages, Classes and Objects

Enhancements over Procedural Languages(C++): New keywords, New data types, new syntax, new I/O, Inline functions, Default function parameters, const, reference, Function Overloading its issues and resolution. New dynamic allocation and de-allocation methods

Classes and Objects: Notions of abstraction, encapsulation, information hiding and modularity. Instantiation and initialization of objects; constructor and destructor, Access Specification, Functions and methods; self reference of objects. Copy Constructor. Static Members. Nested Classes, C++ features: const Members, const functions. Mutables, friend function and classes,

Inheritance and Polymorphism: Basic concept of IS-A relationship. "protected" access specification. Initialization derived objects, Method overriding, Abstract methods and classes. , Polymorphic method calls and dynamic binding, Examples, IS-A versus IMPLEMENTED-IN-TERMS-OF relationship. Multiple Inheritance, The problem of multiple occurrences of the same base and its solution

Operator Overloading (C++): Fundamental ideas. Examples of overloading with arithmetic, relational operators. Operator functions, Overloading of unary/binary operators, Overloading of "new" and "delete" operators, Member vs. non-member, Conversion Operators, Ambiguity, Explicit constructor,

Basic I/O and File I/O: Streams, Standard Streams, File Streams, Opening/Reading/writing a File, Streaming to Functions, Managing I/O Streams, Binary Files, stream errors, Checking the I/O Status Flags

Exception handling: The idea of exception handling and its superiority over traditional error handling. Semantics of *try-catch* blocks and *throw*

Generic Programming: Templates in C++. Function Template definition and instantiation. Class Template definition and instantiation. Template Specialization. Class Template Inheritance. Standard Template Library in C++

Namespace: Defining namespace, using namespace

(IT/PC/B/T/215) Computer Organization and Architecture

Recapitulation of Digital Logic and Circuits

Boolean expression minimization techniques through fundamental theorems: Karnaugh map techniques and Quine McClauskey's tabular method.

Adder, subtractor, encoder, decoder, comparator, multiplexer, parity generators etc.

State Table and State Transition Diagram. Study of different types of flip-flops e.g. R-S, D-type, J-K etc. Registers, Counters.

Overview of Computer Organization and Architecture

Introduction to computer system and its submodules; Basic organization of computer and block level description of the functional units

Arithmetic and Logic Unit, Introduction to memory Unit, control unit and Instruction Set;
Working with an ALU, Concepts of Machine level programming, Assembly level programming and High level programming

Data Representation and Arithmetic Algorithms

Number System and Representation of information: Binary Data representation, two's complement representation and Floating-point representation. IEEE 754 floating point number representation.
Integer Data computation: Addition, Subtraction. Multiplication: Signed multiplication, Booth's algorithm
Division of integers: Restoring and non-restoring division; floating point arithmetic: Addition, subtraction

Processor Organization and Architecture

CPU Architecture, Register Organization, Instruction formats, basic instruction cycle. Instruction interpretation and Sequencing, Various addressing modes and designing of an Instruction set

Hardwired control CPU design; Microprogrammed control CPU design. Micro-instruction sequencing and execution

Introduction to RISC and CISC paradigm; Design issues of a RISC processor and example of an existing RISC processor

Memory and I/O Organization
Concepts of semiconductor memory, CPU- memory interaction, Classifications of primary and secondary memories; Types of RAM and ROM, Allocation policies, Memory hierarchy and characteristics; Organization of memory modules; Cache memory and related mapping and replacement policies; Cache Coherency, Interleaved and Associative Memory; Virtual memory

Introduction to input/output processing, working with video display unit and keyboard and routine to control them; Programmed controlled I/O transfer; Interrupt controlled I/O transfer; DMA controller

Secondary storage and type of storage devices; Introduction to buses and connecting I/O devices to CPU and memory

Introduction to Parallel Processing System

Introduction to pipelining; Flynn's classifications; pipeline processing and pipeline hazards; design issues of pipeline architecture; Instruction level parallelism and advanced issues.

Introduction to interconnection network and practical issues; Examples of interconnection networks

Parallel processing concepts; Parallelism algorithm for multiprocessor systems

(IT/PC/B/S/211) Data Structures and Algorithms Lab

Develop and demonstrate programs for

- defining operations on arrays and different types of lists and their applications like polynomial operations, sparse matrix transposition etc.
- representing **s**tacks, queues and defining operations on them
- applications of stack like infix expression evaluation etc.
- Defining operations like search, insertion, deletion etc. on binary search Trees.
- Defining operations like search, insertion, deletion etc. on balanced binary search Trees
- Representing graphs and defining operations such as Breadth-first, Depth-first Traversals, finding Shortest Path algorithms, finding Minimal Spanning Tree
- Arranging a list using sorting algorithms such as Bubble sort, Selection Sort, Insertion Sort, Quick sort, Merge Sort, Heap sort etc.
- Searching in a list using Binary Search and hashing

(IT/PC/B/S/212) Data Base Management Systems Laboratory

- Design ER diagram and Schema for simple case studies.
- Develop simple and complex queries using SQL and develop Applications.
- Construct user interfaces and generate reports using utilities typically available with RDBMS packages.
- Practice developing applications using embedded SQL on host languages.
- Solve problems using PL/SQL, Stored Procedures, Curser and Triggers.

(IT/PC/B/S/213) Object Oriented Programming Laboratory

Develop and demonstrate programs using

- const, reference, inline function, function overloading, default function parameters, dynamic memory allocation, basic I/O
- Classes, nested classes, access control, constructors, destructors, copy constructors, this pointer, static members, const members, mutable fields, friend function and classes
- Operator overloading, conversion operators, ambiguity and resolution
- Inheritance, access specifiers overriding functions, polymorphism, virtual function/pure virtual function, virtual destructor
- Namespace: name clash, creating and using namespaces
- Exception Handling: throwing and catching, re-throwing exceptions, exception specifications, exception classes
- Templates: template function, template parameter, function template overloading, template function specialization, class templates, template specialization, type conversion, ambiguity, Standard Template Library(STL)
- File I/O

(IT/PC/B/S/214) Assembly and Machine Language Lab

- Introduction to single board microcomputer system.
- Develop and execute simple assembly language programs to get familiar with the instruction set.
- Develop assembly language programs like sorting, finding maximum and minimum numbers on a list.
- Develop assembly language programs involving subroutines and parameter passing
- Develop assembly language programs involving input output programs using peripheral interface.
- Develop assembly language programs for string handling and string manipulation.
- Generate Machine level program from Assembly language program.
- Develop simple machine language program using 8086(or higher) microprocessor kit involving decisions, loops etc.

2nd Year 2nd Semester								
Subject Code	**Subject Name**	**Category**	**Type**	**Contact**			**Credit**	**Marks**
				L	**T**	**P**		
IT/PC/B/T/221	Object Oriented Systems	PC	Basic	3	0	0	3	100
IT/BS/B/T/222	Mathematics for IT-II	BS	Basic	3	0	0	3	100
IT/PC/B/T/223	Software Engineering	PC	Basic	3	0	0	3	100
IT/PC/B/T/224	Graph Theory and Combinatorics	PC	Basic	3	0	0	3	100
IT/PC/B/T/225	Computer Networks	PC	Basic	3	0	0	3	100
IT/PC/B/T/226	Graphics and Geometric Modeling	PC	Basic	3	0	0	3	100
IT/PC/B/S/221	Object Oriented Systems Lab	PC	Basic	0	0	3	1.5	100
IT/PC/B/S/222	Computer Networks Lab	PC	Basic	0	0	3	1.5	100
IT/PC/B/S/223	Software Engineering Lab	PC	Basic	0	1	3	2.5	100
			Sub-Total	18	1	9		
			Total	28			23.5	900

(IT/PC/B/T/221) Object Oriented Systems

Relevance of Java in Distributed Programming Environment: Object Oriented Programming language suitable for use in distributed environments. Concept of The Virtual Machine to facilitate portability, data types, expressions, statements, arrays

Classes, Objects, Interface, Inheritance: Access Specification, Instantiation, Initialization, Finalization, Methods, Static Members, String and String Buffer Classes, Derived classes, Abstract classes, Interfaces

Input/Output: Stream Classes, Reader Classes, Writer Classes, File Input, File Output, Formatted Data Input and Output

Package and Nested Classes: package and package access specification, inner classes, local inner classes, anonymous classes.

Thread Programming: Thread creation; mutual exclusion implementation, Synchronization primitives.

Introspection as a capability to develop software component: Java Reflection, Java Beans

Distributed Software Development: Remote Method Invocation using Java RMI

Introduction to UML: Use case diagrams, Sequence and Collaboration Diagrams, State chart diagrams, Activity Diagrams etc. Forward engineering (Code and Test case generation) and Reverse Engineering using UML diagrams.

Object Oriented Design and Analysis

Software Re-usability: Introduction to Design Patterns.

(IT/BS/B/T/222) Mathematics for IT-II

Probability:

Introduction to probability:

Sample space, Classical, and axiomatic definitions of probability, addition rule and conditional probability, multiplication rule, total probability, Bayes' Theorem and independence, problems.

Random Variables:

Discrete, continuous and mixed random variables, probability mass, probability density and cumulative distribution functions, expectation, variance & Standard Deviation, Chebyshev's inequality.

Special Distributions:

Discrete Distribution Binomial & , Poisson Distribution related problems ; continuous Distribution uniform, exponential, normal Distribution & related problem, Determine of mean & variance for Binomial , Poisson, uniform & normal Distribution. .

Statistics:

Measures of Central Tendency:

Introduction, Mean, Median & Mode, relation between Mean, Median & Mode; moments, skewness & kurtosis. Correlation & regression. (Marks-10)

Random sampling.

Parameter, Statistic and its Sampling distribution, Standard error of statistic. Sampling distribution of sample mean and variance, random sampling from a normal distribution (statement only) and related problems;

Estimation of Parameters:

Unbiased and consistent estimators, Point estimation, Interval estimation, Maximum likelihood estimation of parameters of Binomial and Poisson distribution. Maximum likelihood estimation of parameters of Normal distribution, Confidence intervals and related problems. .

Applied Statistics:

Curve fitting of straight lines, second degree parabola.

Operation Research:

Game Theory:

Introduction, Characteristics of Game Theory, Two Person, Zero sum games, Pure strategy. Dominance theory, Mixed strategies (2x2, mx2), Algebraic and graphical methods

Inventory Control:

Inventory classification, Different cost associated to Inventory, Economic order quantity, Inventory models with deterministic demands, ABC analysis.

Queuing Theory:

Basis of Queuing theory, elements of queuing theory, Kendall's Notation, Operating characteristics of a queuing system, Classification of Queuing models, Preliminary examples of M/M/1:8/FCFA

Project Management:

Introduction to PERT and CPM, critical Path calculation, float calculation and its importance. Cost reduction by Crashing of activity.

(IT/PC/B/T/223) Software Engineering

Introduction to SDLC: Evolution of software, Definition of Software Engineering, Software Production Process and life Cycle models-Build and fix, Waterfall, Rapid prototyping, incremental, evolutionary, Reuse oriented Development and sprial models, comparative analysis of models. Software Prototyping.

Requirements Engineering: Definition of Requirements engineering and its importance. Analysis Heuristic-abstraction, partitioning, view theo points. Tools of structured analysis, namely, data flow

diagrams, data dictionary, data structure analysis, entity relation diagrams, state transition diagram, standard requirement analysis methodologies.

Software Design: Design phase in life cycle, System Design Definitions, Concept and methodologies, data flow oriented Design, Program Design and the requirements, features, classification and use of a CASE tool. Different flavors of architectural representations. Cohesion, coupling and Modularity.

Definition and overview of data oriented design methods. Using Entity Relationship analysis in system design, Entity-life-cycle modelling.

Coding Standards and Guidelines.

Software Testing and Verification:. Black box and white box testing. Unit testing, integration testing, system testing. Techniques to generate test plans. Mathematical methods of software verification. Alpha and Beta testing. Verification and Validation.

Software Measurements and Metrics.

Software configuration management: A SCM scenario, elements of a configuration management system, software configuration items, SCM repository, SCM process

Software quality assurance: Quality, quality control, quality assurance, cost of quality

Standards: Capability Maturity Model Integration, ISO 9001

(IT/PC/B/T/224) Graph Theory and Combinatorics

Graph Theory:

Introduction: Different examples, (dis)connected graph, sub-graph, isomorphism, labeled graph, Euler graph, Hamiltonian graph, Counting on graph.

Operations on graph: deletion of vertex/edge, fusion, union, intersection, ring sum, decomposition of a graph.

Connectivity/ cutest: definition of cut set, edge connectivity, vertex connectivity, cut vertex, relation with edge connectivity and vertex connectivity, k-connected graph, separable graph, 1-isomorphism, 2-connected graph, 2-isomorphism.

Planar graph: definition with examples, non-planar graph, Euler theorem, planarity detection, geometric dual graph, uniqueness of dual, dual of a sub-graph, combinatorial dual, self-dual, maximal planar graph.

Graph Coloring: definition, chromatic number, chromatic partition, independent set, dominating set, chromatic polynomial.

Graph Matching: definition, complete matching. Covering: minimal covering, perfect matching, vertex cover.

Graph representation: incidence **matrix**, adjacency matrix, – Sub-matrices – Circuit Matrix – Path Matrix

Directed Graphs: Types of Directed Graphs, Digraphs and Binary Relations, Directed Paths and Connectedness, Adjacency Matrix of a Digraph.

Trees: definitions, center, radius, diameter, rooted tree; spanning tree, spanning forest, rank & nullity of a graph, fundamental circuit, tree graph, number of spanning tree in complete graph: Prufer sequence.

Cobminatorics

Basic counting rules: sum rule, subtraction principle, product rule, division principle, permutations, r-permutation, combinatorics, sampling problem (with replacement), occupancy problem, binomial coefficient, binomial theorem, multinomial coefficient

Pigeonhole principle: the principle (simple and its generalization), application of the principle.

Principle of inclusion and exclusion: Concept of Venn diagram and counting by Venn diagram, inclusion and exclusion principle, applications of the principle to solve different problems like Occupancy problem, Chromatic polynomial, Derangement problem, Rook polynomials, etc.

Generating functions: power series and its properties, (ordinary) generating function, generating function for a sequence and conversely. Operations on generating function, application of generating function in counting problem, exponential generating function and its application to counting problem.

Recurrence relation: definition with examples, recurrence with more than one sequences, simplification of recurrence relation by: characteristic roots (in case of linear homogenous recurrence relation), generating function.

(IT/PC/B/T/225) Computer Networks

Introduction: Communication Tasks, Communication Model, Network Architecture, ISO/OSI Reference Model, Switching, TCP/IP Model

Error Detection and Correction Techniques: One and Two Dimensional Parity Checks, CRC, Hamming code, Framing: Bit and Character Stuffing,

Flow control: Delays in Point-to-Point links, Stop-and-Wait Flow Control, Effect of Propagation Delay and Transmission Rate on Performance, Sliding Window Protocol, Error Control- ARQ: Stop and Wait, Go-back-N, Selective Reject etc. Transmission Efficiency of ARQ Protocols.

Data Link Control protocols: HDLC, Point-to-Point Protocol. MAC and LLC Sublayers: Channel Allocation Problem, Static and Dynamic Channel Allocation, Pure and Slotted ALOHA, Persistent and non-persistent CSMA,
Collision Free Protocols: Bit-Map protocol, Binary Countdown, Limited Contention protocols, Adaptive Tree Walk protocols,

IEEE 802 Standards for LAN and MANs: Ethernet, Token Bus, Token Ring, DQDB, FDDI, LAN Bridges: IEEE 802.x to IEEE 802.y Bridges, Transparent Bridge, Source Routing Bridge, Mixed Media Bridge etc.

Network Layer: Services, Packet Switching, Congestion
Network Routing: Routing Characteristics, Routing Algorithms-Shortest Path algorithm: Dijkstra's Algorithm, Bellman-Ford Algorithm, Fixed Routing, Flooding, Random Routing,

Adaptive Routing: Flow based Routing, Distance Vector Routing, Link State Routing, Hierarchical Routing, Broadcast and Multicast Routing: Multi-destination routing, Spanning Tree Routing, Reverse Path Forwarding,

Congestion: General principles. Congestion Prevention Policies, Traffic Shaping, Leaky-Bucket Algorithm, Token Bucket Algorithm.

Network Layer Protocols: IPV4 Datagram Formats, IPV4 Packet Forwarding

Unicast and Multicast Routers

Transport layer Protocols

UDP, TCP: Services; TCP Flow Control, TCP Error control, TCP congestion control, TCP timers

(IT/PC/B/T/226) Graphics and Geometric Modeling

Introduction: Objective, applications, Graphics Standards, normalized co-ordinate system, aspect ratio.

Overview of graphics system: Video Display Devices, Raster-Scan and Random-Scan Systems, Graphics Monitors and Workstations, Input and Hard Copy Devices, Graphics Software. (4 hr.)
Raster scan Graphics: Line drawing algorithms, circle/ellipse drawing algorithms, polygon filling algorithms.

Geometric transformation: Homogeneous co-ordinate system, 2D and 3D transformations, projection— orthographic and perspective.

Curve and Surfaces: Curve approximation and interpolation, Lagrange, Hermite, Bezier and BSpline curves/surfaces and their properties, curves and surface drawing algorithms.

Clipping: Window and viewport, 2D and 3D clipping algorithms.
Hidden line and hidden surfaces: Concept of object- and image-space methods, lines and surface removal algorithms.

Intensity and colour models: RGB, YIQ, HLS and HSV models and their conversions, gamma correction, half-toning.

Rendering: illumination models, polygon mesh shading, transparency, shadow, texture.

Geometric modeling: 3D object representation and its criteria, edge/vertex list, constructive solid geometry, wire-frame model, generalized cylinder, finite element methods.

Applications or advance topics: (i) Animation and morphing, (ii) Virtual reality, (iii) User-interface design, (iv) Fractal graphics, (v) Multimedia authoring, (vi) 3D visualization.

(IT/PC/B/S/221) Object Oriented Systems Lab

- Develop Java programs using (i) classes, (ii) inheritance, (iii) nested classes and (iv) Exceptions
- Develop Java programs to solve problems using thread programming
- Develop programs using advanced programming paradigms: (i) Introspection capabilities, and (ii) Generic Programming.
- Model software systems by using different artifacts of Unified Modeling Language
- Develop Java Programs to solve problems using design patterns

(IT/PC/B/S/222) Computer Networks Lab

Part-I: Network Assignments 32 hours

- **Network tools (learning some network commands)**: ipconfig, ping, traceroute, talk, tcpdump, routing table related commands, firewall related etc.
- **Socket programming:** TCP socket, UDP socket, raw socket and application developments
- **Implementation**: ARQ protocols, window protocols etc.
- **Network packet analysis**: wireshark, pcap etc.

- Part-II: Simulations 16 hours
- **Overview of network simulators**: NS-2/3, OMNET++ etc.
- **Case studies**: routing algorithms and other algorithms using simulators

(IT/PC/B/S/223) Software Engineering Lab

- Be familiar with automated test tools and develop test suite using them.
- Be familiar with Build tools and write scripts using them for making executables
- Be familiar with version control tools and use them for development and release of software.
- Be familiar with coding frameworks and use them to develop software systems.

3rd Year 1st Semester									
Subject Code	**Subject Name**		**Category**	**Type**	**Contact**			**Credit**	**Marks**
					L	**T**	**P**		
IT/PE/B/T/311A	Cloud Computing	Elective-I	PE	Basic	4	0	0	4	100
IT/PE/B/T/311B	Sensor Networks								
IT/PE/B/T/311C	Artificial Intelligence								
IT/PC/B/T/312	Wireless and Mobile Networks		PC	Basic	3	0	0	3	100
IT/PC/B/T/313	Web Technologies – I		PC	Basic	3	0	0	3	100
IT/PC/H/T/314	Automata and Compiler		PC	Honours	4	0	0	4	100
IT/PC/B/T/315	Operating Systems		PC	Basic	3	0	0	3	100
IT/PE/B/S/311A	Cloud Computing Lab	Elective-I Lab	PE	Basic	0	0	3	1.5	100
IT/PE/B/S/311B	Sensor Networks Lab								
IT/PE/B/S/311C	Artificial Intelligence Lab								
IT/PC/H/S/312	Compiler Lab		PC	Honours	0	0	3	1.5	100
IT/PC/B/S/313	Operating System Laboratory		PC	Basic	0	0	3	1.5	100
				Sub-Total	17	0	9		
				Total	26			21.5	800

Elective-I

(IT/PE/B/T/311A) Cloud Computing

Introduction to Cloud Computing

Cloud computing at a glance – The vision of cloud computing, Definition of cloud computing, The cloud computing reference model, Characteristics and benefits of cloud computing. Evolution of cloud computing – parallel computing, distributed computing, cluster computing, grid computing, virtualization, Web 2.0, Client/Server computing, P2P computing, service-oriented computing and utility-oriented computing. Business driver for adopting cloud computing. Cloud Service Models – IaaS, PaaS, SaaS, XaaS. Cloud Deployment Models – Private, Public, Hybrid, Community, Cloud Federation.

Virtualization Technologies

Introduction to virtualization. Characteristics of virtualized environment – Security, Managed execution, Portability. Types of Virtualization – Bare Metal and Hosted. Hardware level virtualization – Machine(x86) reference model, Hypervisor, Hardware assisted virtualization, Full virtualization, Paravirtualization. Operating system level virtualization. Other types of virtualization – storage virtualization, Network virtualization, Desktop virtualization. VM Migration techniques. Pros and cons of virtualization. Case studies – Xen, VMware and Microsoft Hyper-V.

Cloud Services and Platforms

Compute services using several case studies: Storage Services, Database Services, Database and Table Service. Application Services, Email service. Content Delivery Services. Analytics Services Deployment and Management Services,. Open Source Cloud Platform – CloudStack, Eucalyptus, OpenStack.

Management of Cloud Resources
Lifecycle management of cloud applications. Monitoring cloud resources. Feedback control based on dynamic thresholds, Bag-of-Task (BoT) scheduling problems, VM Placement problems, Resource bundling, combinatorial auctions, fair queuing, borrowed virtual time, Cloud scheduling subject to deadlines, Cost and Energy efficient Scheduling algorithms, Scheduling in Federated environment. Identity and Access management for Cloud Resources.

Cloud Security
Security architectures to assure secure isolation of physical and logical infrastructures including compute, network and storage, comprehensive data protection at all layers, end-to-end identity and access management, monitoring and auditing processes and compliance with industry and regulatory mandates. Industry security standards, regulatory mandates, audit policies and compliance requirements for Cloud based infrastructures.

(IT/PE/B/T/311B) Sensor Networks

Basics of sensor network: Individual components of sensor network nodes, Network Architecture, Optimization Goals and Design Principles

Communication Protocols in sensor networks: MAC Protocols and their taxonomy, Some example protocols like SMAC, CSMA Protocols, Leach, IEEE 802.15.4 MAC, Bluetooth and Bluetooth LE

Topology Control: Topology control in flat networks and hierarchical networks, Clustering, Combining Power control and hierarchical networks

Routing: Gossiping and Agent Based Unicast, Energy efficient unicast, Broadcast and multicast, Geographic routing, Data Centric Routing and Data Aggregation

Transport Layer and Quality of Service, Coverage and Deployment, Reliable Data Transport, Single packet Delivery and Block delivery, Congestion Control and Rate Control

Attacks and Security Issues

(IT/PE/B/T/311C) Artificial Intelligence

Overview: foundations, scope, problems, and approaches of AI.

Intelligent agents: reactive, deliberative, goal-driven, utility-driven, and learning agents

Heuristic Search: Measuring problem solving performance, details of Blind search and Heuristic search strategies: Greedy best-first search, A* search, AO* search, memory bounded heuristic search: local search algorithms & optimization problems: Hill climbing search, simulated annealing search, local beam search, learning heuristics from experiences

Constraint satisfaction problems: Local search for constraint satisfaction problems. Adversarial search, Games, optimal decisions & strategies in games, the minimax search procedure, alpha-beta pruning, additional refinements, iterative deepening.

Knowledge representation, Reasoning and Expert System: knowledge based Agents, propositional Logic, Representing simple fact in logic, representing instant & ISA relationship, Representing knowledge using rules. First-Order Logic, Resolution and inference in First-Order Logic

Logic programming: forward versus backward reasoning, matching

Planning: planning as search, partial order planning, construction and use of planning graphs

Representing and Reasoning with Uncertain Knowledge: probability, connection to logic, independence, Bayes rule, bayesian networks, probabilistic inference, sample applications.

Decision-Making: basics of utility theory, decision theory, sequential decision problems, elementary game theory, sample applications.

(IT/PC/B/T/312) Wireless and Mobile Networks

Wireless Transmission and Media Access Control:

Transmission Fundamentals, Frequencies and regulations, Signals, Antennas and Signal propagation, Propagation Models, Fading, Multiplexing, Modulation Techniques, Spread Spectrum modulation(FHSS, DSSS), CDMA Wireless Link Improvement Technique, Equalization , Diversity, Error detection, Block Error correction codes, RLP, Convolutional codes.

Motivation, Wireless Issues, FDMA, TDMA, CDMA, SDMA, Fixed ALOHA, CSMA-CA, MACA, Multiple Accesses with Collision Avoidance, Packet Radio Access.

Mobile Telecommunication Systems: GSM, UMTS, IMT-2000, GPRS, LTE and LTE-A
Wireless LANs: Wireless LANS- 802.11 standards, 802.11 MAC management, 802.11 Framing, 802.11 Architecture and services, Physical layer WMAN, Bluetooth, WPAN, IrDA technologies.
Mobility Management: MIPv4, MIPv6, HiMIPv6, Cellular IP, HAWAI, HMIPv6, FMIPv6, PMIPv6, NEMO, DMM.
Mobile Adhoc Networks: Routing protocols: DSDV, DSR, and AODV
Transport Protocols: Traditional TCP, I-TCP, SNOOP, TCP-Freeze, TCP Westwood

(IT/PC/B/T/313) Web Technologies – I

Web Basics: Introduction, Internet and WWW, History, Web Server, Web Browser, URL, Basic Protocols, Secure connections, Setting up web servers

HTML: History, Document Structure, Basic syntax, XHTML, Important tags(e.g. Hyperlink, Lists, Tables, Frames, Images, and Multimedia, Meta tags), Form and form elements, Form submission, Web design

Cascading Style Sheets: Introduction, Advantages, Types of CSS, Syntax, Cascading Rue, Selectors, CSS and page Layout, Overview of CSS3

JavaScript: Variables, Arrays, Functions, Objects, Regular Expression, Browser Object Models, DHTML, Event Handing, DOM, DOM Tree, working with DOM, Working with HTML Forms, Form Verification, AJAX: advantages & disadvantages, Operational principle, AJAX alternatives

HTML5: HTML5 tags(new Inputs, Semantic elements, Canvas, SVG, Media), *HTML5 JavaScript API:* Geo-location, Drag-and-Drop, File API, Web Storage, IndexedDB, Application cache, Web Workers, WebSocket, Server Sent Events, *JavaScript Object Notation (JSON):* JSON Syntax, Data Types, JSON Parsers, JSON Data Transfer Between Client and Server, examples, *JQuery:* Introduction, Selectors, DOM, Events, AJAX, UI

XML Technologies: Introduction, Features of XML, Anatomy of XML documents, Namespace, Valid XML, *Document Type Definition(DTD):* Building blocks, Syntax, *W3C XML Schema:* Syntax, Data Types, Elements, Attributes, Restrictions, Validation, XPath, *XQuery:* FLWOR, Syntax, Functions, XML DOM, Parsing XML, eXtensible Stylesheet Language Transformations (XSLT), XSL-FO.

(IT/PC/H/T/314) Automata and Compiler

Finite Automata (FA): DFA, NFA, Conversion from NFA to DFA, Finite State Machines (Moore and Melay machine).

Regular language: Regular set, regular expression, closure properties of regular languages, pumping lemma for regular language, decision problem for regular languages.

Context free grammar: Definition of grammar, derivation, parse tree, language of a grammar, Chomsky classification of grammar (or language), regular grammar- left liner & right linear grammar, regular grammar & FA. Ambiguity in context-free grammar, Chomsky normal form, pumping lemma for CFG, closure properties of CFL (or CFG), proving some languages are not context-free.

Push Down Automata (PDA): Push down automata, PDA string acceptance by empty stack and by final state, examples of equivalence of PDA acceptance, Conversion from CFG to PDA, introduction to DPDA & DCFL.

Turing machines: Turing machine with examples, variations of basic Turing model: multiple tapes, multi tracks, non-deterministic TM, universal TM, TM as enumerator.

Recursively enumerable languages: Definition of recursive & recursively enumerable language, closure properties of recursive & recursively enumerable languages, context sensitive language

(Un)Decidability: Decidability, undecidability, halting problem, undecidability of halting problem, mention of other unsolvable problems.

Overview of Compiler structure: Various phases of a compiler

Lexical analysis: Regular Expression, for Tokens, DFA Based Lexical Analyzer.

Syntax analysis: Top down parsing: LL(1) parser; bottom up parsing: SLR, LR(1) LALR, Parser

Intermediate code generation: intermediate representations, translation of declarations, assignments, control flow, Boolean expressions, procedure calls, records, arrays, Implementation issues.

Run time system: storage organization, activation tree, activation record, parameter passing, symbol table

Introduction to Code optimization: Basic blocks, local and global optimizations

(IT/PC/B/T/315) Operating Systems

Introduction: Operating system functions, evaluation of O.S., Different types of O.S.: batch, multi-programmed, time-sharing, real-time, distributed, parallel.

System Structure: Different types of protections, operating system structure (simple, layered, virtual machine), O/S services, system calls.

Process Management: Concept of processes, process scheduling, operations on processes, co-operating processes, inter-process communication. Threads: overview, benefits of threads, user and kernel threads.

CPU scheduling: scheduling criteria, preemptive & non-preemptive scheduling, scheduling algorithms (FCFS, SJF, RR, and priority), and algorithm evaluation, multi-processor scheduling.
Process Synchronization: background, critical section problem, critical region, synchronization hardware, classical problems of synchronization, semaphores, examples (producer-consumer, readers-writer, dining philosophers, etc.).

Deadlock: Deadlocks system model, deadlock characterization, methods for handling deadlocks, deadlock prevention, deadlock avoidance, deadlock detection, recovery from deadlock.

Storage Management: Background, logical vs. physical address space, swapping, contiguous memory allocation, paging, segmentation, segmentation with paging. Virtual

Memory: background, paging and segmentation, demand paging, performance, page replacement, page replacement algorithms (FCFS, LRU), allocation of frames, thrashing.

File Systems: file concept, access methods, directory structure, file system structure, allocation methods (contiguous, linked, indexed), free-space management (bit vector, linked list, grouping), directory implementation (linear list, hash table), efficiency & performance.

I/O Management: Blocking and non-blocking I/O, kernel I/O subsystem (scheduling, buffering, caching, spooling and device reservation, error handling), performance. Disk Management: disk structure, disk scheduling (FCFS, SSTF, SCAN, C-SCAN), disk reliability, disk formatting, boot block, bad blocks.

Elective-I Lab

(IT/PE/B/S/311A) Cloud Computing Lab

Enabling instance objects on Simple Storage Service in the cloud and writing programs to access objects;
Study the Cloud Sim simulator;
Write programs for Resource Scheduling in Cloud using a simulator;
Developing a Virtual Private Cloud with two subnets, configured differently regarding security;
Develop programs to interact with a cache cluster ;
Develop programs to create and perform queries in a Relational database in the cloud;
Develop programs to create and perform queries in a No SQL database in the cloud;
Write a program for auto-scaled cluster to process information in a distributed queue;
Develop programs that run in containers to access the cloud;

Write a (Hive) script to perform a MapReduce job on a cloud.

(IT/PE/B/S/311B) Sensor Networks Lab

Learn simulation tools for Sensor Networks;
Learn programming of Sensor nodes by running and modifying existing applications on real sensor nodes;
Implement a multi-hop Adhoc Network using a test bed of SoCs;
Implement a few unicasting routing protocols on a test bed where the Phy and Mac layers are 802.11.ax;
Implement a few unicasting routing protocols by simulation where the Phy and Mac layers are 802.11.ax;
Develop a program to create clusters in a network of nodes in NS3. Chose an appropriate Phy and Mac layer implementation;
Design and implement a WSN application for a few typical scenarios using test bed and simulation tools. Three such applications may be as follows:

a. Consider an ECG monitoring system where the ECG sensors sense electric impulses and sends it to a master node. Design and implement a WSN for this application and analyze the result for different power levels varying from -3dB to -31dB

b. The same ECG monitoring system is used by 3 different patients in different rooms of a hospital. The master node of all the three patients are communicating to a clinic station which is recording the patients data and send it to doctors phone through an android app.

c. Five source nodes sensing temperature values are deployed in the ground floor of a building and these nodes send the values to a sink node deployed in the same floor of the building. A hierarchical network having 2 cluster nodes and three source nodes under each cluster is implemented in the first floor of a building for sensing light intensities. The sink nodes of both networks average the received values and send it to a gateway node located in the second floor.

(IT/PE/B/S/311C) Artificial Intelligence Lab

Implement different heuristic search techniques of AI in python;
Solve different AI problems using searching techniques using conventional procedural programming languages;
Study basics of a logic programming language;
Assignments on knowledge representation and reasoning using the logic programming language;
Design an Expert System as a case study.

(IT/PC/H/S/312) Compiler Lab

Assignments using LEX;
Assignments on Language transformation using YACC;
Design & development of a two-pass assembler;
Design & development of macro processor;
Design of a linking loader.

(IT/PC/B/S/313) Operating System Laboratory

Case study: UNIX;
Assignments on Shell Scripting;

Assignments on Inter Process Communication – Shared Memory, Semaphores, Message Queue etc;
Assignments on Multithreading, using mutex, conditional mutex etc;
Assignments on Signal Handling.

3rd Year 2nd Semester									
Subject Code	**Subject Name**		**Category**	**Type**	**Contact**			**Credit**	**Marks**
					L	**T**	**P**		
IT/PC/B/T/321	Design & Analysis of Algorithms		PC	Basic	3	0	0	3	100
IT/PC/B/T/322	Information Security		PC	Basic	3	0	0	3	100
IT/PC/B/T/323	Web Technologies – II		PC	Basic	3	0	0	3	100
IT/PC/B/T/324	Multimedia Coding and Communications		PC	Basic	3	0	0	3	100
IT/PE/H/T/325A	Soft Computing	Elective-II	PE	Honours	3	0	0	3	100
IT/PE/H/T/325B	Big Data								
IT/PE/H/T/325C	Mobile Applications Development								
	Open Elective		OE	Basic	3	0	0	3	100
IT/PC/B/S/321	Web Application Laboratory		PC	Basic	0	0	3	1.5	100
IT/PE/H/S/322A	Soft Computing Lab	Elective-II Lab	PE	Honours	0	0	3	1.5	100
IT/PE/H/S/322B	Big Data Lab								
IT/PE/H/S/322C	Mobile Applications Development Lab								
IT/PC/B/S/323	Multimedia Lab		PC	Basic	0	1	3	2.5	100
				Sub-Total	18	1	9		
				Total	28			23.5	900

(IT/PC/B/T/321) Design & Analysis of Algorithms

Introduction to analysis: Notion of algorithm, fundamental of analysis frameworks - Asymptotic Notations, worst-case and average-case complexity.

Quick review of basic data structures and algorithms: Analysis of recursive/ non-recursive algorithm; Introduction to amortized analysis of algorithms.

Sorting and Selection algorithms: finding minimum and maximum, kth order statistics, tournament and heap sort, lower bound for sorting.

Hashing: introduction, collision resolution, hash functions, analysis of hashing with chaining and with open addressing.

Union-Find problem: tree representation of a set, weighted union and path compression- analysis.

Design Techniques: dynamic programming: Fibonacci series, matrix chain multiplication; greedy-method: Huffman code, Knapsack problem; divide-and-conquer: quick sort, multiplying large number, matrix multiplication; backtracking: n-queen problem; Branch and bound technique: integer programming, traveling sales man.
String processing: string searching and pattern matching, KMP algorithm and its analysis

Analysis of graph algorithms: shortest path algorithms, minimum spanning tree algorithms, network flow problems.

Complexity classes: P, NP, NP-hard and NP-complete, some NP-complete problems, Approximation algorithms.

(IT/PC/B/T/322) Information Security

Overview and Security Attacks: Security Approaches, Principals of security, Types of attacks: Active attack - interruption, modification, fabrication; Passive attack – release of message contents, traffic analysis; Viruses, Worms, Trojan horse.

Basics of Cryptography: Terminologies of Cryptography, Substitution techniques and Transposition techniques. Characteristics of Good Encryption Technique, Types of Encryption Systems, Confusion and Diffusion, Cryptanalysis.

Mathematics of cryptography: Integer arithmetic, Modular arithmetic, Matrices, Linear Congruence, Group, Ring, Field, Finite Field[GF (2^p)], Primes, Primality Testing, Factorization, Chinese remainder theorem, Quadratic congruence, Exponentiation and Logarithm.

Symmetric Key Encryption: Classical Encryption Techniques, Block Ciphers, Data Encryption Standard (DES), Advanced Encryption Standard (AES), RC4, Confidentiality Using Symmetric Encryption.

Public-Key Encryption: Characteristics of Public Key System, RSA, Key Management, Diffie-Hellman, Elliptic-curve cryptography (ECC).

Integrity, Authentication and Key management: Message Integrity and Message Authentication; Hash Algorithms - MD4, MD5, Secure Hash algorithm; Digital Signatures - RSA scheme, Elgamal scheme; Entity Authentication Protocols – Passwords, Challenge response, Zero Knowledge, Biometric; Key Management – Symmetric Key Distribution and Key Distribution center, Public Key Distribution.

Image Encryption: Overview of image encryption, Confusion and diffusion, Chaotic and Non-Chaotic Image encryption, Performance Measure.

(IT/PC/B/T/323) Web Technologies – II

Server-side Programming: Internet Programming paradigm, Servlets: Server-side Java, Advantages, Alternatives, Architecture, Life Cycle, GenericServlet and HttpServlet, Passing and Retrieving Parameters, Server-Side Include, Servlet-chains, Filters, Handling Cookies, Problems with Servlet, Security Issues

Java Server Pages: JSP and HTTP, JSP Engines, How JSP Works, JSP and Servlet, Anatomy of a JSP Page, JSP Syntax, JSP Components, Beans, Session Tracking, Users Passing Control and Data between Pages, Sharing Session and Application Data

Database Connectivity: JDBC Drivers, Basic Steps, Loading a Driver, Making a Connection, Execute an SQL Statement, SQL Statements, Retrieving Result, Getting Database Metadata, Scrollable and Updatable ResultSet, ResultSetMetadata

CGI: Common Gateway Interface (CGI), Languages for CGI, Applications, Server Environment, Environment Variables, CGI Building Blocks, CGI Scripting Using C, Perl, Python, Shell Script, etc. CGI Security, Alternatives and Enhancements to CGI

Advanced Topics: XML-RPC, SOA, Simple Object Access Protocol (SOAP): SOAP Messages, Current SOAP Implementations, Sending and Receiving SOAP Messages, Web Services: Architecture and Advantages of Web Services, Web Services Description Language (WSDL), Creating and Examining WSDL Files, Overview of Universal Description, Discovery, and Integration (UDDI), UDDI Registries (Public and Private), Core UDDI Elements, Deploying and Consuming Web Services, Introduction to Cloud Computing

Overview of J2EE—Introduction to JavaBeans, Bean Builder, Advantages of JavaBeans. BDK Introspection, Properties, BeanInfo Interface, Persistence, Customizer, JavaBeans API, EJB, Introduction to Struts Framework, Model-View-Controller (MVC) Framework

(IT/PC/B/T/324) Multimedia Coding and Communications

Multimedia Overview: Introduction, Multimedia presentation and production, Multimedia and hypermedia, Hardware and software requirements, Uses of multimedia, Multimedia Authoring, Editing and authoring tools.

Components of Multimedia: Text – types, Unicode standard on file format; Image and graphics, data types, file formats, color science and color model; Audio- digitization, midi, quantization and transformation of audio; Video- types of video signals, analog and digital video, television broadcast standards, pc video; animation- types, principals and techniques, 3D animation, camera, special effects, rendering.

Lossless Compression Techniques: Introduction, Run-length coding, Variable length coding (Shannon-Fano, Huffman, adaptive Huffman), Dictionary based coding, Arithmetic coding, Lossless image compression.

Lossy Compression Techniques: Introduction, Distortion measure, Quantization, Transform coding, Wave-let based coding, Wavelet packets.
Elements of Image Compression System and Standards: JPEG standard, JPEG-2000 standard, JPEG-LS standard, Bi-level Image Compression standard.

Video Coding and Compressing Standards: Introduction, Motion estimation, MPEG-1, MPEG-2, MPEG-4, MPEG-7 etc.

Audio compression Standards: ADPCM, psychoacoustics, MP3, MPEG.

Multimedia communication and Retrieval: Basics of networks, multiplexing technologies, LAN, WAN, ATM, quality of multimedia data transmission, multimedia over IP (RTP, RTCP, RSVP, RTSP), multimedia over ATM networks.

Multimedia architecture: User interface, distributed multimedia application, Play back architecture, temporal relationship, synchronization, multimedia database system, feature extract of image, audio, video.

Elective-II

(IT/PE/H/T/325A) Soft Computing

Introduction: Introduction to soft computing, comparison between soft computing and hard computing, Characteristics of Soft computing.

Fuzzy logic: Introduction to Fuzzy sets, Difference between fuzzy set and crisp set, why and when to apply fuzzy set, Probabilities & Fuzzy Sets, Details of membership functions, Fuzzy logic, Linguistic Variables, Operations on Fuzzy sets, Fuzzy relations, fuzzy rules & fuzzy reasoning.

Fuzzy logic based controller design: Difference with conventional control systems, Fuzzification, Rule Base, fuzzy inference system, Defuzzification, Some applications of Fuzzy sets.

Evolutionary Computing: Introduction, History and inspiration from biology (Darwinian Evolution, Genetics), why evolutionary computing.

Evolutionary Algorithm: What is an evolutionary algorithm, components of evolutionary algorithm-representation, evaluation function (fitness function), population, parent selection mechanism,operators(Mutation ,recombination or crossover), survivor selection mechanism ,initialization and termination condition, example applications (Knapsack problem, Eight Queens problem).

Genetic Algorithm: Introduction of Genetic Algorithms, Different Operators of GA-mutation, inversion, crossover and selection, Bit wise operation in GA, Convergence of GA, Multi-level Optimization, Multi-objective and Multimodal optimization, Non-Pareto approaches to solve MOOPs, Pareto-based approaches to solve MOOPs, Differences and similarities between GA and other traditional Methods, example applications (Job shop scheduling).

Differential Evolution: DE as modified GA, generation of population, different operators with an example.

Bio inspired Optimization Algorithms: Particle Swarm Optimization, Ant Colony Optimization with relevant examples.
Hybrid approaches: Basic concepts, types of hybrid systems, advantages, GA in fuzzy logic controller design.

(IT/PE/H/T/325B) Big Data

Introduction to Big Data
Big data features and challenges, Problems with Traditional Large-Scale System, Sources of Big Data, 3 V's of Big Data.

HDFS CONCEPTS: HDFS Design & Goals • Understand Blocks and Configuration of block size • Block replication and replication factor • Understand Hadoop Rack Awareness and configure racks in Hadoop • File read and writes in HDFS.

HADOOP Architecture, Planning for cluster, Hadoop Components, Modes of Hadoop

MAP-REDUCE: Introduction**,** Architecture of Map-Reduce Word Count Example, Phases of a MapReduce program, Data-types in Hadoop MapReduce, Driver, Mapper and Reducer classes, InputSplit and RecordReader, Input format and Output format in Hadoop, Concepts of Combiner and Partitioner

NOSQL Basics: NOSQL Storage Architecture, CRUD operations with MongoDB, Querying, Modifying andManaging NOSQL Data stores, Indexing and ordering datasets(MongoDB/CouchDB/Cassandra)

Hadoop Eco System: 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. Big SQL : Introduction

(IT/PE/H/T/325C) Mobile Applications Development

Mobile OS: History of mobile devices and OS, Features and Architecture of Mobile OS(Android, iOS, windows etc.) , S/W distribution, Programming tools for app

Opensource Platform using Android: Introduction, Features, Versions, Various Android devices, SDK, IDE System Requirements, Installation, Structure and lifecycle of an application for Android system, Android Project, Directory Structure, Configuration Settings, XML configuration files.

Basic app development: Activity life-cycle, UI Design, Containers and components, Widgets and Layouts, Events and Event Handling, *Intents:* Implicit/Explicit intents, Managing application data, Processing of application resources, content providers, file system, Data persistence: backups, databases, Overview of Threads, The Application Main Thread, Thread Handlers, A Basic Threading Example, Creating a New Thread, Implementing a Thread Handler, Passing a Message to the Handler

Network apps: *Telephony services:* Making calls, Monitoring data connectivity and activity, Accessing phone properties and status, Controlling the phone, Sending messages/emails, Network communication and internet applications, *Sensors:* How Sensors work, Using Orientation and Accelerometer sensors, Best practices for performance. Wi-Fi connections, *Bluetooth communication:* Basics, Permissions, Device discovery, Device connectivity, Server creation, Connection management, *Geographical location:* Use of GPS data, Location based services, Finding current location and listening for changes in location, Working with Google Maps, *Cloud/Web services:* Consuming web services, Parsing JSON and XML, Using WebView

Graphics and Multimedia support: Drawables, Basics of Design, 2D and 3D graphics processing, Canvas/Drawing using a view, Animations, Audio/video playback, MediaPlayer, SoundPool, Camera access: Taking and processing pictures, Media Recorder, Rendering previews Simple game programming, Hardware Acceleration

Security and Permissions: Security architecture, application signing, user identification, Rooting of Devices¸ file access, declaration and verification of permissions, performance, scalability, modifiability, availability, Testing methodologies, Publishing, deployment, maintenance and management, version management, licenses, preparing for distribution

(?) Open Elective

(IT/PC/B/S/321) Web Application Laboratory

Develop and demonstrate programs using

HTML, JavaScript, Cascading Style Sheets, XML, DTD, Schema, XSLT, DOM

CSS3, HTML5, Web Worker, Web Socket, Application Cache, Server Sent Events(SSI), Web Storage, IndexedDB, AJAX, JQuery, JSON

Servlet, JSP, JDBC, CGI(Perl, PHP, Python, C/C++, shell etc.), XML-RPC, SOAP, Web Service, J2EE

Elective -II-Lab

(IT/PE/H/S/322A) Soft Computing Lab

Assignments to implement different Fuzzy Membership functions for different parameter values, Fuzzy sets operations and its properties;

Assignments on Fuzzy Vs Crisp Logic;

Assignments on Fuzzy controller using MATLAB Fuzzy logic toolbox;

Assignments on Analysis of Genetic Algorithm Life Cycle;

Develop programs to solve Classical problems using GA;

Write programs to solve different problems like Knapsack problem, n-Queens problem using Evolutionary Algorithm. Compare the performance of different mutation operations;
Assignments on Multi-Objective optimization problem;
Assignments on Bio Inspired optimization problem (Particle Swarm Optimization, Ant Colony Optimization).

(IT/PE/H/S/322B) Big Data Lab

Design and Develop one pass Map Reduce task on given dataset(s). For example, build an Inverted Index of words to the documents which contain them;
Design and Develop multi- pass Map Reduce task on given dataset(s);
Develop programs to create, read, update and delete operations on a document based database;
Develop programs to create, read, update and delete operations on a column family database;
Develop scripts to create a managed table in HIVE and load the data from HDFS;
Develop scripts to create an external table and load the data from HDFS;
Write programs in Hive Script using JOINS and complex data types.

(IT/PE/H/S/322C) Mobile Applications Development Lab

Introduction to the tools to be used in the lab. Develop and demonstrate programs as follows:
A simple application,
Applications with GUI,
Applications for resource processing,
Applications for data persistence,
Applications for 2D and 3D graphics processing, multimedia processing,
Applications using Camera,
Applications using network connections, Telephony, SMS,
Applications using Wi-Fi, Bluetooth, GPS, Web services,
Applications using sensors.

(IT/PC/B/S/323) Multimedia Lab

Assignment on: Image editing using Photoshop;
Audio editing using Sound Forge;
Animation using Flash;
Video editing using Premier;
Authoring using Director;
Advanced Animation using 3D Max.

4th Year 1st Semester									
Subject Code	**Subject Name**		**Category**	**Type**	**Contact**			**Credit**	**Marks**
					L	**T**	**P**		
IT/PC/B/T/411	Machine Learning		PC	Basic	3	0	0	3	100
IT/PE/B/T/412A	Data Warehousing and Data Mining	Elective-III	PE	Basic	3	0	0	3	100
IT/PE/B/T/412B	IoT and Next Generation Networks								
IT/PE/B/T/412C	Bio-Informatics								
IT/PC/B/T/413	Distributed Computing		PC	Basic	3	0	0	3	100
IT/PC/H/T/414	Network Security		PC	Honours	3	0	0	3	100
IT/PC/B/S/411	Machine Learning Lab		PC	Basic	0	1	3	2.5	100
IT/PS/B/S/412	Project		PS	Basic	0	2	7	5.5	200
IT/PS/B/S/413	Seminar		PS	Basic	0	1	2	2	100
	Internship		-	-	-	-	-	0	-
				Sub-Total	12	4	12		
				Total	28			22	800

(IT/PC/B/T/411) Machine Learning

Introduction to Machine Learning: A brief introduction to Machine Learning, Applications of ML, Design Perspective and Issues in ML, Supervised Learning, Unsupervised Learning,A Formal Learning Model and its representation, The Runtime of Learning

Evaluating Hypotheses – Estimating Hypotheses Accuracy, Basics of sampling Theory, Comparing Learning Algorithms; - Bayesian Learning – Bayes theorem, Concept learning, Bayes Optimal Classifier, Naïve Bayes classifier, Bayesian belief networks

Artificial Neural Networks: Early Models, Perceptron rule/multi-layer perceptrons, Artificial Neural Network, activation function, multi-layer neural network.

Feedforward neural network: Training Neural Network: Risk minimization, loss function
Back-propagation I, Back-propagation II, Initialization, Training & Validation regularization, model selection, and optimization , Conditional Random Fields: Linear chain, partition function, Markov network, Belief propagation, Training CRFs, Hidden Markov Model, Entropy.

Probabilistic Neural Network: Hopfield Net, Boltzman machine, RBMs, Sigmoid net, Autoencoders.

Modern Practical Deep Networks : Perspectives and Issues in deep learning framework, Deep Feedforward Networks, Regularization for Deep Learning, Optimization for Training Deep Models, Convolutional Networks, Sequence Modeling: Recurrent and Recursive Nets

Classification and Clustering: : Linear Models: Linear Classification, Logistic Regression , Linear Discriminant Analysis, Separating Hyper-plane Approaches, SVM –Formulation, SVM –Interpretation & Analysis, SVMs for Linearly Non Separable Data

Reinforcement Learning: Introduction to Reinforcement Learning, RL Framework , Solution Methods & Applications, Introduction to Immediate RL, Bandit Optimalities, Value function based methods
Policy Gradient Methods: Policy Search, REINFORCE, Contextual Bandits, Full RL Introduction Returns, Value Functions and MDPs
Dynamic Programming and Monte carlo methods: Lpi Convergence, Value Iteration, Policy Iteration, Dynamic Programming
Temporal Difference Methods : Off Policy MC, UCT, TD(0), Q-Learning

Elective-III

(IT/PE/B/T/412A) Data Warehousing and Data Mining

Module-1
Data Warehousing and Business Analysis: Basic concepts and Components of Data warehousing; Building a Data warehouse; Data Warehouse models-Data Mart; Metadata; Data Cube-multidimensional data model, Online Analytical Processing (OLAP), Multidimensional versus Multi-relational OLAP, OLAP Tools; Data Warehouse Design and Usage; Data Warehouse Implementation-OLAP Server Architectures-ROLAP versus MOLAP versus HOLAP; Data Cube Technology: Preliminary Concepts.
Module-2
Introduction to Data Mining: History of Data Mining, Definition, Knowledge Discovery vs. Data mining, Issues in data mining.
Patterns of Data Mining: Class Description, Characterization & Discrimination, Mining Frequent Patterns, Associations and Correlations, overview of cluster Analysis (preliminaries) and outlier analysis (preliminaries), Evolution Analysis.
Data Preprocessing: Data Summarization, data Cleaning, data Integration and Transformation, data Reduction, Data Discretization and Concept Hierarchy Generation.

Module-3
Classical Data Mining approaches: Scalable Frequent Itemset Mining Methods, The Apriori Algorithm, Mining various Kinds of Association Rules, Pattern-Growth Approach and Vertical Data Format for mining Frequent Itemsets, From Association mining to Correlation Analysis, Constraint based Association Mining, Mining in Multilevel and Multidimensional Space, Constraint-Based Frequent Pattern Mining, High-Dimensional Data mining with examples

Module-4
Data Classification and Prediction: Issues Regarding Classification and Prediction, Applications on-Decision Tree Induction, Bayesian Classification, and Rule-Based Classification; Classification by Association, Model Evaluation and Selection, Methods of Improving Classification Accuracy, Classification by Back-propagation , Classification Using Frequent Patterns, Multiclass Classification, Semi-Supervised Classification, Applications on K-Nearest Neighbor Classifier.

Module-5
Cluster Analysis and outlier detection: Types of data and requirements in Cluster Analysis, Partitioning methods, Application based Partitioning Methods in Large databases- From K-Means to CLARANS, Application of Hierarchical methods- BIRCH and Chameleon; Application of Density-Based Methods- DBSCAN, OPTICS, and DENCLUE; Grid based Methods- STING; and Clustering High Dimensional Data- CLIQUE; Types of Outliers, Challenges in Outlier Detection, Outliers Detection Methods, Statistical Approaches, Proximity-Based Approaches, Outlier Detection in High-Dimensional Data with examples.

Module-6

Overview of application oriented mining: Mining Text Data, Mining Biological Data, Time Series Data etc.

(IT/PE/B/T/412B) IoT and Next Generation Networks

Introduction: Defining IoT, characteristics of IoT, challenges of IoT, Technologies leading to IoT, Functional blocks of IoT, M2M vs IoT. IoT Ecosystem: 7 layer model and protocols.

IoT data link protocols: Performance parameters, issues and challenges, IEEE 802.15.4, 802.11 AH, LoRaWAN, LTE-A, Z-wave, G.9959

Network layer: Routing protocols: RPL, CORPL, Encapsulation protocols: 6LoWPAN, IPv6 over G.9959.

Transport and session layer: Need for new protocols, MQTT, SMQTT, CoAP, XMPP

IoT Management protocols: IEEE 1905.1, Smart transducer interface.

IoT Applications: Home Automation, Smart manufacturing and smart factory, Surveillance applications, Smart parking, Intelligent traffic systems, Smart vehicles, Smart water management, IoT for smart cities.

Next generation Networks: MPLS, 5G Networks, MIMO, Vehicular Communication, SDN, Network slicing, D2D, Multi Radio Access Technologies

(IT/PE/B/T/412C) Bio-Informatics

Fundamental of Cell Biology: Definition. Basic concepts: protein and amino acid, DNA & RNA, Biological Sequence, structure and function, Genomes; Pattern recognition and prediction, Homology and Analogy.

Bioinformatics databases: Introduction, Type of databases, Nucleotide sequence databases: Primary nucleotide sequence databases, Secondary nucleotide sequence databases; Protein sequence databases, Sequence motif databases, Protein structure databases.

Functional proteomics and genomics: Mapping and Sequencing Genomes, Genetic Interactions, Protein profiling.

Sequence alignment and database searching: Introduction to database search, Algorithms issues in database search, Sequence database search, Single sequence alignments, Pair wise alignments: Scoring matrix, PAM, BLOSUM; Dynamic Programming, Heuristic methods: FASTA, BLAST; Multiple Sequence Alignments.

Pattern Analysis: Feature extraction, Classification: Linear classification, linear classification function and artificial neural, artificial neural networks, Support vector machines; Clustering: K-means clustering, hierarchical clustering; Dimensionality Reduction & Principal Component analysis: SDV, geometric interpretation of SDV, PLS method; Parametric Transformations: Hough transform, Generalized Hough transforms, geometric hashing;

Evolutionary trees: phylogeny: Ultrasonic trees, parsimony, Ultrametric problem, perfect phylogeny, phylogenetic alignment, connection between multiple alignment and tree construction

Some advanced topics: DNA Mapping and sequencing, Map alignment, Large scale sequencing and alignment, Shotgun, DNA sequencing, Sequence assembly, Gene predictions, Molecular predictions with DNA strings

Markov chains and applications: Machine Learning Methods, Hidden Markov models, Applications of HMM in gene identification

Some Tasks in Computational Biology: Fragment assembly, Sequence alignment, Gene finding, Promoter identification, Phylogenetic tree construction, Protein superfamily classification, Protein structure prediction, Protein folding

(IT/PC/B/T/413) Distributed Computing

Fundamental concepts: Models, Issues, Complexity measures, proving correctness

Clocks and Event Ordering: Concept of clock in Distributed System, Limitation of Distributed System, Clock synchronization, Lamport's Logical Clock, Vector Clocks, Causal ordering of messages- Birman-Schiper Stephen Protocol, Schiper Eggli Sandoz Protocol.

Global state and snapshot recording algorithms: System model, Snapshot algorithms for FIFO channels, Variations of Chandy-Lamport algorithm, Snapshot algorithms for non-FIFO channels, Snapshots in a causal delivery system, Monitoring global state, Necessary and sufficient conditions for consistent global snapshots, Finding consistent global snapshots in a distributed computation.

Termination detection: Introduction and issues

Fundamental Algorithms: Wave and Traversal Algorithms: Definition and use of wave algorithms, A collection of wave algorithms, Traversal algorithms, Leader Election algorithms: Introduction, Ring Networks, Arbitrary networks, The Korach-Kutten-Moran Algorithm.

Distributed Mutual exclusion: Permission based (Lamport, Ricart-Agarwala, Roucairol-Carvalho, Maekawa), Quorum-based mutual exclusion algorithms (Maekawa's algorithm, Agarwal–El Abbadi quorum-based algorithm), Token based (Suzuki Kasami, Raymond's Tree-based algorithm)

Deadlock detection: System model, Models of deadlocks, Knapp's classification of distributed deadlock detection algorithms, Mitchell and Merritt's algorithm for the single resource model, Chandy–Misra–Haas algorithm for the AND model, Chandy– Misra–Haas algorithm for the OR model, Kshemkalyani–Singhal algorithm for the P-out-of-Q model

Distributed File System: NFS, Google file systems

Distributed Transactions: The Management of Distributed Transactions, A Framework for Transaction Management , Supporting Atomicity of Distributed Transactions, Concurrency Control for Distributed Transactions, Architectural Aspects of Distributed Transactions;

Distributed Concurrency Control: Foundation of Distributed Concurrency Control, Distributed Deadlocks, Concurrency Control based on Timestamps, Optimistic Methods for Distributed Concurrency Control, Execution schedules;

(IT/PC/H/T/414) Network Security

Introduction to Network Security: Overview - Define trust, weaknesses and vulnerabilities, Security Objectives; Understanding Vulnerabilities the Need for Security - Risk and Vulnerability, TCP/IP Suite Weaknesses, Buffer Overflows, Spoofing Techniques, Social Engineering; Understanding Defenses - Digital IDs, Intrusion Detection System, Encrypted Login, Firewalls, Reusable Passwords, Antivirus Software, Encrypted Files, Biometrics

Security at the Application layer: E-MAIL-E-mail Architecture; PGP – Scenarios, Key Rings, PGP Certificate, Key Revocation, PGP packets and Messages; S/MIME – MIME, S/MIME, Application of S/MIME

Security at the Transport layer: SSL Architecture, Four Protocols – Handshake, ChangeCipherSpec, Alert, Record, SSL Message formats, Transport Layer Security

Security at the Network layer: IPSec – Transport and Tunnel Mode, IPSec Security Association, Security protocols, Services Provided by IPSec , Security Policy, Internet Key Exchange (IKE) - Improved Diffie-Hellman Key Exchange, Phases and Modes, SA Algorithms, ISKAMP

Firewalls: Definition, Types of Firewalls - Circuit-Level Firewalls, Proxy Server Firewalls, Non-stateful Packet Filters, Stateful Packet Filters, Personal Firewalls (Packet Inspection Firewalls, Application Proxy Server: Filtering Based on Known Services, Virtual Private Network (VPN) Firewalls, Small Office or Home (SOHO) Firewalls, NAT Firewalls), Configuration and Implementation of a Firewall, Improving Security Through the Firewal, Firewall Services and Limitations

Access Control and Authorization: Access Rights, Access Control Systems - Physical Access Control, Access Cards, Electronic Surveillance, Biometric, Event Monitoring; Authorization Systems – Centralize, Decentralized, Implicit, Explicit, Authorization Principles - Least Privileges, Separation of Duties; Web Access and Authorization

Authentication: Authentication Elements, Types of Authentication - Non-repudiable and repudiable; Authentication Methods - Password Authentication, Public Key Authentication, Remote Authentication, Anonymous Authentication, Digital Signatures-Based Authentication, Wireless Authentication

IEEE 802.11 Wireless LAN Security: Authentication – Pre-WEP authentication, Authentication in WEP, Authentication and Key agreement in 802.11i; Confidentiality and Integrity - Data Protection WEP, Data Protection TKIP and CCMP.

Types of attacks, their analysis and mitigations: phishing, wormhole, Sybil, DOS-DDOS, Intrusion Detection System

Web Services Security: Recapitulation : Technologies for Web Services, WS-Security - Token Types, XML Encryption, SML Signatures, SAML – Assertion Type, Creating/Communicating Assertions, Other Standard – WS-Trust, WS-Security Policy

(IT/PC/B/S/411) Machine Learning Lab

Be familiar with necessary tools and languages for using machine learning techniques.

Assignments for finding the most specific hypothesis from a given set of training data samples.

Assignments on implementation of artificial neural networks (ANN) with back propagation and belief propagation, and using them to solve real world problems.

Assignments combining Hidden Markov Model and ANN.

Assignments using CNN and RNN to solve practical problems in areas such as game playing, sentence understanding.

Implementation of statistical classifiers for a sample training data set and to compute different metrics (such as accuracy, recall) of these classifiers.

Develop machine learning methods to cluster data and modify existing methods to solve the problem better.

Be familiar with tools for reinforcement learning (RL) (such as openAI gym or TensorLayer in TensorFlow) and assemble RL modules for tackling some interesting problems.

(IT/PS/B/S/412) Project

Each student will have to carry out a project work for one year based on a suitable topic chosen in consultation with a teacher (the supervisor) concerned. This work will continue for two semesters in the final year. The marks for this subject will be awarded at the end of the second semester along with the marks obtained in (IT/PS/B/S/422).

(IT/PS/B/S/413) Seminar

In this subject, each student will have to present a seminar on a topic in consultation with a teacher concerned and will be evaluated based on the content and format of his/her presentation. The marks for this subject will be awarded at the end of the second semester along with the marks obtained in (IT/PS/B/S/423). The topic must be related to the broad domains of study in this course but the topic must not be chosen such that it is wholly contained in the syllabus of some subject in this course.

4th Year 2nd Semester									
Subject Code	**Subject Name**		**Category**	**Type**	**Contact**			**Credit**	**Marks**
					L	**T**	**P**		
IT/PC/H/T/421	Data Science		PC	Honours	3	0	0	3	100
IT/HS/B/T/422	Management		HS	Basic	3	0	0	3	100
IT/PE/H/T/423A	Pattern Recognition and Applications	Elective-IV	PE	Honours	4	0	0	4	100
IT/PE/H/T/423B	NLP and Text Mining								
IT/PE/H/T/423C	Cyber Forensics and Security								
IT/PC/B/T/424	Digital Image Processing		PC	Basic	3	0	0	3	100
IT/PC/B/S/421	Comprehensive Viva Voce		PC	Basic	0	0	3	1.5	100
IT/PS/B/S/422	Project		PS	Basic	0	2	7	5.5	200
IT/PS/B/S/423	Seminar		PS	Basic	0	1	2	2	100
				Sub-Total	13	3	12		
				Total	28			22	800

(IT/PC/H/T/421) Data Science

Introduction to Data Science: Basics of Data Science, The need for Business Analytics, Data Science Life Cycle, Different tools available for Data Science

Statistical Inference: Data exploration, Introduction to Research Methods, Central Tendency, Variability, Standardizing, Normal Distribution, Sampling Distributions, Hypothesis Testing, Estimation (Point estimate and Interval estimate), t-tests , ANOVA, Correlation, Regression, Chi-square Test

Data Science Tools and Techniques: Introduction of Hadoop file system and Map-reduce, Virtualization platforms, Cloud platforms;
Programming tools – R, Python, etc.
R: R packages and R Operators;
Python libraries: SciPy and sci-kitLearn, PyBrain, Pylearn2;

Information Retrieval and Web Search: Design issues related to IR, Working principle of Search Engine like Google, Well-known IR techniques used in various domains.

Business Intelligence and Financial Analysis: Understanding the BI process, Strategies of information gathering, the distinction between intelligence, information and data, Information asymmetry and competitive advantage, comparison with competitive intelligence, Comparison with business analytics, Success factors of implementation.

Social Network and Sentiment Analysis: Types of Networks- nodes, edges, adjacency matrix, one and two-mode networks, node degree, Random network models, Concepts: connected components, giant component, preferential attachment, Network centrality, betweenness, closeness, eigenvector centrality (+ PageRank), network centralization, Community: clustering, community structure. Introduction to Sentiment, Sentiment analysis with examples; Recommender System: Introduction to Recommender Systems, Eliciting Ratings and other Feedback Contributions, Implicit Ratings, Taxonomy of Recommender Systems, Non-Personalized Recommenders Content-Based Recommenders, Methods of Filtering.

Data Visualization: Introduction to data visualization, Terminology. Basic Charts and Plots, Multivariate Data Visualization; Principles of Perception, Text Data Visualization, Interactivity and Animation; Temporal Data Visualization, Geospatial Data Visualization, Visualization Case Studies, Redesign Principles and Design Dimensionality

Time Series: Introduction of Time Series data, Time Series variables, Different components of Time Series data, Visualize the data to identify Time Series Components, Implement ARIMA model for forecasting, Exponential smoothing models, Identifying different time series scenario based on which different Exponential Smoothing model can be applied, Implement respective ETS model for forecasting

(IT/HS/B/T/422) Management

Principles of managements: Concepts of management, development of scientific management, principles of Frederick Taylor & Henry Favol, functions such as planning, organizing staffing leading, motivating communicating controlling decision making span of control.

Personal Management: Meaning, functions of personal management, manpower planning, collective bargaining, wages & salary administration, labor welfare, training, trade unions, Industrial Factories Act, Industrial Boils Act, Trade Union Act.

Plant Management: Plant location, plant layout, types of maintenance such as break down, predictive & preventive maintenance, stores management, industrial safety, causes & cost of accidents, safety programs, production planning & control job, batch & process type of production.

Marketing Management: Definition & scope, selling & modem concepts of marketing, market research, new product development, product life cycle, product lunching, sales promotion, pricing, channels of distribution, advertising market segmentation, marketing mix.

Material Management: Importance of Materials Management, Classification, Codification, Forecasting, Necessity of Inventory.

Financial Management: Sources of finance, financing organization, types of capital, elements of costs & allocations of indirect expenses, cost control, break even analysis, budges & budgetary control, equipment replacement policy, make or buy analysis, balance sheet, ratio analysis, profit & loss statement.

Elective-IV

(IT/PE/H/T/423A) Pattern Recognition and Applications

Module I: Introduction and mathematical preliminaries:

Introduction to Pattern recognition, its Applications and Examples, Basics of Linear Algebra and Vector Spaces, Basics of probability theory, Estimation theory, Matrices, Metric and non-metric proximity measures, Distance Matrices, Decision boundary, Decision Region, Difference between Supervised and unsupervised learning, Training set, test set; standardization and normalization.

Module II: Classification techniques:

Supervised Learning, Bayes decision rule, Errors in probability theory, Linear Discriminant Function, Non-linear Decision Boundaries, Minimum Distance Classifier, K-NN Classifier, Fisher's LDA, Support Vector Machine, Bagging, Boosting / AdaBoost, Regression & Classification, Logistic Regression, Decision Trees.

Module III: Clustering techniques:

Unsupervised Learning, Basics of Clustering; similarity / dissimilarity measures; clustering criteria, Minimum within cluster distance criterion, K-means algorithm, Single linkage and complete linkage algorithms, MST, K-medoids, DBSCAN

Module IV: Feature Extraction & Selection:

PCA, Kernel PCA, Branch and bound algorithm, sequential forward / backward selection algorithms, Probabilistic separability based criterion functions, interclass distance based criterion functions**.**

Module V: Advancement and application of pattern recognition:

Applications of machine learning

and pattern recognition in solving problems drawn from domains of audio classification, bio-metric recognition, image retrieval, bio-informatics etc.

(IT/PE/H/T/423B) NLP and Text Mining

NLP

Basics of NLP:

Human languages, models, ambiguity, processing paradigms; Phases in natural language processing applications; Text representation in computers, encoding schemes, Regular Expressions, Finite State Automata, Word Recognition, lexicon, Word Tokenization, Normalization, Sentence Segmentation, Named Entity Recognition, Multi Word Extraction, Spell Checking – Bayesian Approach, Minimum Edit Distance, Context Free Grammar and Parsing

Morphology and Finite State Transducers

Inflectional and Derivational Morphology, Finite State Morphological Parsing, The Lexicon and Morphotactics, Morphological Parsing with Finite State Transducers, Combining FST Lexicon and Rules, Orthographic Rules and Finite State Transducers, Porter Stemmer

Introduction to N-grams

Simple (Unsmoothed) N-grams, Smoothing – Add-One Smoothing, Witten-Bell Discounting, Good-Turing Discounting; Backoff, Deleted Interpolation, N-grams for Spelling, Entropy, Cross Entropy for comparing models.

Hidden Markov Models and Parts Of Speech Tagging

Markov Chain, Hidden Markov Models, Forward Algorithm, Viterbi Algorithm, Part of Speech Tagging: Rule based POS tagging, Stochastic POS tagging, Transformation based tagging, Multiple tags and multiple words, Handling of unknown words, named entities, multi word expressions.

Semantics analysis

Meaning representation, Syntax- Driven Semantic analysis, Relation among lexemes and their senses- Homonymy, Hyponymy, Synonymy. Lexical semantics, WordNet: A database of lexical relations, Word Sense Disambiguation, Computational Lexical Semantics: Thesaurus based and Distributional Word Similarity.

Text Mining

Information Retrieval and Extraction

Boolean Retrieval, Term weighting and vector space model, Term-document incidence, The Inverted Index, Query Optimization, Phrase Queries, Ranked Retrieval – Term Frequency – Inverse Document Frequency based ranking, Zone Indexing, Query term proximity, Cosine ranking, Combining different features for ranking, Search Engine Evaluation, Relevance Feedback

Question Answering and Textual Entailment

Open and Restricted Domain Question-Answering; Question Classes and Processing; Context and Data Source; Extraction and Formulation of Answers; Web exploitation: Real Time, Multilingual and Interactive QAs; Textual Entailment: Learning to recognize features; Textual Inference and Semantic Entailment.

Text Summarization

Automatic Summarization: Factors and Directions, Extraction, Abstraction, Maximum Entropy and Aided Summarization; Keyphrase Extraction; Supervised and Unsupervised Learning for Sentence Compression, Sentence Fusion, Document Summarization: Single and Multidocument.

Performance Measure

Precision, Recall and F-Measure, Confusion Matrix; MAP, MRR, N-gram Co-Occurrence Statistics for Summarization; Measures: Intrinsic (Coherence, Informativeness, Utility Method, Content Similarity, BLEU and ROUGE)

(IT/PE/H/T/423C) Cyber Forensics and Security

Introduction to Computer Forensics: computer crimes, evidence, extraction, preservation, etc.

Overview of hardware and operating systems: structure of storage media/devices; windows/Macintosh/ Linux -- registry, boot process, file systems, file metadata.

Data recovery: identifying hidden data, Encryption/Decryption, Steganography, recovering deleted files.

Digital evidence controls: uncovering attacks that evade detection by Event Viewer, Task Manager, and other Windows GUI tools, data acquisition, disk imaging, recovering swap files, temporary &cache files

Computer Forensic tools: Encase, Helix, FTK, Autopsy, Sleuth kit Forensic Browser, FIRE, Found stone Forensic ToolKit, WinHex, Linux dd and other open source tools.

Network Forensic: Collecting and analyzing network-based evidence, reconstructing web browsing, email activity, and windows registry changes, intrusion detection, tracking offenders, etc.

Mobile Network Forensic: Introduction, Mobile Network Technology, Investigations, Collecting Evidence, Where to seek Digital Data for further Investigations, Interpretation of Digital Evidence on Mobile Network.

Software Reverse Engineering: defense against software targets for viruses, worms and other malware, improving third-party software library, identifying hostile codes-buffer overflow, control hijacking attacks, provision of unexpected inputs, Exploitation techniques and fuzzing- Finding vulnerabilities and exploits.

Dealing with bad (legacy) application code: Sandboxing and Isolation. Least privilege, access control, operating system security

Malicious Software and Software Security- Malicious Web, Internet Security Issues, Types of Internet Security Issues, Computer viruses, Spyware, Key-Loggers, Secure Coding, Electronic and Information Warfare.

Mobile platform security models- Android, iOSMobile platform security models, Detecting Android malware in Android markets.

Basic web security model: Browser content, Document object model (DOM), Same-origin policy.

Web Application Security: SQL injection, Cross-site request forgery, Cross-site scripting, Attacks and Defenses, Generating and storing session tokens, Authenticating users, The SSL protocol, The lock icon, User interface attacks, Pretty Good Privacy.

Computer crime and Legal issues: Intellectual property, privacy issues, Criminal Justice system for forensic, audit/investigative situations and digital crime scene, investigative procedure/standards for extraction, preservation, and deposition of legal evidence in a court of law.

(IT/PC/B/T/424) Digital Image Processing

Fundamentals: Overview of Image Processing System, image digitization (sampling and quantization), basic relationship between pixels, Fundamentals of Color image and Color Models

Image Transform: Fourier transform (1D, 2D) and its properties, FFT, DCT, Hadamard transform, Karhunen – Loeve transforms.

Image Enhancement: Spatial Domain methods- Contrast Intensification (linear and nonlinear stretching), Histogram equalization, Histogram specification, Spatial filtering: Smoothing (liner, order-statistic), sharpening filters (Laplacian), Frequency domain filters : Smoothing, Sharpening filters, Homomorphic filtering.

Image Segmentation: Detection of discontinuities (point, line & edge), Edge Linking and Edge Following by Local Processing, Hough Transform, Region Extraction by Pixel based Approach (Thresholding, Choice of Feature, Optimum Threshold etc.), Region Extraction by Region based Approach (Region Growing, Splitting, Merging, Split and Merge).

Morphological Image Processing: Preliminaries, Erosion and Dilation, Opening and Closing, Some Basic Morphological Algorithms: boundary extraction, region filling.

Image representation & description: Representation: Chain Codes, Polygonal Approximation, Skeletons, medial axis transform, thinning, Descriptor: shape number, Fourier descriptor, statistical moments, Geometrical Attributes (perimeter, area, etc.), Texture Descriptor (GLCM).

Image Compression: Objective, Feasibility, performance measure, lossy/lossless compression, Huffman coding, Arithmetic coding, block truncation coding, vector quantization, JPEG.

(IT/PC/B/S/421) Comprehensive Viva Voce

Each student will have to attend a viva-voce examination before a panel of experts drawn from people inside and outside Jadavpur University. Questions will be asked from any topic taught as a part of this curriculum.

(IT/PS/B/S/422) Project

Each student will have to carry out a project work for one year based on a suitable topic chosen in consultation with a teacher (the supervisor) concerned. This subject is in continuation to the project work

started in the first semester of the final year in the subject (IT/PS/B/S/412). The marks for this subject will be awarded at the end of the second semester along with the marks obtained in (IT/PS/B/S/412).

(IT/PS/B/S/423) Seminar

In this subject, each student will have to present a seminar on a topic in consultation with a teacher concerned and will be evaluated based on the content and format of his/her presentation. The topic must be related to the broad domains of study in this course but the topic must not be chosen such that it is wholly contained in the syllabus of some subject in this course.

Open Electives (Catered by Dept. of IT)

(FET/OE/B/T/0XX) Database Management Systems Basics

Introduction: History of Evolution of DBMS and advantages over traditional file system, Three-schema architecture of DBMS and Data Independence. Introduction to DDL and DML. Ideas about different kind of users of DBMS and available databases in market.

Data Model: Introduction to Relational data model; Keys, Entity-Relationship Model ,Relational Algebra

Database Design: Different types of dependencies, Normalization

SQL: Introduction to SQL, Application development using SQL

Data Storage and Querying: Physical data structure ,Evaluation of Relational Algebra expressions
Transaction Management: Transaction Processing, Concurrency control and Recovery management ,Transaction Model Properties and State , Serializability, Lock-based, Two-phase Locking.

(FET/OE/B/T/0XX) Object Oriented Programming Fundamentals

Basic Concepts of Object Oriented Programming (OOP) – Objects, Classes and Message Passing, Differences between conventional and Object-Oriented programming, advantages and disadvantages of OOP.

Enhancements over Procedural Languages: New data types. Function Overloading and its resolution, New dynamic allocation and de-allocation methods.

Classes and Objects: Notions of abstraction, encapsulation, information hiding and modularity. Instantiation and initialization of objects; constructor and destructor, Access Specification, Functions and methods; self reference of objects, Copy Constructor, Static Members.

Inheritance and Polymorphism: Basic concept of IS-A relationship. "protected" access specification, Initialization and de-initialization of derived objects, Polymorphic method calls and dynamic binding Abstract methods and classes. Examples, IS-A versus IMPLEMENTED-IN-TERMS-OF relationship, Multiple Inheritance, The problem of multiple occurrence of the same base and its solution.

Operator Overloading (C++): Fundamental ideas, Examples of overloading with arithmetic, relational operators. Overloading of unary operators others.

Basic I/O and File I/O.

Exception handling: The idea of exception handling and its superiority over traditional error handling. Semantics of *try-catch* blocks and *throw*.