Biju Patnaik University of Technology, Orissa

M.Tech Syllabus
in
Computer Science & Engineering

From
2009 -2010 Academic Session
Analysis and Design of Algorithm

UNIT-1
Algorithm paradigms, Asymptotic notations, Recurrences, Divide and conquer (Merge sort, Heap sort, Quick sort and its correctness proofs) Lower bounds of sorting, Counting sort.

UNIT-II
Randomization (Randomization quick sort, Primality testing), Dynamic Programming (Floyd-Warshall Algorithm, Longest Common Subsequence, Matrix chain multiplication), Greedy Method (Single source shortest path, M, Knapsack problem, Minimum cost spanning trees, Task scheduling),

UNIT- III
Polynomial time, Polynomial-time verification, NP completeness and reducibility, NP completeness proofs,, Cook’s theorem, NP complete problem

UNIT – IV
Geometric algorithms (range searching, convex hulls, segment intersections, closest pairs), Numerical algorithms (integer, matrix and polynomial multiplication, FFT, extended Euclid’s algorithm), Internet algorithm (text pattern matching, tries, Ukonnen’s algorithm).

Books:

ADVANCED COMPUTER ARCHITECTURE

Introduction: Review of basic computer architecture, quantitative techniques in computer design, measuring and reporting performance;
CISC and RISC processors, Pipelining: Basic concepts, instructions and arithmetic pipeline, data hazards, control hazards and structural hazards, techniques for handling hazards, Exception handling, pipeline optimization techniques;
Hierarchical memory technology: Inclusion, Coherence and 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, super-scalar, super-pipelined and VLIW processor architectures, array and vector processors;
Multiprocessor architecture: Taxonomy of parallel architectures;
Centralized shared-memory architecture: Synchronization, memory consistency, interconnections networks, Distributed shared-memory architecture, cluster computers.

Books:


OBJECT ORIENTED SYSTEM

UNIT-1
Real world domains, object oriented approach and technology, objects instances and concepts, Objects and classes of objects, generalized object oriented software, Development cycle, Object oriented programming language, object-oriented analysis of a real world domain object model. The notation of encapsulation and information hiding, object identity: entity and attributes, data and knowledge: The notion of inheritance, Relationship between objects: Association, Generalization/ Specialization, Aggregation, Object and States, Dynamic behavior of objects.

UNIT-II
Object-Oriented analysis: introduction, Techniques for information gathering for RA, use case driven object oriented analysis, concepts and principles, identifying the elements of an object model, Management of Object-Oriented Software projects, Object oriented analysis, domain analysis and generic components of object-oriented analysis model, object behavior model.

The intent of object-oriented metrics, the distinguishing characteristics and metrics for the object-oriented design model, class oriented metrics, operation oriented metrics, metrics for object oriented testing, metrics for object-oriented projects.

UNIT-III
Introduction to UML : The meaning of object-orientation, object identity, encapsulation, information hiding, polymorphism, genericity, importance of modeling, principles of modeling, object oriented modeling, conceptual modeling of the UML, Architecture.
Basic structural modeling : classes, relationships, common mechanisms, diagrams, advanced structural modeling : advanced relationship interfaces, roles, packages, instances.

UNIT-IV

UNIT-V
Behavioral modeling: interactions, use cases, use case diagrams, activity diagrams. Advanced Behavioral modeling: Events and signals, state machines, process and threads, time and space, state chart diagram. Architectural Modeling: Terms, concepts, examples, modeling techniques for component diagrams and deployment diagram

Suggested Reading:
3. Larmen
Real Time Systems

UNIT-1 [10Hrs]
Introduction: What is real time, Applications of Real-Time systems, A basic model of Real-time system, Characteristics of Real-time system, Safety and Reliability, Types of Real-time tasks, timing constraints, Modelling timing constraints
Real-Time Task Scheduling: Some important concepts, Types of Real-time tasks and their characteristics, Task scheduling, Clock-Driven scheduling, Hybrid schedulers, Event-Driven scheduling, Earliest Deadline First (EDF) scheduling, Rate monotonic algorithm (RMA).

UNIT-2 [10Hrs]
Scheduling Real-time tasks in multiprocessor and distributed systems: Multiprocessor task allocation, Dynamic allocation of tasks. Fault tolerant scheduling of tasks. Clock in distributed Real-time systems, Centralized clock synchronization

UNIT-3 [5Hrs]
Commercial Real-time operating systems: Time services, Features of a Real-time operating system, Unix as a Real-time operating system, Unix-based Real-time operating systems, Windows as a Real-time operating system, POSIX, A survey of contemporary Real-time operating systems. Benchmarking real-time systems.

UNIT-4 [5Hrs]
Real-time Communication: Examples of applications requiring real-time communication, Basic concepts, Real-time communication in a LAN. Soft Real-time communication in a LAN. Hard real-time communication in a LAN. Bounded access protocols for LANs. Performance comparison, Real-time communication over packet switched networks. Qos framework, Routing, Resource reservation, Rate control, Qos models.

Books:


Fuzzy Inference System: Mamdani fuzzy models, Sugeno Fuzzy Models, Tsukamoto fuzzy models, other considerations.

Least Square Method for system Identification: System Identification, Basic of matrix manipulations and calculus, Least-square estimator, Geometric interpretation of LSE, Recursive least-square estimator, Recursive LSE for time varying systems, Statistical Properties and maximum likelihood estimator, LSE for nonlinear models.

Derivative-based optimization: Descent methods, the method of steepest descent, Newton’s methods, Step size determination, conjugate gradient methods, Analysis of quadratic case, nonlinear least-squares problems, Incorporation of stochastic mechanism.

Derivative-free optimization: Genetic algorithm simulated annealing, random search, Downhill simplex search, Swarm Intelligence, genetic programming.

Adaptive Networks: Architecture, Back propagation for feed forward networks, Extended back propagation for recurrent networks, Hybrid learning rule: combing steepest descent and LSE.


Learning from reinforcement: Failure is the surest path to success, temporal difference learning, the art of dynamic programming, Adaptive heuristic critic, Q-learning, A cost path problem, World modeling, other network configurations, Reinforcement learning by evolutionary computations.


Adaptive Neuro-fuzzy inference systems: ANFIS architecture, Hybrid learning algorithms, Learning methods that cross-fertilize ANFIS and RBNF, ANFIS as universal approximator, Simulation examples, Extensions and advance topics.


Books:
Service Oriented Architecture

Defining SOA, Business Value of SOA, Evolution of SOA, SOA characteristics, concept of a service in SOA, Stages of the SOA lifecycle, SOA Delivery Strategies, service-oriented analysis, Capture and assess business and IT issues and drivers, determining non-functional requirements, service-oriented design process, design activities, Distributing service management and monitoring concepts


Computer Graphics

Introduction: Display of entities, geometric computation and representation, graphics environments;
Working principles of display devices: Refreshing Raster scan devices, vector devices, cathode ray tube terminals, plotters;
Display of colors: Look-up tables, display of gray shades, half toning;
Display and drawing of graphics primitives: Point, line, polygon, circle, curves, and texts;
Coordinate conventions: World coordinates, device coordinates, normalized device coordinates, view-port and window, zooming and panning by changing coordinate reference frames;
Computations on polygons: Point inclusion problems, polygon filling, polygon intersections, clipping, polygonization of a point set, convex hull computation, triangularization of polygons;
Transformations in 2D and 3D: Translation, Rotation, Scaling, Reflection;
Projection: Perspective and parallel projections, isometric projection, Transformation matrices;
Volume and surface representation: Polygonal meshes, parametric curves and surfaces, Cubic and Bi-cubic Splines, Voxels, Octree and Medial axis representation, Sweep representation, surfaces and volumes by rotation of curves and surfaces, Fractal modeling;
Hidden surface and Line Elimination: Elimination of back surfaces, Painters’ algorithms, Binary space partitioning tree;
Rendering and visualization: Shading model, constant, Goraud and Phong shading, Ray tracing algorithm, Radiosity computation;
Computer animation: Fundamental concepts.

Books:
Wireless Sensor Networks

Unit I
Introduction: the vision, Networked wireless sensor devices, Applications, Key design challenges.
Network deployment: Structured versus randomized deployment, Network topology, Connectivity, Connectivity using power control, Coverage metrics, Mobile deployment.

Unit II
Synchronization: Issues & Traditional approaches, Fine-grained clock synchronization, and Coarse-grained data synchronization.

Unit III
Wireless characteristics: Basics, Wireless link quality, Radio energy considerations, SINR capture model for interference.
Medium-access and sleep scheduling: Traditional MAC protocols, Energy efficiency in MAC protocols, Asynchronous sleep techniques, Sleep-scheduled techniques, and Contention-free protocols.
Sleep-based topology control: Constructing topologies for connectivity, constructing topologies for coverage, Set K-cover algorithms.

Unit IV
Routing: Metric-based approaches, Routing with diversity, Multi-path routing, Lifetime-maximizing energy-aware routing techniques, Geographic routing, Routing to mobile sinks.
Data-centric networking: Data-centric routing, Data-gathering with compression, Querying, Data-centric storage and retrieval, The database perspective on sensor networks.
Reliability and congestion control: Basic mechanisms and tunable parameters, Reliability guarantees, Congestion Control, Real-time scheduling.

Books:
Stochastic Processes

Introduction to Probability; the axioms, the concept of random variables; functions of one, two and sequence of random variables.
General Concepts of stochastic processes; random walks and other applications; spectral representation; spectrum estimation; mean square estimation; entropy; markov chains and markov processes and queuing theory.

Reference Book

Formal Language and Automata Theory

Formal languages and their related automata: Turing machines, Type-0 languages, Linear bounded automata and CSLs; Time and Tape bounded Turing machines, time and space bounds for recognizing CFLs;
Turing computability: Number theoretic computations by Turing machines and indexing; Axiomatic systems, their soundness and completeness,
Recursive function theory: Primitive recursive functions and primitive recursive predicates; Some bounded operations, Unbounded minimalization and μ-Recursive Functions, Godel Numbering, Ackermann’s function, recursive and general recursive functions;
Computability and decidability: Computable functions, computable sets, decision problems, Fix-point theory of programs, functions and functionals, Verification methods, Lambda calculus and applications.

Reference Books :

Software Technologies Lab.

Object-oriented programming concepts and implementation of abstract data types; Implementation of graph algorithms; Linear programming with applications; Basic of OS programming process creation and synchronization, shared memory and semaphore shell programming.
Software Engineering


Text Books:

Reference Books:
1. I Sommerville, Software Engineering, Pearson Education.
2. P. Jalote, An Integrated Approach to Software Engineering, Narosa,
4. Baude, Object Oriented Software Engineering, Wiley.
Distributed Operating Systems


Text Books:

Reference Books:
5. P. S. Pacheco, *Parallel Programming with MPI*, Morgan Kaufmann.

DISTRIBUTED DATABASE SYSTEM

2. Distributed Database design – A frame work, the design of database fragmentation, the allocation of fragments. Translation of global queries into fragment queries, query optimization.
4. Reliability: Basic concepts, commit protocols, consistent view of Network, Detection and Resolution of Inconsistencies, check points and cold restart.
5. Commercial Systems: Tranclem’s ENCOMPASS Distributed database systems, IBM’s Inter system communication, feature of distributed ingres and Oracle.

Text Book:
COMPILER CONSTRUCTION

Review of compiler fundamentals – Lexical analysis, parsing, semantic analysis, error recovery and intermediate code generation; Runtime storage management; Code Generation; Code improvement – Peephole optimization, dependence analysis and redundancy elimination, Loop optimization, procedural and interprocedural optimization, instruction scheduling, optimization for memory hierarchy; compilation for high performance architecture; Probability and retargetability;

Selected topics from Compilers for imperative: Object-oriented and mark-up languages, parallel and distributed programming and concurrency.

Text books and references:
1) A. V. Aho, R. Sethi, Lam, and J. D. Ullman, “Compilers”, Pearson Education.

Simulation and Modeling


References:
Mobile Computing


References:

J2EE

Introduction: Java and Java applications; Java Development Kit (JDK); Java is interpreted, Byte Code, JVM; Object-oriented programming; Simple Java programs. Data types and other tokens: Boolean variables, int, long, char, operators, arrays, white spaces, literals, assigning values; Creating and destroying objects; Access specifiers. Operators and Expressions: Arithmetic Operators, Bitwise operators, Relational operators, The Assignment Operator, The? Operator; Operator Precedence; Logical expression; Type casting; Strings;
.Control Statements: Selection statements, iteration statements, Jump Statements.
Classes, Inheritance, Exceptions, Applets: Classes: Classes in Java; Declaring a class; Class name; Super classes; Constructors; Creating instances of class; Inner classes.
.Inheritance: Simple, multiple, and multilevel inheritance; Overriding, overloading. Exception handling: Exception handling in Java. The Applet Class: Two types of Applets; Applet basics; Applet Architecture; An Applet skeleton; Simple Applet display methods; Requesting repainting; Using the Status Window; The HTML APPLET tag; Passing parameters to Applets; getDocumentbase( ) and getCodebase( ); ApletContext and showDocument( ); The AudioClip Interface; The AppletStub Interface; Output to the Console.
Multi Threaded Programming, Event Handling: Multi Threaded Programming: What are threads? How to make the classes threadable; Extending threads; Implementing runnable; Synchronization; Changing state of the thread; Bounded buffer problems, read-write problem, producer-consumer problems. Event Handling: Two event handling mechanisms; The delegation event model; Event classes; Sources of events; Event listener interfaces; Using the delegation event model; Adapter classes; Inner classes.
Swings: Swings: The origins of Swing; Two key Swing features; Components and Containers; The Swing Packages; A simple Swing Application; Create a Swing Applet; Jlabel and ImageIcon; JTextField; The Swing Buttons; JTabbedpane; JScrollPane; JList; JComboBox; JTable.

TEXT BOOKS:
Graph Theory

Basic Concepts: Graphs and digraphs, incidence and adjacency matrices, isomorphism, the automorphism group; Trees: Equivalent definitions of trees and forests, Cayley's formula, the Matrix-Tree theorem, minimum spanning trees; Connectivity: Cut vertices, cut edges, bonds, the cycle space and the bond space, blocks, Menger's theorem; Paths and Cycles: Euler tours, Hamilton paths and cycles, theorems of Dirac, Ore, Bondy and Chvatal, girth, circumference, the Chinese Postman Problem, the Travelling Salesman problem, diameter and maximum degree, shortest paths; Matchings: Berge's Theorem, perfect matchings, Hall's theorem, Tutte's theorem, Konig's theorem, Petersen's theorem, algorithms for matching and weighted matching (in both bipartite and general graphs), factors of graphs (decompositions of the complete graph), Tutte's f-factor theorem; Extremal problems: Independent sets and covering numbers, Turan’s theorem, Ramsey theorems; Colorings: Brooks theorem, the greedy algorithm, the Welsh-Powell bound, critical graphs, chromatic polynomials, girth and chromatic number, Vizing's theorem; Graphs on surfaces: Planar graphs, duality, Euler's formula, Kuratowski's theorem, toroidal graphs, 2-cell embeddings, graphs on other surfaces; Directed graphs: Tournaments, directed paths and cycles, connectivity and strongly connected digraphs, branchings; Networks and flows: Flow cuts, Max flow min cut theorems, perfect square; Selected topics: Dominating sets, the reconstruction problem, intersection graphs, perfect graphs, random graphs.

Text Books:

2. N. Deo, Graph Theory with Applications to Engineering and Computer Science, Prentice Hall of India, 2004.

Reference Books:
VLSI Design

Introduction to VLSI Design Methodologies, Full Custom Design, Semi Custom Design and Programmable design, VLSI Design Flow, Design Entry, Synthesis, Floorplanning, Place & Route, Timing analysis, Front – end design and Backend design.
Front End Design: Introduction to high level design, Hardware Description Language.
Synthesis tools : Synopsis.
Backend Design: Introduction to low level Design.
MOS Structure: Band Diagram, NMOS, PMOS, CMOS digital logic gates, Inverters
Introduction to SPICE (T_Spice) for circuit simulation VLSI Technology.
Fabrication Process (NMOS & CMOS)
Wafer Preparation, Oxidation, Photo & Ion Lithography, Etching, Diffusion, Ion implantation, Metalization.
Design of Telecom Chips
Introduction to VLSI Design modulators, Demodulators, Transiver ICS, coder & Decoders. Companies Involved in Communication chip design.

Suggested text books and references
1) Application specific Integrated Circuits by Smith (For Unit –I)
2) VHDL by Douglas Perry, TMH Publication (for Unit-II)
3) VLSI Design & Techniques, Pucknell & Eshraghian, PHI (For Unit-III & Unit-V)
4) VLSI Technology, S. M. Size, Mc Graw Hill (For Unit-IV)
5) Resources from Internet : www.ti.com
CRYPTOGRAPHY

Introduction to Cryptography: Basics of Symmetric Key Cryptography, Basics of Asymmetric Key Cryptography, Hardness of Functions


Goldreich-Levin Theorem: Relation between Hardcore Predicates and Trap-door permutations

Formal Notions of Attacks: Attacks under Message Indistinguishability: Chosen Plaintext Attack (IND-CPA), Chosen Ciphertext Attacks (IND-CCA1 and INDCCA2), Attacks under Message Non-malleability: NM-CPA and NM-CCA2, Interrelations among the attack model

Random Oracles: Provable Security and asymmetric cryptography, hash functions

One-way functions: Weak and Strong one way functions

Pseudo-random Generators (PRG): Blum-Micali-Yao Construction, Construction of more powerful PRG, Relation between One-way functions and PRG, Pseudorandom Functions (PRF)

Building a Pseudorandom Permutation: The Luby Rackoff Construction: Formal Definition, Application of the Luby Rackoff Construction to the construction of Block Ciphers, The DES in the light of Luby Rackoff Construction

Left or Right Security (LOR)

Message Authentication Codes (MACs): Formal Definition of Weak and Strong MACs, Using a PRF as a MAC, Variable length MAC

Public Key Signature Schemes: Formal Definitions, Signing and Verification, Formal Proofs of Security of Full Domain Hashing

Assumptions for Public Key Signature Schemes: One way functions Imply Secure One-time Signatures

Shamir's Secret Sharing Scheme

Formally Analyzing Cryptographic Protocols

Zero Knowledge Proofs and Protocols

References:

2. Wenbo Mao, Modern Cryptography, Theory & Practice, Pearson Edu. (Low Priced Ed.)

REFERENCE BOOKS:

Speech Processing

Speech Processing: Introduction; Brief Review of Regular Expressions and Automata; Finite State Transducers; Word level Morphology and Computational Phonology; Basic Text to Speech; Introduction to HMMs and Speech Recognition. Indian language case studies; Part of Speech Tagging; Parsing with CFGs; Probabilistic Parsing. Representation of Meaning; Semantic Analysis; Lexical Semantics; Word Sense; Disambiguation; Discourse understanding; Natural Language Generation; Techniques of Machine Translation; Indian Language case studies.

Pattern Recognition


References:
EMBEDDED SYSTEMS

Module – I (12 Hours)
Introduction: Features of Embedded systems, Design matrices, Embedded system design flow, SOC and VLSI circuit.
ARM: An advanced Micro Controller, Brief history, ARM pipeline, Instruction Set Architecture ISA: Registers, Data Processing Instructions, Data Transfer Instructions, Multiplications instructions, Software interrupt, Conditional execution, branch instruction, Swap instruction, THUMB instructions. FPGA

Module – II (12 Hours)
Devices and device drivers, I/O devices, Serial peripheral interfaces, IIC, RS232C, RS422, RS485, Universal serial bus, USB Interface, USB Connector IrDA, CAN, Bluetooth, ISA, PCI, PCI – X and advance busses, Device drivers.
Real time operating system: Hard real time, firm real time, soft real time, Task periodicity: periodic task, sporadic task, aperiodic task, task scheduling, scheduling algorithms: clock driven scheduling, event driven scheduling.

Module – III (08 Hours)
Low power embedded system design: Dynamic power dissipation, Static power dissipation, Power reduction techniques, system level power management.

Module – IV (08 Hours)
Hardware and software partitioning: K-L partitioning, Partitioning using genetic algorithm, particle swarm optimization, Functional partitioning and optimization: functional partitioning, high level optimizations. Hardware software co-simulations

Text Books:
1. “Embedded System Design” by Santanu Chattopadhay, PHI
2. “Embedded system architecture, programming and design” By Raj Kamal, TMH

Reference Books:
1. “Hardware software co-design of Embedded systems” By Ralf Niemann, Kulwer Academic.
2. “Embedded real time system programming” By Sriram V Iyer, Pankaj Gupta, TMH.

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