Department of Electronics and Communication

J.K. Institute of Applied Physics & Technology

University of Allahabad, Allahabad

M. Sc. (Computer Science) Course Structure and Syllabus

First Semester	Course Code	Credits	Five theory Paper & Practical Labs	Sessional Marks	End Semester Marks
Paper – 1	MCS 521	3	Discrete Mathematical Structures	40	60
Paper – 2	MCS 522	3	Database Systems	40	60
Paper – 3	MCS 523	3	Data Structures	40	60
Paper – 4	MCS 524	3	Digital Electronics	40	60
Paper - 5	MCS 525	2	Programming in C	40	60
Practical	MCS 526	8	Practical Lab	40	60

Second Semester	Course Code	Credits	Five theory Paper & Practical Labs	Sessional Marks	End Semester Marks
Paper – 1	MCS 527	3	Operating Systems	40	60
Paper – 2	MCS 528	3	Theory of Computation	40	60
Paper – 3	MCS 529	3	Design & Analysis of Algorithms	40	60
Paper – 4	MCS 530	3	Computer Organization & Architecture	40	60
Paper - 5	MCS 531	2	Software Engineering	40	60
Practical	MCS 532	8	Lab	40	60

Third Semester	Course Code	Credits	Five theory Paper & Project	Sessional Marks	End Semester Marks
Paper – 1	MCS 607	3	Artificial Intelligence	40	60
Paper – 2	MCS 608	3	Compiler Design	40	60
Paper – 3	MCS 609	3	Computer Networks*	40	60
Paper – 4	MCS 610	3	Elective - I	40	60
Paper - 5	MCS 611	2	Computer Graphics	40	60
Practical	MCS 612	8	Project (Phase - One)(Dissertation 4 credits & viva voce 4 credits)	40	60

Fourth Semester	Course Code	Credits	Four theory Paper & Project	Sessional Marks	End Semester Marks
Paper – 1	MCS 613	3	Advanced Concept of Programming Language	40	60
Paper – 2	MCS 614	3	Operational Research	40	60
Paper – 3	MCS 615	3	Elective – I Computer Vision	40	60
Paper – 4	MCS 616	3	Elective – II Natural Languages Processing	40	60
Practical	MCS 617	4	Project (Phase - II) - Dissertation	40	60
		4	Project (Phase - II) - Viva-voce	40	60
		2	Paper Writing & Presentation	40	60

M. Sc. First Semester

Paper I: Discrete Mathematical Structure

Unit 1: Mathematical Logic: **08 Lectures**

Statements, Connectives, Statement formulas, Truth functional rules, Interpretation of formulas, Tautologies, Equivalence, Functionally complete set of connectives, Normal forms, Inference, Theory of statement calculus, Consistency of premises,

Unit 2: Predicate Logic **08 Lectures**

Predicates, statement functions, Quantification, Interpretation of predicate formulas, Inference theory for predicate calculus, Informal & formal proofs

Unit 3: Set Theory: **08 Lectures**

Basics of set theory, Properties of relations, equivalence & compatibility relation, Representation of relations, Reflective, symmetric & transitive closures, Characteristic functions of a set and its properties, Principle of inclusion and exclusion, its applications

Unit 4: Graph Theory: **08 Lectures**

Definition Simple digraphs, Matrix representations, Paths, Distances, Connectedness of digraphs, Path and reachability matrices, Boolean sum and product of bit matrices, Warshall's algorithm for transitive closure of relations

Unit 5: Lattices: **08 Lectures**

Partially ordered sets, Hasse diagrams, Elements of poset, Bounds, Lattices, Joint, Meet, Different types of lattices and their examples. Distributive and Modular lattices,

References: 1 Discrete Mathematical Structures with Application to computer Science: Tremblay & Manohar

2 Discrete Mathematical Structures: Preparata and Yeh

M. Sc. First Semester

Paper II: Database Systems

Unit 1: Introduction: **12 Lectures**

Data, information and knowledge, Characteristics of database approach, Data independence, Architecture of database system, Data dictionary, Types of database language, database system life cycle, Overview of hierarchical, network and relational model.

Relations and Codd's rules, Concepts of keys, Relation Algebra – Select, Project, Joins, Set operations, Update operations – tuple relational calculus, Relational Calculus vs. relational algebra.

Data definition, data manipulation, view definition, nested queries, updation, Embedded SQL, Handling of nulls and cursors.

Unit 2: Data Models: **08 Lectures**

Conceptual, Logical and Physical design, ER models, ER diagrams, Strong and weak entity sets, Generalization, Specialization and Aggregation, Conversion of ER model into relational schemas,

Unit 3: Normalization: **10 Lectures**

Normalization concepts, Functional dependencies and dependency preservations, Normal forms – 1NF, 2NF, 3NF, BCNF, 4NF, 5NF, DKNF, Indexing, File organization, De-normalization, Clustering of tables and indexes.

Unit 4: Transaction Handling: **05 Lectures**

Transaction recovery, System recovery, Two phase commit, concurrency problems, locking, deadlocks, security, discretionary and mandatory access control, data encryption

Unit 5: Distributed databases: **05 Lectures**

Overview of query processing, concurrency control and recovery in distributed databases, overview of client/server architecture and its relationship with distributed databases, performance benchmark and performance tuning of databases.

References:

1 Introduction to Database System – C.J. Date
2 Database Systems – Mcfadden et.al.
3 Database Concepts – Navathe et.al.
4 Database Structured Techniques for Design Performance – S. Atre

M. Sc. First Semester

Paper III: Data Structures

Unit 1: Introduction: **06 lectures**

Data Abstraction and Algorithm, Analysis , Data types / objects / structures, Abstract definition of data structures , Representation and implementation, Time requirements of algorithms, Space requirements of algorithms.

Unit 2: Arrays and Linked list: **10 Lectures**

Array implementation and addressing with examples Array applications and representation, Polynomials, Sparse matrices, String-pattern Matching

Singly liked lists, list heads, circular list, doubly liked lists, orthogonal lists, generalized (recursive) lists, applications.

Unit 3: Stacks and Queues: **06 Lectures**

Basic ideas, array and linked representation. Prefix/ infix / postfix expressions and their inter-conversion for evaluation, Priority, queues and simulation, Recursion

Unit 4: Trees and Graphs : **12 Lectures**

Definition, terminologies and properties , Binary tree representation traversals and applications, Threaded binary trees, Binary Search trees ,AVL Trees

Definition ,terminologies and properties, Graph representations, Minimum spanning trees , Depth-first search , Breadth-first search , Networks

Unit 5: Sort and Search Algorithms: **06 Lectures**

Internal and External Sorting algorithms , Heap sort, Merge sort, Quick-sort , General radix sort, Symbol tables, sequential search , Binary search , Interpolation search, Tries

References:

1. Data Structures and Program Design- Robert Kruse.
2. Data Structures- Horowitz and Sahni
3. Data Structures through C- A. Tennenbaum

M. Sc. First Semester

Paper IV: Digital Electronics

Unit 1: Introduction to Binary systems and Boolean Algebra: 08 Lectures

Digital systems, Number representation in different bases and their inter conversion, Compliments, Arithmetic operations on binary numbers, Binary codes; Basic theorems and properties, Switching algebra, Switching function and their representations. Canonical forms of switching functions and their transformations, operations over switching functions, Digital logic gates- symbols, logic expression and their truth tables.

Unit2I : Digital ICs & Combinational Logic Circuits: 08 Lectures

Characteristics of digital ICs. Introduction to logic families- RTL,DTL, TTL,ECL,MOS and CMOS circuits and comparison of their performance.
Binary adder and Subtractor circuits, Magnitude comparator, Decoders, Encoders, Multiplexer and demultiplexer, Realization of switching expressions by decoders, encoders, multiplexer and Demultiplexer, Programmable logic circuits, Tri-state logic.

Unit 3: Combinational Circuit Design: 08 Lectures

Minimization Techniques, Realization of switching expressions by Karnaugh map, VEM and Quinne-Mclusky methods, Combinational circuits and their analysis. Realization of switching expressions by two level AND, OR, NOT gates; NAND gates only; NOR gates only and Ex-OR and AND gates only; MUX based circuit design

Unit 4: Synchronous Sequential Logic Circuits: 08 Lectures

Sequential circuits, latches and Flip Flops, Analysis of clocked sequential circuits. State reduction and assignment, design of synchronous circuits, shift registers, ripple counters, synchronous counters.

Unit 5: Asynchronous Sequential Logic: 08 Lectures
Analysis procedure, circuits with latches, Design procedure, reduction of states and flow tables .Races and race Free State assignments, Hazards.

References:
1. Digital Design : Morris Mano (PHI)
2. Digital circuits & logic design: S.C.Lee (PHI)
3. Digital electronics (circuits, systems & ICs) : S.N.Ali (Galgotia)
4. Digital electronics: W.H.Gothmann (PHI)
5. Switching theory : A.K Gautam (Katsons)

M. Sc. First Semester

PAPER V: COMPUTER PROGRAMMING IN C

Unit 1: **08 Lectures**

History, Introduction to C, Structure of C programs, Compilation & execution of C programs, Data types & sizes, Declaration of variables, Modifiers, Identifiers, Identifiers & keywords, Symbolic, C Pre-processor, Unary operators, Arithmetic & Logical operators, Bit-wise operators, Assignment operators, and expressions, Conditional expression, Precedence & order of evaluation.

Unit 2: **08 Lectures**

If-else, Switch, Break, Continue, Comma operator, Go-to statement, For, While, Do-while, Linear arrays, Multi-dimensional arrays, Passing arrays to functions, Arrays & Strings

Unit 3: **08 Lectures**

Built-in & User-defined Function declaration, Definition & function call, Parameter passing: Call by value, Call by reference, Recursive function, Multi-file programs, Command line parameters, macros

Unit 4: **08 Lectures**

Structures & Union, Self-referential structure, Pointers, Pointer to pointer, Dynamic memory allocation, Calloc & Malloc functions, Array of pointers, Function of pointers, Structures and pointers, Linked list: Single, Double, File Handling in C: Opening, Closing and creating a data file, Read and Writing functions, Unformatted data files.

Unit 5: **08 Lectures**

Introduction to LINUX, LINUX system organization (the kernel and the shell), Files and directories, Editors (vi and ed), Types of Shells, hell variables, Shell script, Shell commands, user-id, group-id, pipes, System booting, shutting down, handling user account.

References:

1. Gottfried, Programming in C, Schaum series, TMH
2. Yashwant Kanitkar, Let us C, BPB
3. Linux Networking & System Administration, Terry Collings and Kurt Wall (Wiley)
4. Red Hat Linux 9, Bill Ball and Hoyt Duff (Pearson Education)

M.Sc. SECOND SEMESTER

Paper I: Operating Systems

Unit 1: Overview: **08 Lectures**

Introduction to OS – its functional behavior and responsibilities, Need for some of monitor/command interpreter, Types of operating systems, System structure, Hierarchical and layered organization of OS, Review of I/O and interrupt structure.

Unit 2: Process Management: **08 Lectures**

Operating system kernel, Data structures for processes and resources, Context switching, Process control primitives, Process scheduling.

Unit 3: Memory Management: **08 Lectures**

Memory management concepts, Relocation, Linking, Multiprogramming with fixed partitions, Swapping, Variables partitions, Overlays, Virtual memory, Segmentation, Paging, Storage allocation strategies, Load control and thrashing.

Unit 4: File and I/O Management: **08 Lectures**

Organization of file and I/O subsystems, Directory management, Basic file system, file descriptors, File manipulation, File organization methods, Management of auxiliary storage space, Command language and file system utilities, I/O subsystems, Programmed I/O, DMA, Interrupt driven I/O, Recovery procedures.

Unit 5: Protection and Security: **08 Lectures**

Protection vs. Security**,** Safeguards, , Protection problems, Formal models of protection.

References:

1 Introduction to Operating Systems: Deitel
2 Operating System Concepts: Peterson and Silbershatz
3 Modern Operating Systems: Andrew S Tanenbaum

M.Sc. SECOND SEMESTER

Paper II: Theory of Computation

Unit 1: Recursive functions: **06 Lectures**

Partial and Total functions, Products and generalized composition, Initial functions, Primitive recursive functions, Regularity, Minimization, Recursive & Partial recursive functions, Bounded sums and products, Bounded minimization, Ackermann's function

Unit 2: Formal Languages: **06 Lectures**

Strings, Free Semi-group, Languages, Generative grammars and their languages, Chomsky's classification of grammars and languages

Unit 3: Finite Automata: **06 Lectures**

Deterministic and Non-deterministic finite automata, Machines with move on empty strings, Regular sets, Regular expressions, Relationship with regular grammars, Pumping lemma for regular sets and its uses, Closure properties of regular sets, Minimization of finite automata

Unit 4: Context Free Grammars: **10 Lectures**

Derivation trees, Simplification of context free grammars, Chomsky normal form, Greibach normal form, Decision algorithm

Pushdown automata:

Instantaneous description, Languages accepted by finite states and empty stacks, Deterministic pushdown automata, Relationship with context free language

Unit 5: Turing Machines: **12 Lectures**

Instantaneous description, Languages, String manipulation, Turing compatibility of functions, Equivalence between Turing compatibility and partial recursiveness

Undecidability:

Recursively enumerable and recursively decidable languages, Undecidability of decision algorithm for type 0 grammars, Church-Turing Thesis, Halting problem

References:

1. Automata, Language & Computation – Hopcraft & Ullman
2. Theory of Computability – Hennie
3. Formal Languages – Revesz
4. Discrete Mathematical Structures with application to Computer Science – Tremblay & Manohar

M.Sc. SECOND SEMESTER

Paper III: Design and Analysis of Algorithms

Unit 1: Algorithm Analysis Techniques: 10 Lectures

Recurrences: substitution, iteration and master methods, Divide-and-conquer: general approach, binary search, merge sort, quick sort, Strassen's matrix multiplication, Greedy algorithms: general approach, activity selection, knapsack problem, minimum-spanning tree, Diskstra's algorithm, Huffman code

Unit 2: Dynamic Programming: 08 Lectures

General approach, matrix-chain multiplication, all-pairs shortest paths, binary search tree, traveling salesperson, 0/1 knapsack problem

Unit 3: Backtracking: 06 Lectures

N-queen problem, sum of subsets, knapsack problem, generation of all cliques, traveling salesperson problem, Graph coloring

Unit 4: Randomizing &Approximation Algorithms: 10 Lectures

Numerical Integration, Primality testing, randomized min-cut, randomized algorithm for n-queens, quick-sort
Job scheduling, Bin packing, Set cover, Max cut

Unit 5: Lower Bound Theory: 06 Lectures

Decision tree, Reduction method, Amortized analysis. NP-completeness, Approximation algorithms

References:

1. Fundamental of Computer algorithms – Horowitz and Sahni
2. The art of Computer Programming – Donald Knuth
3. Design Methods and Analysis of Algorithms – S.K. Basu
4. The Design and Analysis of Computer Algorithms – Aho, Hopcraft and Ullaman
5. Genetic Algorithm in Search, Optimization and Machine Learning – David E. Goldberg
6. Algorithm + Data Structure = Programs – N. Wirth

M.Sc. SECOND SEMESTER

PAPER IV: COMPUTER ARCHITECTURE & ORGANIZATION

Unit 1: **08 Lectures**

Basic building blocks of digital computer- Essential and non-essential components; Basic functional block diagram of a computer; Stored Program Concepts, Generation of Computers and Programming languages. Computer memory: Types of read/write memories- Static memory, Dynamic Memory, NVRAM etc., various types of ROMs.

Unit 2: **08 Lectures**

Components of CPU, Bus systems, Data path. Instruction set completeness, Instruction Formats. Control unit, Micro-programmed and hardwired controls. CISC and RISC architecture.

Unit 3: **08 Lectures**

Memory organization, Primary and secondary storages, Cache and its mapping, Memory hierarchy. Basic I/O methods. Memory mapped and Standard Input-Output.
Memory management techniques – Relocation, Swapping, Partitioning, Paging, Segmentation, Combined Systems; Concept of virtual memory.

Unit 4: **08 Lectures**

Microprocessor: Essential and non-essential components, Microprocessor 8085: Architecture, Instruction set, Addressing modes, Pin diagram, Timing diagram, Interrupts etc. Assembly language programs (for 8085) for simple problems such as Maximum finding, Summation, Sorting, Searching, delay routines etc.

Unit 5: **08 Lectures**

Microprocessor 8086: Architecture, Addressing modes, Pin diagram, classification of interrupts and interrupt Vector Table. Concept of Math co-processor. Comparative study of microprocessors.

References:

1. Digital Computer Electronics : Malvino
2. Microprocessor Architecture Programming Applications with 8085/8080A: Brey
3 .Digital System Design and Microprocessor: Hayes, John P.
4. Computer Architecture and Organization: Hayes, John P.
5. Computer System Architecture: Mano, M. M.
6. Digital Computer Fundamentals: Bartee

M.Sc. SECOND SEMESTER

Paper V: Software Engineering

Unit 1: Evolution and Scope of Software Engineering: 08 Lectures

Introduction to Software Engineering: Definitions, Software development and life-cycle models, Introduction to SEI-CMM

Unit 2: Software Project Management: 08 Lectures

Project Planning, Cost and Resource Estimation, Project Scheduling, Project Control, Risk Management

Unit 3: Software Requirement Analysis: 08 Lectures

Principles, Tasks, Techniques, Software prototyping, Requirements specifications - Principles and Representation, Structured analysis

Unit 4: Software Design Process: 08 Lectures

Fundamental principles, Design Techniques, Structured Design, User Interface Design

Unit 5: Software Testing and Debugging: 08 Lectures

Software verification and validation fundamentals, Testing principles- White box and Black box testing, Static analysis, Symbolic execution, Testing strategies, Debugging.

References:

1 Software Engineering: Ian Sommerville, Pearson Education
2 Software Engineering: R. S. Pressman, McGraw Hill
3 An Integrated Approach to Software Engineering: Pankaj Jalote

M.Sc. THIRD SEMESTER

Paper I: Artificial Intelligence

Unit 1: Introduction: **08 Lectures**

What is AI?; Scope of AI: Games, theorem proving, Natural language processing, Vision and speech processing, Robotics & Expert systems, AI techniques, Introduction to intelligent agents.

Unit 2: Search Techniques: **08 Lectures**

State space search, control strategies: Depth first search, Breadth first search and Production systems; Use of heuristics: Hill climbing, Best first search, A* algorithm- admissibility, AND/OR graph – AO*, Constraint satisfaction; Game playing: Minimax and Alpha-Beta searching, Genetic algorithms.

Unit 3 & 4: Knowledge Representation: **16 Lectures**

Propositional logic: its syntax and semantics; Reasoning patterns in propositional logic: Resolution, forward and backward reasoning.First order logic: Syntax and semantics; Inference in first order logic: Unification, Forward & backward chaining, Resolution., Structured knowledge representation: Semantic Net, Frames, and Conceptual graphs.
Uncertain knowledge and reasoning: Introduction to probabilistic reasoning; representing vagueness- fuzzy sets and fuzzy logic.

Unit 5: Machine Learning: **08 Lectures**

Different forms of learning; Concept learning system; Inductive learning; Learning decision trees; Neural network: single layer feed forward network.

References:

1 Artificial Intelligence: Rich and Knight
2 Artificial Intelligence: A Modern Approach: Stuart Russell and Peter Norvig
3 Introduction to Artificial Intelligence: Partick Winston
4 Artificial Intelligence: Nilsson

M.Sc. THIRD SEMESTER

Paper II: Compiler Design

Unit 1: Introduction: **08 Lectures**

Compilers and Translators, Overview of the Compiling Process, Syntactic and Lexical Structure of a Language.

Unit 2: Lexical Analysis **08 Lectures**

Regular Expression, Finite Automata, Specification and Recognition of Tokens, Simple Approaches to Lexical Analyzer Design.

Unit 3: Syntactic Analysis **08 Lectures**

Context free grammar, Syntax and Parse Trees, Derivation of parse trees, ambiguity, Top-Down and Bottom-Up Parsing, Basic parsing techniques: shift reduce, operator- precedence, predictive parsing, LR Parsers.

Unit 4: Intermediate Code: **08 Lectures**

Postfix notation, syntax trees, three address code (quadruples, triples and indirect triples), Syntax directed translation, Symbol table organization, Run time storage management, Error detection and recovery

Unit 5: Code Generation and Optimization: **08 Lectures**

Basic issues in code generation and optimization, Elementary idea about loop optimization, DAG, Global data flow analysis, Register utilization, usage count analysis, heuristic ordering algorithm for DAG and optimal ordering algorithm for trees, peephole optimization

Book Recommended:

(1) The Theory and Practice of Compiler Writing: -Trembley and Sorenson
(2) Principles of Compiler Design: -Aho and Ullman
(3) Compilers: Principles, Techniques and Tools -Aho, Ullman and Sethi
(4) The Essence of Compilers -Robin Hunter

M.Sc. THIRD SEMESTER

Paper III: Computer Graphics

Unit 1: Introduction to Computer Graphics: 10 Lectures

Introduction, Graphics display devices, Graphics Input & Output devices, Raster scan graphics, Line and Circle generation techniques, Scan conversion, Frame buffer, Filling algorithms.

Unit 2: Geometrical Transformation: 10 Lectures

Two dimensional transformations, Clipping and windowing methods for 2D images, Three dimensional transformations, Parallel and perspective projections, Viewing transformations and viewing systems.

Unit 3: Curves 04 Lectures

Parametric and non-parametric curves and their representations, Cubic splines, Bezier and B-splines

Unit 4: Surfaces 06 Lectures

Parametric surfaces, Surfaces of revolution, Sweep surfaces, Quadric surfaces, Bilinear surfaces, B-spline and Bezier surfaces, Generalized cylinders and cones, Polygon mesh and wire-frames.

Unit 5: Realism in 3-D Graphics: 10 Lectures

Hidden lines and hidden surfaces, Floating horizon algorithm, Roberts algorithm, Phong reflection model, Incremental shading techniques, Gouraud and Phong shading, Rendering process, z-buffer algorithm, Scan line and area coherence methods. Introduction to Ray tracing

References:

1 Computer Graphics: Principles and Practice: Foley et al.
2 Computer Graphics: Hern and Baker
3 Procedural elements in Computer Graphics: David F. Rogers
4 Computer Graphics: A. Plastock and Gordon Kelley
5 Computer Graphics for IBM PC: J. Mcgregger and Alan Watt
6 Mathematical Elements for Computer Graphics: David F. Rogers and J.A.Adams
7 Three-Dimensional Computer Graphics: Allan Watt

M.Sc. THIRD SEMESTER

Paper IV: Computer Networks

Unit 1: Introduction: **08 Lectures**

History of data communication, Advantages and Disadvantages of a Computer Networks; Classification of Computer Networks; Active and Passive Components used in a network design; Importance of channel bandwidth and system noise, Protocols and their role in computer network

Unit 2: Data Transmission Basics: **08 Lectures**

Error detection and correction methods, Data compression, Protocol basic, Circuit, Message, Packet and Cell switching, Connection oriented and connectionless services, ISO-OSI model, TCP/IP model, UDP

Unit 3: Computer Network Basics: **08 Lectures**

Physical layer communication, Media, Signals and Bits, Time division and frequency division multiplexing, Encoding, Modulation, Delay, Bandwidth and noise; Comparative Study of various media used in Connection oriented networks and connection-less networks; Network and packet communication, Network topology, LAN wired/wireless, Ethernet, CSMA/CD, CSMA/ CA, Token passing rings, FDDI, Wireless networks

Unit 4: Network Devices: 0**8 Lectures**

Network Interconnections with repeaters, Switches, Bridges, Routers and gateways, DSU/CSU, XDSL and cable modems, Store and forward, Next-Hop forwarding, Wide Area Network, Router & Routing Techniques

Unit 5: Inter-networking: **08 Lectures**

IP addressing, Subnetting, CIDR, Address binding with ARP, Datagram encapsulation and fragmentation, Adaptive retransmission, ICMP and error handling; Network applications, Client-Server concepts and application, DNS, HTTP, Email and web browsing, Broadband Multi-Service networks, FDDI- II, Cell based networks, ATM LANs, ISDN; Introduction to IPV6

References:

1 Computer Networks :Tanenbum, A.S
2 Data and Computer communication :Stallings, William
3 Inter Networking With TCP/IP Vol I, II,III: Comer, D.E. and Stevens D.L.
4 Computer Network and Distributed Data Processing : Martin.J.
5 Local Networks : Stalling, William
6 Data Communication and Networking : Forouzan, B.A
7 Tele Communication Switching Systems and Networks: Viswanathan Thiagrajan

M.Sc. THIRD SEMESTER

Paper V (Elective)

Any one paper from the following list –

- **A.** Image Processing
- **B.** Big Data Analysis
- **C.** Mobile Communication
- **D.** Advanced Computer Algorithms
- **E.** High Performance Computing

Paper V A (Elective): Image Processing

Unit 1: Introduction: **08 Lectures**

Image representation and modeling, 2-D linear system, Luminance, Contrast and Brightness, Color representation, Visibility functions, Monochrome and color vision model.

Unit 2: Image Quantization and Image Transforms: **08 Lectures**

Sampling theorem, Anti-aliasing, image quantization, Orthogonal and unitary transforms, DFT, Cosine transform, Hadamard transform, Haar transform, KL transform.

Unit 3: Image Enhancement: **08 Lectures**

Point operation, Histogram modeling, Filtering and spatial operations, Transform operations, Multispectral Image Enhancement

Unit 4: Image Restoration: **08 Lectures**

Image formation models, Noise models, Inverse and Wiener filtering, Least square filters, Recursive filters, Maximum entropy method, Blind deconvolution, Bayesian method of noise removal, Image reconstruction, Tomography, Radan transform, Back-projection, Reconstruction algorithm, Algebraic method of reconstruction, Fan-beam reconstruction.

Unit 5: Data Compression: **08 Lectures**

Data compression vs. Bandwidth, Pixel coding, Predictive coding, Transform coding, Coding of two-tone images.

References:

1. Fundamentals of Digital Image Processing: Anil K. Jain
2. Digital Image Processing: R. Chellappa
3. Image Processing for Scientific Applications: Bernd Jahne
4. Digital Image Processing: R.C. Gonzalez & R.E. Woods
5. The Image Processing Handbook: J.C. Russ
6. Digital Image Processing: W.K. Pratt
7. Digital Image Restoration: Andrews & Hunt

M.Sc. THIRD SEMESTER

Paper V B (Elective): Big Data Analysis

Unit 1: Introduction: **08 Lectures**

Data Science, Big Data and its importance, Prediction vs. Inference, Statistical learning, Unsupervised and Supervised learning, Drivers for Big data, Big data analytics, Big data applications, Basic R concepts, Data transformation and data visualization in R.

Unit 2: Hadoop: **08 Lectures**

Introduction to Hadoop and Hadoop Architecture, Apache Hadoop & Hadoop EcoSystem, Moving Data in and out of Hadoop, Understanding inputs and outputs of MapReduce.

Unit 3: Querying in Big Data: **08 Lectures**

HDFS Overview, Hive Architecture, Comparison with Traditional Database, HiveQL Querying Data, Sorting and Aggregating, Map Reduce Scripts, Joins & Sub queries, HBase concepts, Advanced Usage, Schema Design, Advance Indexing, PIG, Zookeeper,HBase uses Zookeeper.

Unit 4: Data Base for the Modern Web: **08 Lectures**

Introduction to Mongo DB key features, Core Server tools, Mongo DB through the JavaScript's Shell, Creating and Querying through Indexes, Document-Oriented, principles of schema design, Constructing queries on Databases, collections and Documents, MongoDB Query Language.

Unit 5: Big Data Security: **08 Lectures**

Big Data Privacy, Ethics and Security, Steps to secure big data, Cloud security, Hadoop Security Design, Hadoop Kerberos Security Implementation & Configuration, Audit logging in Hadoop cluster, Data security and event logging.

Recommended Readings:

1. Boris lublinsky, Kevin t. Smith, AlexeyYakubovich, "Professional Hadoop Solutions", Wiley
2. Chris Eaton,Dirk Derooset. al. , "Understanding Big data ", McGraw Hill
3. Kyle Banker,PiterBakkum, Shaun Verch, "MongoDB in Action", Dream tech Press
4. Tom White, "HADOOP: The definitive Guide", O Reilly
5. VigneshPrajapati, "Big Data Analyticswith R and Hadoop", Packet Publishing.

M.Sc. THIRD SEMESTER

Paper V C (Elective): Mobile Communication

Unit1. **08 Lectures**

Introduction, Applications, History, A Simplified Reference Model, Wireless Transmission, Frequency For Radio Transmission, Signals, Antennas, Signal Propagation, Multiplexing, Modulation, Spread Spectrum.

Unit 2 **08 Lectures**

Medium Access Control, Hidden And Exposed Terminals, Near And Far Terminals, SDMA, FDMA, TDMA, CDMA, Elements Of Cellular Radio System Design, Introduction To Cellular Mobile Systems, Why Cellular Mobile Systems, A Basic Cellular System, Elements Of Cellular Radio System Design, Concept Of Frequency Reuse Channels, Hands Off, Cell Splitting.

Unit 3: **08 Lectures**

Mobile Network Layer, Mobile IP, IPv6, Dynamic Host Configuration Protocol, Mobile Ad-Hoc Networks, Routing, Destination Sequence Distance Vector, Dynamic Source Routing.

Unit 4: **08 Lectures**

Mobile Transport Layer, Traditional TCP, Congestion Control, Slow Start, Fast Retransmit/ Fast Recovery, Implication Of Mobility, Classical TCP Improvements, TCP Over 2.5/ 3G Wireless Networks, Performance Enhancing Proxies.

Unit 5: **08 Lectures**

GSM, Mobile Services, System Architecture, Radio Interface, Protocols, Localization and Calling, Handover, Security, New Data Services.

References:

1. *Mobile Cellular Telecommunication: Analog and Digital Systems by W.C.Y Lee, Mc Graw- Hill.*
2. *Mobile Communications by Jochen Schiller, Pearson Education.*

M.Sc. THIRD SEMESTER

Paper V D (Elective): ADVANCED COMPUTER ALGORITHMS

Unit 1 **08 Lectures**

String Algorithms: Rabin-Karp Fingerprinting Algorithms, Tries, Suffix Trees.

Network Flow: Flow and cuts, Augmenting Paths, Minimum-cost Flows, Bipartite matching, Cycle Algorithms, Strongly Polynomial Time Analysis, Minimum cuts without flows.

Unit 2 **08 Lectures**

Approximation Algorithm: P and NP, NP completeness, NP-Hardness , Greedy Approximation Algorithm, Dynamic Programming and Weakly Polynomial-Time Algorithms, Linear Programming Relaxations, Randomized Rounding, Limits to approximability, Vertex Cover, Wiring and TSP, Semidefinite Programming, Euclidian TSP.

Unit 3 **08 Lectures**

Online Algorithm: Ski Rental, River Search Problem, the k-Server Problem, List Ordering and Movo-to-Font.

Fixed Parameter Algorithms: Another Way of Coping with NP-Hardness, Parameterized Complexity, Kemeliztion, Vertex Cover, Connections to Approximation

Unit 4 **08 Lectures**

Computational Geometry: Convex Hull, Line-segment Intersection, Sweep Lines, Voronoi Diagrams, Range Trees, Seidel's Low-dimensional LP Algorithm.

Unit 5 **08 Lectures**

External-Memory Algorithms: Accounting for the Cost of Accessing Data from Slow Memory, Sorting, B-trees, Butter Trees, Cache-oblivious Algorithm for Matrix Multiplication and Binary Search.

Streaming Algorithm: Sketching, Distinct and Frequent Elements.

References:

Michel T. Goodrich and R. Tamassia, Algorithm Design, john Wiley & sons

H. Dorit ed, Approximation Algorithm for NP-Hard Problems, H. Dorit, PWS Publishing Company, Boston.

Robert Tarjan, Data Structures and Network Algorithm, SIAM Philadelphia.

Allan Borodin and El-Yaniv Ran, Online Computation and Competitive Analysis, Cambridge University Press.

Motwani and Raghvan, Randomized Algorithm, Cambridge University Press

Cormen Leiseron, Rivest and Stein, Introduction to Algorithm, MIT Press.

M.Sc. THIRD SEMESTER

Paper V E (Elective): HIGH PERFORMANCE COMPUTING

Unit 1: Introduction **08 Lectures**

Introduction to Supercomputing, Supercomputing architecture, Vector machine, Parallel processor, Pipelining, Vectorization, Parallelization, Comparison of Serial, Parallel and Vector architectures, Multi-threaded execution models, Parallelizing compilers, State of the art research & future direction.

Unit 2: Microprocessor & System architecture **08 Lectures**

Pipelining, Superscalar design, SIMD, Multi-threading, Asynchronous microprocessor for high performance processing and low power applications.

Unit 3: Multi-processor architecture **08 Lectures**

Classification, MIMD, Distributed memory system, Parallel architecture, Distributed memory systems, Clusters, Grids, Interconnection networks.

Unit 4: Tightly coupled systems **08 Lectures**

Cache coherence, Consistency, Synchronization, SMP, ccNUMA, COMA, Performance evaluation, Speed up limitations, Amdahl's Law and extensions, Scaled Speed up, Pipelined speed-up

Unit 5: Parallel Programming Paradigms **08 Lectures**

Program analysis, Parallelization of algorithm, Parallel linear algebra routines, Loop Optimization, Implementation, Principal of locality, Caches & buffers, Massively data parallel algorithms, Array notation, Parallel & Vector C Code.

Queuing Theory & Computer Performance Evaluation:

Operation Analysis-Little's theorem, Utilization Law, Forced flow law, Application of these results to computer system, Cyclic queues-models of a multi-programming environment and models of interactive systems, Queuing networks-analysis of complex computer system.

Reference:

D.A. Patterson & J. L. Hennessy, Computer architecture: A quantitative approach, Morgan Kaufman Pub.

D Kuck, The Structure of Computer & Computation, Wiley

J. M. Ortega, Introducti9on to Parallel & Vector solution of Linear system, Plenum

Quinn, Efficient algorithms for Parallel Computers, McGraw Hill

P.J. Hatcher & M J Quinn, Data Parallel Programming on MIMD Computer, MIT Press

K Chandy & C Sauer, Computer System Performance Modeling, Prentice Hall

L Kleinrock, Queuing System Vol I & II, Wiley

E Coffman & P Denning, Operating System theory Prentice Hall

M.Sc. FOURTH SEMESTER

Paper 1: Advanced Concepts of Programming Languages

Unit 1: **08 Lectures**

Programming language Concepts, Paradigms and models, Typed vs. un-typed languages, Procedural languages, declarative languages, block structured languages, , object oriented languages,

Unit 2: **08 Lectures**

Data types, control structures, I/O statements, User-defined and built-in functions, parameter passing

Unit 3: **08 Lectures**

Object Oriented Concepts: Data abstraction, Class, object, Polymorphism, inheritance, different types of polymorphism and inheritance, dynamic binding, reference semantics and their implementation

Unit 4: **08 Lectures**

Horn Clause and their execution, example programs in Prolog

Unit 5: **08 Lectures**

Case study and Lab: Any two of JAVA/ C++/Prolog/Python/C#

M.Sc. FOURTH SEMESTER

Paper II: Operational Research

Unit 1: Network Analysis: **06 Lectures**

Terminology of network, Shortest route problem, minimal spanning tree problem, max-flow problem.

Unit 2: Project Scheduling by PERT, CPM: **08 Lectures**

Diagram, representation, critical path calculation, construction of time chart and resource labeling, probability and cost consideration in project scheduling, project control.

Unit 3: Linear Programming: **10 Lectures**

Simplex Method, Revised simplex method, Duality in Linear programming, Application of Linear Programming to Economic and Industrial Problems.

Unit 4: Nonlinear Programming: **5 Lectures**

The Kuhn-Tucker conditions, Quadratic programming, Convex programming.

Unit 5: Replacement Models & Sequencing Model: **11 Lectures**

Introduction, Replacement policies for items whose efficiency deteriorates with time, Replacement policies for items that fail completely

Classification of self problems, processing of n jobs through two machines, three machines, processing of two jobs through m machines

References:

1 Operations Research- Taha
2 Introduction to Operations Research- B.E. Gillet
3 Optimization Theory and Applications- S.S.Rao
4 Linear programming- G.Hadley

M.Sc. FOURTH SEMESTER

Paper III and Paper IV are electives.

Any two papers may be opted from following list

- **A.** Mobile Ad hoc Networks
- **B.** Cyber Security
- **C.** Multimedia Technology
- **D.** Ubiquitous Computing
- **E.** Natural Language Processing
- **F.** Computer Vision
- **G.** Information Retrieval

PAPER A (Elective): Mobile Adhoc Networks (MANET)

Unit 1: Mobile Ad Hoc Network: 08 Lectures

Introduction, Wireless Networks, Mobile Ad Hoc Network- Definition, History. MANET Applications and Scenarios, Ad Hoc Network Characteristics, Classification of Ad Hoc Networks.

Unit 2: MAC Layer Protocols for Ad Hoc Wireless Networks: 08 Lectures

Introduction, Important Issues and the Need for Medium Access Control (MAC) Protocols, Classification of MAC Protocols- Contention-Based MAC Protocols, MAC Protocols Using Directional Antennas, Multiple-Channel MAC Protocols, Power-Aware or Energy-Efficient MAC Protocols.

Unit 3: Routing Protocols for Ad Hoc Wireless Networks: 08 Lectures

Introduction, Design Issues of Routing Protocols for Ad Hoc Networks, Classification of Routing Protocols. Proactive Routing Protocols – Destination-Sequenced Distance Vector (DSDV), Optimized Link State Routing (OLSR) Protocol. Reactive Routing Protocols- Ad Hoc

On-Demand Distance Vector (AODV), Dynamic Source Routing (DSR) Protocol. Hybrid Routing Protocols - Zone Routing Protocol (ZRP).

Unit 4: Transport Protocols for Ad Hoc Networks: 08 Lectures

Introduction, Transmission Control Protocol's (TCP's) Challenges and Design Issues in Ad Hoc Networks, TCP Performance over That of Mobile Ad Hoc Networks (MANETs), Ad Hoc Transport Protocols, Application-Controlled Transport Protocol (ACTP).

Unit 5: Mobility Models for Ad Hoc Networks: 08 Lectures

Introduction, Mobility Metrics, Impact of Mobility Models on MANET, Mobility Model Classifications, Random Walk Mobility, Random Way-point Mobility.

References

1. Jonathan Loo,Jaime Lloret, and Jesus Hamilton Ortiz, "Mobile Ad Hoc Networks – Current Status and Future Trends " CRC Press, Taylor & Francis Group 2012.
2. Subir Kumar Sarkar,T G Basavaraju and C Puttamadappa, "Ad Hoc Wireless Networks-Principles, Protocols and Applications" Auerbach Publications, Taylor & Francis Group, New York London, 2008.
3. Radhika Ranjan Roy "Handbook of Mobile Ad Hoc Networks for Mobility Models" Spriger 2011.

Paper B (Elective): Cyber Security

Unit 1: Introduction: 08 Lectures

Nature of Cyberspace, CIA triad, Technical aspects of threats and vulnerabilities, Vulnerability scanning, vulnerability probe, Open VAS, Networks vulnerability scanning, Network sniffers and injection tools, Types of cybercrimes, IT Act, 2000

Unit 2: Encryption & Decryption: 08 Lectures

Terminology, Mono-alphabetic ciphers, Poly-alphabetic substitution ciphers, Transpositions, Stream & block ciphers, Secure encryption systems, Public key encryption systems, RSA encryption, EL Gamal & Digital Signature algorithms, Hash algorithms, Secure secret key systems, DES algorithm, Enhancing cryptographic security

Unit 3: Network Defence Tools: 08 Lectures

Firewall Basics, Packet Filter Vs Firewall, How a Firewall Protects a Network, Packet Characteristic to Filter, Stateless Vs Stateful Firewalls, Network Address Translation (NAT) and Port Forwarding, the basic of Virtual Private Networks, Linux Firewall, Windows Firewall, Denial of service attacks, Snorts: Introduction Detection System

Unit 4: Web Security: 08 Lectures

Basic web security model, Web application security, Session management and user authentication, HTTPS: goals and pitfalls, Content security policies, Web workers and extensions, Introduction to web application tools

Unit 5: Security in mobile platform: 08 Lectures

Mobile platform security models, Understanding Android security, Real time privacy monitoring on smartphones, Mobile threats and malware, Mobile web app security

Recommended Readings:

1. Dieter Gollmann, "Computer Security", Wiley
2. Ross Anderson, "Security Engineering", Wiley
3. Nina Godbole and SunitBelpure, "Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Wiley

Paper C (Elective): Multimedia Technology

Unit 1: Multimedia Technology: **08 Lectures**

Elements of Multimedia; Creating multimedia applications; Multimedia file & I/O functions; Multimedia data structures; Multimedia file formats; Multimedia Protocols

Unit 2: Multimedia Audio: **08 Lectures**

Digital sound; Audio compression & decompression; Companding; ADPCM compression; MPEG audio compression; True Speech; Special effects and Digital Signal Processing; Audio synthesis; FM synthesis; Sound blaster card; Special effect processors on sound cards; Wave table synthesis; MIDI functions; Speech synthesis & Recognition

Unit 3: Multimedia Video: **08 Lectures**

Representation of Digital video; Video capture; Frame grabbing; Full motion video; Live video in a window; Video processor; Video compression & decompression; Standards for video compression & decompression; Playback acceleration methods

Unit 4: Creating Multimedia Animation: **08 Lectures**

Icon animation; Bit-map animation; Real-time vs Frame by Frame animation; Object modeling in 3D animation; Motion control in 3D animation; Transparency; Texture, Shadows, Anti-aliasing; Human modeling & Animation; Automatic motion control

Unit 5: Multimedia Authoring Tools: **08 Lectures**

Project editor; Topic editor; Hot-spot editor; Developing a multimedia title; Multimedia text authoring systems; Usage of authoring tools; Multimedia DBMS; Documents, Hypertext and MHEG; Multimedia on LAN; Video Conferencing techniques

References:

1. Multimedia: Computing, Communications & Applications – Nahrstedt & Steinmetz
2. Computer Speech Processing – Fallside F.
3. Speech Analysis, Synthesis & Perception – Flanagan,J.L.
4. Hypertext & Hypermedia- Nielsen J.
5. Digital Processing of Speech Signala- Rabiner L.R. & Schafer L.W.

Paper D (Elective): Ubiquitous Computing

Introduction:
Real life example of ubiquitous computing, Major trends din computing (mainframe, desktop and ubiquitous computing), Wearable computing, Pervasive computing: Design Issues for Ubiquitous Computing, Integration and Processing of Sensor-Based Input; Wireless Infrastructures; Sensing and Context Awareness, Use of RFID, Some Computer Science Issues in Ubiquitous Computing.

Essential technologies for ubiquitous computing:
Operating environment, Networking, Sensors, Location sensing; Smart Environment, Smart Devices, Perceptual components, Multisensor perception, answering machine, Room ware, Wireless sensing environment.

Wireless standards & protocols:
Wireless network types and standards, Ad-hoc network, Sensor network, IrDA, Bluetooth, 1EEE 802.11, WLAN, Wireless link, 802.11 LAN architecture, Bluetooth architecture, Sensor and smart spaces, Sensor Networking and sensor protocol, Mobility and Mobile networking, Mobile IP.

Cellular networks:
Mobile radio communication, Cellular system architecture GSM and CDMA, WCDMA.

Performance & QoS issues in wireless networks:
Network performance measures, Quality of Service, Need of feedback control, Bandwidh sharing and faimess, TCP over link, Packet Loss, Single cell and multicell wireless networks, Saturation throughout analysis, Real-time examples.

Privacy & Security:
Issues, Challenges, Attacks in Privacy & Security, Security issues in sensor networks, Security issues in ad-hoc networks, Resurrecting Duckling model of security.

Mobile computing:
Mobile computing vs. Distributed computing, Characteristic of mobile network, Mobile computing models, Unaware client/server model, Thin client/server model, Disconnected operation, Dynamic client/server model, Mobile agents, Challenges in mobile computing, mobile computing and databases.

Context aware computing:
Context-aware systems, Context-aware architecture, Context-aware applications, Adaptive GSM Phone/PDA, Handling multiple context, Issues and challenges.

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Paper -E (Elective): Natural Language Processing

Unit 1: Introduction and Applications **08 Lectures**

Natural language Processing (NLP), Brief history of NLP research, key issues, current applications, Language models.

Unit 2: Morphological and Syntactic Analysis **12 Lectures**

Morphological analysis, Part of Speech Tagging, Syntax and Grammar: From words to phrases, Classes of phrases, defining phrases using context-free grammars, Some context-free grammars for English, Syntactic Parsing – Top-down and bottom up parsing, Probabilistic Parsing.

Unit 3: Semantic and Discourse Analysis **12 Lectures**

Semantic Analysis, Lexical, Semantics, Ambiguity, Word Sense disambiguation, knowledge-based and Machine Learning Approaches to Word Sense Disambiguation, State of the art techniques in WSD, Local discourse Context and Anaphora Resolution, World Knowledge, Discourse Structure.

Unit 4: NLP Applications **08 Lectures**

Text summarization, Information Extraction, Machine Translation, spoken dialogue systems.

Reference:

1. Jurafsky and J. Martin, Speech and Language Processing, Prentice Hall.
2. S. Pinker, The Language Instinct, Penguin.
3. P. Mattews, Linguistics: A very short introduction, OUP.
4. C.D. Manning and H. Schutce, Foundations of Statistical Natural Language Processing, MIT Press.

Paper F (Elective): Computer Vision

Unit 1 **08 Lectures**

The digitized image and its properties, Data structures for image analysis, Pixel brightness and Geometric transforms, Edge detectors, Zero-crossings, Canny edge detection, Edges in multispectral Images.

Unit 2 **08 Lectures**

Segmentation: Thresholding, Edge-based segmentation, region-based segmentation, Matching.

Shape Representation: Region identification, Contour-based shape representation and description, Region-based shape representation and description, Shape classes, Object recognition.

Unit 3 **08 Lectures**

Image Understanding: Image understanding control strategies, Active contour models-makes, Pattern recognition methods in image understanding. Scene labeling and constraint propagation, Semantic image segmentation and understanding, Hidden markov models.

Unit 4 **08 Lectures**

3D Vision: JD vision tracks, Geometry for 3D vision, Single camera calibration,Two cameras, Stereopsis, Three or more cameras, Radiometry and 3D vision, Shape from X, 3D model based vision, 2D–view based representation of 3D scene.

Unit 5 **08 Lectures**

Motion Analysis: Differential motion analysis methods, Optical flow, Analysis based on correspondence of interest points, Kalman filters, Object tracking, Tracking in wavelet domain.

Paper G (Elective): Information Retrieval

Unit 1: Introduction **08 Lectures**

Introduction to Information Retrieval, Information Retrieval models, Boolean, Probabilistic and Vector space retrieval models

Unit 2: Indexing and Boolean retrieval **08 Lectures**

Tokenization, elimination of stop words, Normalization (equivalence classing of terms), Stemming and lemmatization, posting lists & its implementations, Positional postings and phrase queries, Bi-word indexes, Positional indexes, Tolerant Retrieval, Index compression, Zipf's law, distributed and dynamic indexing

Unit 3: Vector space model **08 Lectures**

Term frequency and weighting, Inverse document frequency, Tf-idf weighting scheme, Scoring methods, Index elimination, Champion lists, Latent semantic indexing, cluster pruning, Evaluation methods

Unit 4: Query Expansion and Relevance Feedback **08 Lectures**

Query expansion, Relevance feedback and pseudo relevance feedback: Ide's & Rocchio's algorithm for relevance feedback, Relevance feedback on the web, Evaluation of relevance feedback strategies, Pseudo relevance feedback, Indirect relevance feedback, Query modification techniques.

Unit 5: Further topics: Clustering algorithms **08 Lectures**

Flat and hierarchical clustering: k-means, top down and bottom up clustering, XML retrieval – indexing, scoring and retrieval, Web Search: Crawling architecture, link analysis, pagerank and HITS algorithm, Introduction to Semantic Web

Books:

1. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze, "An Introduction to Information Retrieval", Cambridge University Press, 2009.

2. Ricardo Baeza-Yates & Berthier Ribeiro-Neto, "Modern Information Retrieval" (second edition), Addison-Wesley, 2010.

3. Selected papers from "Recommended Reading for IR Research Students" Moffat *et al.*, 2005