SYLLABUS OF MASTER OF COMPUTER SCIENCE AND ENGINEERING

First Semester

Category - Departmental / Specialization Basket

Paper- I

PG / CSE / T / 111A  Theory of Computing


References:
2. D.P. Bovet & P. Gescenzi: Introduction to Theory of Complexity, PH.

Paper- II

PG / CSE / T / 112A  Advanced Algorithms

Algorithmic paradigms: Median and order statistics, Advanced data structures, Dynamic Programming, Greedy, Branch-and-bound; Asymptotic complexity, Amortized analysis; Graph Algorithms: Shortest paths, Flow networks; NP-completeness; Approximation algorithms; Randomized algorithms; Linear programming; Special topics: Geometric algorithms (range searching, convex hulls, segment intersections, closest pairs), Numerical algorithms (integer, matrix and polynomial multiplication, FFT, extended Euclid's algorithm, modular exponentiation, primality testing, cryptographic computations), Internet algorithms (text pattern matching, tries, information retrieval, data compression, Web caching).

References:
3. J. Kleinberg and É. Tardos. Algorithm Design. Addison-Wesley, 2005
Paper- III

PG / CSE / T / 113A  High Performance Architecture

Introduction: review of basic computer architecture, quantitative techniques in computer design, measuring and reporting performance. CISC and RISC processors.

Pipelining: Basic concepts, instruction and arithmetic pipeline, data hazards, control hazards, and structural hazards, techniques for handling hazards. Exception handling.

Hierarchical memory technology: Inclusion, Locality properties; Cache memory organizations, Techniques for reducing cache misses; Virtual memory organization, mapping and management techniques, memory replacement policies.

Instruction-level parallelism: basic concepts, techniques for increasing ILP, dynamic scheduling (Tomasulo's Algorithm), reorder buffer and instruction commit, branch prediction and advanced instruction delivery, speculative execution. Superscalar, super-pipelined and VLIW processor architectures.


Non von Neumann architectures: data flow computers, reduction computer architectures, systolic architectures.

Multicore Architecture.

References:

PG / CSE / T / 113B  Advanced Operating Systems

References:

Category – Inter-Disciplinary Basket

Paper- IV

PG / CSE / T/ 114A Advances in Artificial Intelligence

Introduction, Major approaches to AI (viz., symbol Processing & Subsymbolic approaches), A brief introduction to connectionist approach, Subsumption architecture and Evolutionary approach under subsymbolic approaches, Major subfields of AI, Intelligent search( viz., state space search, Algorithm A*, GA etc.), Knowledge representation through predicate calculus, resolution reputation system, reasoning using Horn clauses, case based reasoning, reasoning with uncertain information (viz., Probabilistic inference, Bayes networks, default reasoning, D-S theory, Fuzzy sets and fuzzy logic, Learning Bayes networks, Machine Learning: a brief introduction, Neural networks, Intelligent agents.

References:

PG / CSE / T/ 114B Embedded & Real-time Systems


References:
3. Real time systems - Jane Liu, Prentice Hall

PG / CSE / T/ 114C Computer Communication Network

Review of data communication principles: communication fundamentals, signals and channel characteristics, line codes, modulation and Modem, repeaters/equalizers, asynchronous/synchronous/interruptly synchronous data communication; data transparency; error detection and correction techniques principle of CRC; stop-and-wait protocol and its efficiency analysis. 

Review of point-to-point channel sharing techniques: FDM, TDM and TDM hierarchy; polling and concentration; spread spectrum communication and CDMA.

Network structure and architecture: concept of communication subnet and its 2-level hierarchy; network architecture and OSI architectural reference model.

Network Layer: Connectionless and connection-oriented services; datagram and V.C subnet organization; routing techniques static multipath; isolated/centralized/distributed dynamic, DVR, LS, hierarchical and multidestination; congestion avoidance and control. Local area networks (LANS): IEEE standards and protocol layers, Ethernet and token ring LAN-architecture, protocol management.

LAN Internetworking: Principle, relaying devices- bridges and switches, transparent and source routing bridges.

TCP/IP and the global Internet: Architecture and protocol layer of the global Internet, IPv4 protocol format, IP addresses-classful and classless, IP address management-subnetting, proxy ARP and DHCP, datagram forwarding, routing in the Internet, intra-domain and inter-domain protocols, IPv6, Transport layer protocols and addressing, NAT box. An overview of network security.

References:
Advanced Database System Concepts

Relational Database Management Issues - Transaction Processing, Concurrency, Recovery, Security and Integrity.
Multimedia Database - Multimedia and Object Oriented Databases, Basic features of Multimedia data management, Data Compression Techniques, Integrating conventional DBMSs with IR and Hierarchical Storage Systems, Graph Oriented Data Model, Management of Hypertext Data, Client Server Architectures for Multimedia Databases,

References:

Object oriented Design & Techniques

Object Oriented Programming (OOP) - Classes, Objects, Attributes, Methods, Messages, Abstraction, Encapsulation, Modularity, Inheritance, Generitance, Exception Handling. These concepts are to be introduced with reference to the language features of C++, Smalltalk and Java. [Parsons, Winston Budd]. OO Life Cycle Models, Object Oriented Analysis (OOA), Object Oriented Design (OOD), Object Oriented Testing, Metrics for Object Oriented Systems. [Pressman, Chapters 19-23]. OMT Methodology. [Rambaugh, Chapters 3-6 and 8-10].

References:

PG / CSE / T/ 115B VLSI System Design

Introduction to VLSI Design, Design Styles and parameters, popular technologies. Logic implementation with nMOS, CMOS. DCVS and PLAs. Pass vs. transistor logic, transit time, clocking, scaling, PLA minimization and folding, SIMPLIFY, ESPRESSO. Testability Issues. Physical Design algorithms: Partitioning, Floor planning and placement, Routing, compaction, gate arrays, FPGAs, MCMs. Data structures for layout design - MAGIC. Design Rule checking, Expert systems, symbolic layout, complexity of layout algorithms.

References:
2. A. Mukherjee: Introduction to CMOS VLSI, Prentice Hall.
3. Fabricius: Introduction to VLSI Design, TMH.
4. T. Ohtsuki: Layout Design and Verification, North Holland.

PG / CSE / T/ 115C Wireless Communication & Mobile Computing


References:
5. Charles Parkins – Mobile Adhoc Networks
6. Wireless Communication - W. Stallings
7. Mobile Communication – J. Schiller
Machine Learning


Instance-Based Learning: Constructing explicit generalizations versus comparing to past specific examples. k-Nearest-neighbor algorithm. Case-based learning.


References:
3. Ethem Alpaydin. Introduction to Machine Learning, MIT press
Paper – VI

PG / CSE / T/ 116A  Image Processing

Introduction, image definition and its representation, neighborhood. Orthogonal transformations like DFT, DCT, Wavelet.
Enhancement: contrast enhancement, smoothing and sharpening, filtering and restoration
Segmentation: pixel classification, global/local gray level thresholding, region growing, split/merge techniques, edge detection operators, Hough transform. Image feature/primitive extraction, component labeling, medial axis transform, skeletonization/thinning, shape properties, textural features – moments, gray level co occurrence matrix, structural features, Fourier descriptor, polygonal approximation.
Compression: coding, quantization, spatial and transform domain based compression. Color image processing: color model, enhancement, and segmentation.
Mathematical morphology: basic concepts, erosion, dilation, opening, closing. Advanced applications like biomedical image processing, digital watermarking, etc

References:

PG / CSE / T/ 116B  Modeling and Simulation


References:
Information and Coding Theory

Information Theory

Coding Theory

References:

Category – Sessional Courses

Sessional – I
PG / CSE / S / 111 Assignment

Sessional – II
PG / CSE / S / 112 Seminar

Second Semester

Category - Departmental / Specialization Basket

Paper – VII
PG / CSE / T/ 127A Distributed Operating Systems


**References:**

**PG / CSE / T/ 127B  Distributed Systems**


**References:**
2. Tel: Introduction to Distributed Algorithms.

**PG / CSE / T/ 127C  Pattern Recognition**


Unsupervised learning and clustering: Data description and clustering –similarity measures, criterion for clustering, Methods of clustering - partitional, hierarchical, graph theoretic, density based, Cluster validity

Feature extraction and feature selection: Problems of dimensionality- Feature extraction -- PCA-Feature selection –Karhunen Loeve, stochastic approximation, kernel approximation, divergence measures

**References:**
Computational Geometry

Combinatorial Geometry: fundamental concepts, permutation tables, direction of point sets, zones in arrangements, complexities of families of cells.

Geometric Algorithms: Data Structures and complexity-construction and maintenance of convex hills; planar point location and triangulation, range search; line segment interconnection; proximity-closest pair, Voronoi diagrams; Half space intersection. Linear programming in 2, 3, and higher dimensions; intersection of polygons, polyhedron; geometry of rectangles; decomposition of polygons; visibility problems. NP-hard problems in geometry. Applications: Hidden line and Hidden surface elimination, Plano mover's problem; polygon containment problems, obstacle avoidance motion planning of robots; geometric modeling.

References:

Paper VIII

Complexity of Computation

Relativizations of the P = NP problem, Co-NP and function problems, Randomized Complexity classes-RP, PP, ZPP, BPP, Random Sources.
- Approximability thresholds, L-reductions, class MAXSNP, non-approximability results.
- Isomorphism and density Oracles.
- Inside P-class NC, P completeness, RNC algorithms.
- Logarithmic space, L = NL problem, Alternation classes, Games.
- Polynomial Hierarchy-Optimization problems. PNP, FP NP, Interactive protocols, Circuit Complexity measures, asymptotic results and universal circuits, Monotone functions, Threshold functions, Razborov's Method, Circuits and Turing Machines, Uniform circuits, Bounded depth circuits, branching programs.
- Algebraic complexity.

References:
5. Wagner & Weichsung: Computational Complexity.
Information Security


Suggested Text:

References:

Soft Computing

Fuzzy logic: Conventional and fuzzy sets, operations on fuzzy sets, fuzzy numbers, crisp relations and fuzzy relations, realization of fuzzy systems using fuzzy relations, application of fuzzy logic in optimization, vision, pattern recognition.


Evolutionary computing: Introduction to Evolutionary Computation: Genetic algorithms, Genetic programming, Evolutionary strategies, Evolutionary programming. Genetic algorithms – Chromosome representation, encoding, decoding, Genetic operators: Selection, Crossover, Mutation, Elitism, Schema Theorem, EGA, Convergence theorem, real-coded GA, Ordered GA, Steady-state GA, Multi-objective evolutionary algorithms, applications in search and optimization. Recent advances in Evolutionary Computing (Particle Swarm Optimization, Ant Colony Optimization).


References:
7. C. M. Bishop, Neural Networks for Pattern Recognition, Oxford University Press, 1995.

PG / CSE / T/ 128D Software Engineering

Introduction and Brief Overview - Software process, modeling and analysis, software architecture, software design.
Software Modeling, Analysis, Testing - Analysis modeling and best practices, traditional practice diagrams such as DFDs and ERDs etc, Traditional Testing techniques – white box and black box testing.
Object-Oriented Software Engineering - Concept of OO Software – Design and Analysis, Overview of various UML diagrams and UML analysis modeling, analysis case studies, analysis tools, analysis patterns, OO software testing. Case study with complete examples
Software Architecture - Architectural styles, architectural patterns, analysis of architectures, formal descriptions of software architectures, architectural description languages and tools, scalability and interoperability issues, web application architectures, case studies.
Software Design - Design best practices, design patterns, extreme programming, refactoring, design case studies, component technology, object oriented frameworks, distributed objects, object request brokers, case studies.
Web Engineering, Clean room Engineering and other recent topics

References:
2. E. Gamma, R. Helm, R. Johnson, and J. Vlissides. Design Patterns: Elements of Reusable Object-Oriented Software. Addison-Wesley, 1995

**PG / CSE / T/ 128E High Speed Networking**

High-speed Modems: Dial-up and ADSL Modems.
High-speed (concurrent) data link protocols: Sliding window and time-multiplexed stop-and-wait
High-speed LANs and MANs: Fast and Gigabit Ethernet, FDDI, DQDB and Fibre Channel
Queueing Theory and applications: Preliminaries; discussions of important results and network applications of M/M/1 and M/G/1 queuing systems.
ISDN, B-ISDN, Frame Relay and ATM: Introduction, telephone network overview; broad features of ISDN, B-ISDN and Frame Relay networks; design features, protocol-layered architecture and high-speed operation of ATM network.
Review of TCP/IP and the global Internet
High-speed IP router design: IP router intervals, making NICS and switching fabrics faster.
High speed packet processing: Overview of different packet processing functions performed by a router; high-speed implementation of IP address lookup and packet filtering/packet classification
Overview of network processors

**Paper IX**

**PG / CSE / T/ 129A Combinatorial Algorithm**

Ear decompositions, Nonbipartite matching, Gallai-Milgram and Bessy-Thomasse theorems on partitioning/covering graphs by directed paths/cycles, Minimization of submodular functions, Matroid intersection, Polymatroid intersection, Jump systems, Matroid union, Matroid matching, path matchings, Packing trees and arborescences, Packing directed cuts and the Lucchesi-Younger theorem, Submodular flows and the Edmonds-Giles theorem, Graph orientation, Connectivity tree and connectivity, augmentation, Multicommodity flows.

**PG / CSE / T/ 129B Natural Language Processing**

- Semantic Interpretation - Logical Semantics, Script, Conceptual Dependency.
- Discourse Interpretation - Paragraph, Story, Dialogue understanding. Anaphora Resolution.
- Natural Language Generation.
References:

PG / CSE / T/ 129C  Data Warehousing & Data Mining

Introduction, Data warehousing and OLAP technology for data mining, Classification of data mining techniques, Discovery and analysis of patterns, trends, and deviations, Data pre-processing, Data mining primitives, languages and systems, Data mining models: decision trees, genetic algorithms, neural nets, etc. Clustering, Enabling data mining through data warehouse. Data marts, Multidimensional databases, Data mining applications, Descriptive data mining: characterization and comparison, Association analysis, Classification and prediction, Cluster analysis, Mining complex types of data, Applications and trends in data mining.

References:
2. Jiawei Han and Micheline Kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann Publishers.
3. Margaret Dunham, Data Mining: Introductory and Advanced Topics, Prentice Hall.

PG / CSE / T/ 129D  VLSI Testing & Verification

Faults, errors and fault models: Stuck-st, stuck-open, stuck-on, bridging, physical, delay; PLA fault, memory fault; t-diagnosable systems. Single and Multiple stuck-at faults. Fault equivalence, dominance, collapsing, check-points. Test generation- Boolean differences, D-algorithm, PODEM, FAN; testability analysis, random sampling and random pattern testability, testability directed test generation. Design for testability, Built-in self test techniques, LSSD Syndrome and parity testing; signature analysis. Testing of sequential
circuits-scan path, full and partial scan, random path self checking designs, m-out-of-n codes, Berger code, testing of delay and stuck-open faults. Verification: Verification by simulation, techniques of formal verification, use of BDDs in verification.

References:

PG / CSE / T/ 129E  Cryptography

Extended Euclidean Algorithm, Congruence, Chinese Remainder Theorem, Euler's Theorem, Primitive elements and conjugates in finite fields, Quadratic Reciprocity Law, Jacobi and Legendre's symbols, Gaussian Integers, Carmichael Numbers and strong pseudo-primes, Addition Chain Problems.
- Factorization schemes of Solovay-Strassen, Miller-Rabin, Pollard, Factor bases and Continued Fraction methods.
- Classical Cyphers and one time pad, Public Key Cryptography-Diffie Hellmann, RSA, Massey O'Mara, El Gamal Schemes, Kbapsacj based schemes, Mental Poker, Linear Feedback Shift Registers-Threshold schemes for Key Management, Access Control, Inference Control-Security of Statistical Databases.
- Elliptic curve Cryptosystems and Factorization-Lenstra's Algorithm.
- Group Algebra, Weight Enumerators and Krawtchouk Polynomials, Automorphism groups of codes, Designs and codes-intersection numbers of t-designs.

References:
2. Irlinsf & Rosen: Second Course in Number Theory, Springer.
5. Steven Roman: Coding and Information Theory, Springer.

Category – Inter Disciplinary Basket

Paper – X

PG / CSE / T/ 1210A  Service Oriented Architecture

SOA Fundamentals: Defining SOA, Business Value of SOA, Evolution of SOA, SOA characteristics, concept of a service in SOA, misperceptions about SOA, Basic SOA architecture, infrastructure services, Enterprise Service Bus (ESB), SOA Enterprise Software models, IBM On Demand operating environment.
Web services Technologies: XML technologies – XML, DTD, XSD, XSLT, XQuery, XPath Web services technologies - Web services and SOA, WSDL, SOAP, UDDI.

SOA Planning and Analysis: Stages of the SOA lifecycle, SOA Delivery Strategies, service-oriented analysis, Capture and assess business and IT issues and drivers, determining non-functional requirements (e.g., technical constraints, business constraints, runtime qualities, non-runtime qualities), business centric SOA and its benefits, Service modeling, Basic modeling building blocks, service models for legacy application integration and enterprise integration, Enterprise solution assets(ESA).

SOA Design and implementation: service-oriented design process, design activities, determine services and tasks based on business process model, choosing appropriate standards, articulate architecture, mapping business processes to technology, designing service integration environment (e.g., ESB, registry), Tools available for appropriate designing, implementing SOA, security implementation, implementation of integration patterns, services enablement, quality assurance.

Managing SOA Environment: Distributing service management and monitoring concepts, operational management challenges, Service-level agreement considerations, SOA governance (SLA, roles and responsibilities, policies, critical success factors, and metrics), QoS compliance in SOA governance, role of ESB in SOA governance, impact of changes to services in the SOA lifecycle.

References:

PG / CSE / T/ 1210B  Multimedia Technologies


References:
1. J. Keyes: Multimedia Handbook, MH.
PG / CSE / T/ 1210C Network Security


Suggested Text:

References:

PG / CSE / T/ 1210D Parallel Computing Techniques

Introduction to High Performance Computing: Milestones and applications.
High-Performance Computing architectures: Overview of the major classes of HPC architectures and their evolution.
Parallel programming models and performance analysis: Parameterisation, modeling, performance analysis, Amdahl’s law, efficiency, and benchmarking of systems.
Programming parallel computers: Overview of parallel programming, parallel languages, parallelizing compilers, message passing and data parallel programming models, introduction to MPI and OpenMP.
Multi-Thread Models with primary sources of overhead, memory architecture and memory access times and associated sources of overhead; Multi-Process Execution Model; Performance Tuning via Overhead Reduction; Task Scheduling; Data Partitioning and its Effect on Performance.
Restructuring for Parallel Performance - Loop Transformations; Data Transformations; Dependence Analysis; Compiler Strategies.
Parallel Algorithms - Cyclic Reduction; Iterative Algorithms (Jacobi, Gauss-Seidel and Red-Black Orderings);

References:
3. Parallel Programming in C with MPI and OpenMP by M.J. Quinn, McGraw-Hill Science/Engineering/Math
4. Other materials will be provided in the class.
PG / CSE / T/ 1210E  Bioinformatics

Fundamental of Cell Biology: Prokaryotes to eukaryotes, Single cells to multicellular organisms, Structure of cell, Internal organization of cell, Central dogma, DNA-RNA-Protein, Transcription, Translation, Gene, Promoter


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

References:
1. Introduction to Bioinformatics, Arthur M. Lesk, 2002, Oxford University Press
2. Introduction to Bioinformatics, Teresa Attwood, David Parry-Smith, 2001, Prentice Hall

Category – Sessional Courses

Sessional – I

PG /CNS / S / 121  Term Paper Leading to Thesis

Sessional – II

PG /CNS / S / 122  Seminar

Third and Fourth Semester

Sessional 1

PG /CNS / TH / 21  Thesis Work

Sessional 2

PG /CNS / VV / 22  Viva – Voce