MCA Course Structure

Paper	Course Code	L-T-P-C	Credits	Paper Name	Sessional Marks	End Semester Marks	Total Marks
1st Semester							
Paper – 1	MCA 501	3-0-0-3	3	Discrete Mathematical Structures	40	60	100
Paper - 2	MCA 502	3-0-0-3	3	Database Systems	40	60	100
Paper – 3	MCA 503	3-0-0-3	3	Data Structures	40	60	100
Paper - 4	MCA 504	3-0-0-3	3	Digital Electronics	40	60	100
Paper - 5	MCA 505	3-0-0-3	3	Computer Programming in C	40	60	100
Practical	MCA 506	0-0-6-3	3	Digital Electronics Lab	40	60	100
	MCA 507	0-0-6-3	3	C Programming Lab	40	60	100
	MCA 508	0-0-6-3	3	Communication Skill Lab I	40	60	100
Total Credit			24				
2nd Semester							
Paper – 1	MCA 509	3-0-0-3	3	Operating System	40	60	100
Paper - 2	MCA 510	3-0-0-3	3	Theory of Computation	40	60	100
Paper – 3	MCA 511	3-0-0-3	3	Design and Analysis of Algorithms	40	60	100
Paper - 4	MCA 512	3-0-0-3	3	Computer Architecture and Organization	40	60	100
Paper - 5	MCA 513	3-0-0-3	3	Software Engineering	40	60	100
Practical	MCA 514	0-0-12-6	6	Data Structure and Algorithm Lab in C++	40	60	100
	MCA 515	0-0-6-3	3	Communication Skill Lab II	40	60	100
Total Credit			24				
3rd Semester							
Paper – 1	MCA 601	3-0-0-3	3	Artificial Intelligence	40	60	100
Paper - 2	MCA 602	3-0-0-3	3	Compiler Design	40	60	100
Paper – 3	MCA 603	3-0-0-3	3	Computer Graphics	40	60	100
Paper - 4	MCA 604	3-0-0-3	3	Computer Networks	40	60	100
Paper - 5	MCA 605	3-0-0-3	3	Web Technology	40	60	100
Practical	MCA 606	0-0-6-3	3	Computer Graphics Lab	40	60	100
	MCA 607	0-0-6-3	3	Programming Lab in JAVA	40	60	100
	MCA 608	0-0-6-3	3	Database Lab	40	60	100
Total Credit			24				
4th Semester							
Paper – 1	MCA 609	3-0-0-3	3	Advanced Concept of Programming Languages	40	60	100
Paper - 2	MCA 610	3-0-0-3	3	Operational Research	40	60	100
Paper – 3	MCA 611	3-0-0-3	3	Cyber Security	40	60	100
Paper - 4	MCA 612	3-0-0-3	3	Multimedia Technology	40	60	100
Paper - 5	MCA 613	3-0-0-3	3	Machine Learning	40	60	100
Practical	MCA 614	0-0-6-3	3	Machine Learning Lab using Python / R	40	60	100
	MCA 615	0-0-6-3	3	Mini Project I (SRS and Design)	40	60	100
	MCA 616	0-0-6-3	3	Industrial Training of at least 4 weeks (during summer vacations between 4th semester and 5th semester)	40	60	100

Paper	Course Code	L-T-P-C	Credits	Paper Name	Sessional Marks	End Semester Marks	Total Marks
Total Credit			24				
5th Semester							
Paper – 1	MCA 701	3-0-0-3	3	Big Data Analytics	40	60	100
Paper - 2	MCA 702	3-0-0-3	3	Digital Communication I	40	60	100
Paper – 3	MCA 751	3-0-0-3	3	Elective – 1	40	60	100
Paper - 4	MCA 752	3-0-0-3	3	Elective – 2	40	60	100
Practical	MCA 703	0-0-6-3	3	Data Analysis Lab	40	60	100
	MCA 704	0-0-6-3	3	Elective Lab	40	60	100
	MCA 705	0-0-12-6	6	Mini Project II (Implementation and Testing)	40	60	100
Total Credit			24				
6th Semester							
Colloquium	MCA 706	0-0-6-3	3	Colloquium	40	60	100
Project	MCA 707	0-0-12-6	6	Project – Seminar	40	60	100
	MCA 708	0-0-12-6	6	Project – Dissertation	40	60	100
	MCA 709	0-0-12-6	6	Project – Viva voce	40	60	100
	MCA 710	0-0-6-3	3	Project – Paper writing and presentation	40	60	100
Total Credit			24				

Total Credits – 144

List of Electives

Elective 1

Paper 3 (A) Advanced Computer Architecture
Paper 3 (B) Information Retrieval
Paper 3 (C)Natural Language Processing

Elective 2

Paper 4 (A) Advanced Computer Algorithms
Paper 4 (B). High Performance Computing
Paper 4 (C) Image processing

MCA SYLLABUS

MCA FIRST SEMESTER

PAPER I: DISCRETE MATHEMATICAL STRUCTURES

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 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,

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References:

1 Discrete Mathematical Structures with Application to computer Science: Tremblay & Manohar
2. Discrete Mathematical Structures: Preparata and Yeh

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

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

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.

Unit 2: 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)

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)

MCA 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

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

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

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

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

MCA 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

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

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

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: 08 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

PAPER V: WEB TECHNOLOGY

Unit I 08 lectures

Core Java: Introduction, Operator, Data Type, Variable, Control Statements, Methods and Classes, Inheritance, Package and Interface, Exception Handling, Multithreading programming, I/O, Java Applet, String handling, Networking, Event handling, Introduction to AWT controls, Layout managers, Menus, Images, Graphics.

Unit II 08 lectures

Communication Issues, the Client, Multi-departmental & Large scale Websites, Quality Assurance and testing, Technological advances and Impact on Web Teams.
HTML: Formatting Tags, Links, List, Tables, Frames, Forms, Comments in HTML,DHTML.

Unit III 08 lectures

Java Script: Introduction, Documents , Forms, Statements, Functions, Objects in JavaSScript, Events and Event Handling, Arrays, Buttons, Checkboxes, Text fields and Text areas.

Unit IV 08 lectures

XML: Introduction, Displaying an XML Document, Data Interchange with an XML document, Document type definitions, Parsers using XML, Client-side usage, Server Side usage.

Unit V 08 lectures

Common Gateway Interface (CGI), PERL,RMI, COM/DCOM, VBScript, Active Server Pages(ASP).

References:

1. Burdman, "Collaboratie Web Development", Addison Wesley.
2. Sharma & Sharma, "Developing E-Commerce Sites" , Addison Wesley.
3. Ivan Bayross, "Web Technologies Part II", BPB Publications.
4. Margaret Levine Young, " The complete Reference INTERNET", TMH
5. Naughton, Schildt, "The Complete REfernce JAVA @", TMH
6. Balaguruswamy E, " Programming in JAVA"< TMH
7. ShishirGundavarma, "CGI Programming on the world Wide Web", O'Reilly & Associate.
8. DON Box, "Essential COM", Addison Wesley.
9. GergBuczek, " ASP Developer's Guide", TMH

MCA 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#

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 labelling, 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

PAPER III: 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 IV: 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 V: MACHINE LEARNING

Unit 1: 08 Lectures

Machine learning problems, types of learning, designing a learning system, Introduction of inductive learning, learning semantic networks, general setting for induction

Unit 2: 08 Lectures

Languages for learning, version space learning, Induction of decision trees, OneR, ID3, Relational Learning and Inductive Logic Programming, Bayesian learning, Bayesian belief networks

Unit 3: 08 Lectures

Supervised learning setup. LMS, Logistic regression. Perceptron, Exponential family, Generative learning algorithms. Gaussian discriminant analysis. Naive Bayes, Support vector machines.

Unit 4: 08 Lectures

Instance-based learning, Analytical (Explanation-Based) Learning, Unsupervised learning: clustering, K-means, EM, PCA

Unit 5: 08 Lectures

Deep learning, neural networks and convolution neural networks, end-to-end learning, recurrent networks, generative models, variational inference

Recommended readings

1. Bishop, Christopher - Neural Networks for Pattern Recognition
2. Duda, Richard, Peter Hart, and David Stork - Pattern Classification
3. Hastie, T., R. Tibshirani, and J. H. Friedman - The Elements of Statistical Learning: Data Mining, Inference and Prediction
4. David - Information Theory, Inference, and Learning Algorithms
5. Mitchell, Tom - Machine Learning

MCA FIFTH SEMESTER

PAPER I: 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.

PAPER II: DIGITAL COMMUNICATION I

Unit 1: Basic Information Theory & Channel Capacity: 10 Lectures

Mathematical models for information sources; Discrete memory-less source; Logarithmic measure of information; Entropy as a measure of Uncertainty; Interrelations between entropies; Conditional entropies; Average Mutual information, Properties of Mutual information; Binary Symmetric Channels, Discrete memory-less channels, Shannon-Hartley capacity theorem, Shannon's limit; Capacity of a channel of infinite Bandwidth; Equivocation and effective transmission rate.

Unit 2: Source Coding: 06 Lectures

Coding for discrete memory-less source; Fixed length code words; Source coding theorem; Variable length code-words; Unique decodability and prefix conditions; Kraft inequality; Significance of prefix condition; Shannon-Fano coding; Huffmann Coding Technique

Unit 3 & 4: Channel Coding: 16 Lectures

Linear block codes- Introduction to Galois field algebra; Linear block Codes- the Generator matrix & Parity check matrix; Construction of standard array; Syndrome calculation; Hamming weight and Hamming distance; Error correcting and detecting capability of linear codes; Hamming codes; Hadamard codes

Definition and algebraic structure of cyclic codes, Binary cycle properties; Encoding in Systematic forms; Circuits for dividing polynomials; Systematic encoding with an (n-k) stage shift register; Syndrome calculation and error detection with an (n-k) stage shift register.

Convolutional Codes-Convolutional encoding; Representation of convolutional Encodes; The state diagram; The tree diagram; The trellis diagram; Optimum decoding of the Convolutional codes- The Viterbi algorithm, Sequential decoding; Comparison and

Limitations of Viterbi and Sequential decoding; Distance properties of convolutional codes; Error correcting capability of convolutional codes.

Unit 5: Pulse Code Modulation: 08 Lectures

Basic elements of a PCM System, Quantization Electrical representation of binary digits, Companding, Differential PCM, Delta Modulation, Adaptive delta modulation, Comparison of ADM & DM,

References:

1. Modern Digital Communication System: B.Sklar (Addition Wesley)
2. Principle of Digital Comm: J. Das, S.K. Mullick, P.K. Chatterjee (Wiley)
3. Digital Communication: John G. Proakis (TMH)
4. An Introduction to Error Correcting Codes : S. Lin (McGraw Hill)
5. Digital Communication : S. Haykin (Wiley)
6. Digital Communication : Fundamentals & Applications : B. Sklar (Pearson)

ELECTIVE - 1

PAPER III (A): ADVANCED COMPUTER ARCHITECTURE:

Unit 1: CPU architecture: 08 Lectures

Comparative study of 32-bit processors; Comparative study of Microcontrollers; Future Trends

Unit 2: Parallel Processing Systems: 08 Lectures

Flynn's Classification, Pipeline Processors, Instruction Pipelining, Internal Forwarding, Pipeline Hazards, Tightly & Loosely coupled systems; Job Sequencing & Collision prevention, Interleaved Memory; Amdahl's Law; Vector Processing, Design of Vectorizing compilers, Automatic detection of parallelism,

Unit 3: Case Studies of Array & Vector Processors: 08 Lectures

Case studies of vector processors, Array processors, Network design issues, Mesh Network, Barrel Shifter, Cube, Hypercube, Parallel algorithms on hyper cubes, Multiprocessor system, Multiprocessor interfacing schemes

Unit 4: Other Architectures: 08 Lectures

RISC; Comparison with CISC; Parameter passing in RISC, Comparison of commercial RISC systems; Systolic Architecture; Data flow architectures; Comparison with control flow systems; Template implementation; Transputer architecture; Communication channels; Occam & programming environment

Unit 5:Introduction to Parallel Algorithms: 08 Lectures

Addition on Tree, Cube, Mesh, Linear Array, PSN, etc. Matrix multiplication on Mesh, Cube, Torus, etc.; Parallel Sorting; Associative Processing

References:

1. Computer Architecture & Parallel processing – Hwang & Briggs
2. Computer Architecture – Jean Loop Bear
3. Introduction to Distributed and Parallel computing- Crichlow
4. Designing Efficient Algorithms for parallel Computers- M.J.Quinn
5. Introduction to Parallel Algorithms- Joseph JA
6. The Design and Analysis of Parallel Algorithms- S.G.Akl

PAPER III (B): 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

PAPER III (C): NATURAL LANGUAGE PROCESSING

Brief history of NLP research, current applications, generic NLP system architecture, knowledge-based versus probabilistic approaches.

- Finite-state techniques, Inflectional and derivational morphology, finite-state, transducers.
- Prediction and part of speech tagging, Corpos, simple N-grams, Word prediction, stochastic tagging, evaluating system performance.
- Parsing and generation, Generative grammar context-free grammars, parsing and generation with context-grammars, weights and probabilities.
- Parsing with constraint-based grammars, Constraint-based grammar, Unification.
- Compositional and lexical semantics, Simple compositional semantics in constraint-based grammar- Semantic relations, WorldNet, Word senses, Word sense disambiguation. Discourses and dialogue, Anaphors resolution, discourse relations. Applications: Machine translation, email response, spoken dialogue systems.

Reference

Jurafsky and J. Martin, Speech and Language processing. Prentice Hall.

S. Pinker, The language instinct, Penguin.

P. Matthews, Linguistics: a very short introduction, OUP.

C.D. Manning and H. Schutze, Foundations of Statistical natural Language Processing, MIT Press.

ELECTIVE -2

PAPER –IV (A): 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.

PAPER –IV (B): 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

Paper IV (C) 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