Ph D(CSE) Qualifying Examination Syllabus

(Updated as on June 2021)

All research scholars are required to pass the qualifying examination in the three subjects of the concerned research group as per the rules of the university. The detailed syllabus for the courses is given in succeeding sections.

1. Cyber Security Research Group

Cryptography and Network Security Techniques

Unit No.1:

Foundation of Security & Cryptography: OSI security architecture, Security Policy, Classical encryption techniques (Substitution Techniques, Transposition Techniques and Staganography) & Design Principle of Block Ciphers: DES

Unit No.2:

Block Cipher Algorithms: AES, Pseudo Random Numbers & Stream Ciphers: Multiple Encryptions, Block Cipher modes of operation, stream ciphers, Confidentiality

Unit No. 3:

Public Key Cryptography: RSA, Key management, Hashes & Message Digest: Authentication functions, Message authentication codes, Hash functions and their security

Unit No.4:

Digital Signature, Certificates & standards, Authentication: X.509 Authentication service, Electronic Mail Security: S/MIME

Unit No.5:

IP and Web Security Protocols: IPSec, Secure socket layer and transport layer security, secure e-transaction, System Security: Computer Virus, Firewall & Intrusion Detection, Trusted systems, Security Investigation/Audit

Reference Book:

1. Cryptography & Network Security, Principles and Practice, "William Stalling"

Computer Network Programming (To Be Conducted as a Lab Examination)

Unit No. 1: Introduction and TCP/IP

Introduction, A Simple Daytime Client, Protocol Independence, Error Handling: Wrapper Functions, A Simple Daytime Server, Road Map to Client-Server Examples in the Text, OSI Model, BSD Networking History, Test Networks and Hosts, Unix Standards, 64-bit Architectures

Unit No. 2: The Transport Layer: TCP and UDP

Introduction, UDP, TCP, Stream Control Transmission Protocol, TCP Connection Establishment and Termination, TIME_WAIT State, SCTP Association Establishment and Termination, Port Numbers, TCP Port Numbers and Concurrent Servers, Buffer Sizes and Limitations, Standard Internet Services, Protocol Usage by Common Internet Applications

Unit No. 3: Sockets Introduction

Introduction, Socket Address Structures, Value-Result Arguments, Byte Ordering Functions, Byte Manipulation Functions, inet_aton, inet_addr, and inet_ntoa Functions, inet_pton and inet_ntop Functions, sock_ntop and Related Functions, readn, writen, and readline Functions

Unit No.4: Elementary TCP Sockets

Introduction, Socket Function, Connect Function, Bind Function, Listen Function, Accept Function, Fork, Exec Functions, Concurrent Servers, Close Function, Getsockname, Get peername Functions

Unit No. 5: TCP Client-Server Example

Introduction, TCP Echo Server: main Function, Str_echo Function, TCP Echo Client: main Function, Str_cli Function, Normal Startup, Normal Termination, Posix Signal Handling, Handling SIGCHLD Signals, Wait and waitpid Functions, Connection Abort before accept Returns, Termination of Server Process, SIGPIPE Signal, Crashing of Server Host, Crashing and Rebooting of Server Host, Shutdown of Server Host

Unit No. 6: I/O Multiplexing: The select and poll Functions

Introduction, I/O Models, Select Function, Str_cli Function, Batch Input', Shutdown Function, Str_cli Function, TCP Echo Server, Pselect Function, Poll Function, TCP Echo Server

Unit No. 7: Socket Options

Introduction, Getsockopt, Setsockopt Functions, Checking If an Option Is Supported and Obtaining the Default, Socket States, Generic Socket Options, IPv4 Socket Options, ICMPv6 Socket Option, IPv6 Socket Options, TCP Socket Options, SCTP Socket Options, Fcntl Function

Unit No. 8: Elementary UDP Sockets

Introduction, Recvfrom, Sendto Functions, UDP Echo Server: main Function, Dg_echo Function, UDP Echo Client: main Function, Dg_cli Function, Lost Datagrams, Verifying Received Response, Server Not Running, Connect Function with UDP, Dg_cli Function, Lack of Flow Control with UDP, Determining Outgoing Interface with UDP, TCP and UDP Echo Server Using select

Unit No. 9: Elementary SCTP Sockets

Introduction, Interface Models, sctp_bindx Functions, sctp_connectx Function, sctp_getpaddrs Function, sctp_freepaddrs Function, sctp_getladdrs Function, sctp_freeladdrs Function, sctp_sendmsg Function, sctp_recvmsg Function, sctp_opt_info Function, sctp_peeloff Function, shutdown function

Unit No. 10: SCTP Client/ Server Example

Introduction, SCTP One-to-Many-Style Streaming Echo Server & client: main function SCTP Streaming Echo Client: str_cli Function, Exploring Head-of-Line Blocking, Controlling the Number of Streams, Controlling Termination

Unit No. 11: Name and Address Conversions

Introduction, Domain Name System (DNS), gethostbyname Function, gethostbyaddr Function, getservbyname and getservbyport Functions, getaddrinfoFuncation, gai_strerror Functions, freeaddrinfo Function, getaddrinfo Function: IPv6, getaddrinfo Function: Examples, host_serv Function, tcp_connect Function, tcp_listen Function, udp_client Function, udp_connect Function, udp_server Function, Re-entrant Function, gethostbyname_r and gethostbyaddr_f Function, Obsolete IPv6 Address Lookup Function

Reference Book:

1. Unix Network Programming, Volume 1, Third Edition, "W. Richard Stevens, Bill Fenner, Andrew M. Rudoff"

Mathematical Foundations for Cryptography

Unit No. 1: Divisibility & Congruence

Divisibility, Primes, Binomial Theorem, Congruence, Solutions of congruence's, The Chinese Remainder Theorem, Techniques of Numerical Calculations, Public-Key Cryptography, Prime Power

Modulo, Prime Modulus, Primitive Roots, Power Residues & Congruence of Degree Two.

Unit No. 2: Number Theory, Quadratic Reciprocity and Quadratic Forms

Number Theory from Algebraic Viewpoint, Groups, Rings, Fields, Quadratic Residues, Quadratic Reciprocity, Binary Quadratic Forms, Equivalences and Reduction of Binary Quadratic Forms.

Unit No. 3: Functions of Number Theory & Diophantine Equations

Greatest Integer Function, Arithmetic Function, Combinatorial Number Theory, Diophantine ax+by=c, Simultaneous Linear Equations, Assorted Examples, Ternary Quadratic Forms, Rational Points on Curves, Elliptic Curves, Factorization Using Elliptic Curves.

Unit No. 4: Prime & Multiplicative Number Theory

Elementary Prime Number Estimates, Dirichlet Series, Estimates of Arithmetic Functions, Primes in Arithmetic Progression, Unique Factorization & Primes in Quadratic Fields Having the Unique Factorization Property.

Unit No. 5: The Partition Function & Density of Sequences of Integers

Introduction Partitions Functions, Ferrers Graph, Formal Power Series, Generating Functions, Euler's Identity, Euler's Formula, Asymptotic Density, Schnirelmann Density and the αβ Theorem

Reference Book:

1. An Introduction to Theory of Numbers, Fifth Edition, "Ivan Niven, Herbert S. Zuckerman, & Hugh L. Montgomery" John Willey & Sons.

2. Artificial Intelligence Research Group

Artificial Intelligence

Unit No. 1:

Introduction to AI Applications and AI Techniques, Production Systems, Control Strategies, Reasoning - Forward and Backward Chaining.

Unit No. 2:

Definitions of A Rational Agent, Reflex, Model-Based, Goal-Based, and Utility-Based Agents, The Environment in Which a Particular Agent Operates.

Unit No. 3

Breadth First Search, Depth First Search, Iterative Deepening, Uniform Cost Search, Hill Climbing, Simulated Annealing, Genetic Algorithm Search, Heuristic Search, Best First Search, A* Algorithm, AO* Algorithm, MinmaxAnd Game Trees, Refining Minmax, Alpha – Beta Pruning, Constraint Satisfaction.

Unit No.4:

First Order Predicate Calculus, Resolution, Unification, Natural Deduction System, Refutation, Logic Programming, PROLOG, Semantic Networks, Frame System, Value Inheritance, Conceptual Dependency, Ontologies.

Unit No. 5:

Basic Representation for Planning, Symbolic-Centralized vs. Reactive-Distributed, Partial Order Planning Algorithm.

Unit No. 6:

Different Types of Uncertainty - Degree of Belief And Degree of Truth, Various Probability Constructs - Prior Probability, Conditional Probability, Probability Axioms, Probability Distributions, and Joint

Probability Distributions, Bayes' Rule, Other Approaches to Modeling Uncertainty Such as Dempster-Shafer Theory and Fuzzy Sets/Logic.

Unit No. 7:

Component Steps of Communication, Contrast Between Formal and Natural Languages in The Context Of Grammar, Parsing, and Semantics

Reference Books:

1. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach (2nd ed.), Pearson Education, 2006.

Databases, Data Mining & Information Retrieval

Unit No 1: Databases

Introduction to Database Management Systems

Unit No 2: Entity-Relationship Model (including UML introduction): Introduction to Conceptual Modeling, ER Modeling

Unit No 3: Relational Model:

Concepts, Constraints, Languages, Design, Programming and Relational Calculus, Relational Languages like SQL (including JDBC for database connectivity, ODBC,JDBC and SQLJ), SQL, Data Manipulation, Data Definition, SQL, Advanced SQL, Other Relational Languages, Embedded SQL and Dynamic SQL.

Unit No 4:Integrity and Security:

Constraints and User privileges in databases in general and in specific to Oracle, Relational Database Design, Functional Dependencies, Lossless and Dependency, Preserving Decomposition and Normalization (1NF,

2NF, 3NF, BCNF and 4NF), Application Design and Development, Object oriented and Object Relational Database

Unit No 5: File Storage Methods:

File Storage Methods, Indexing and Hashing.

Unit No 6: Query Optimization:

Query Processing and Query Optimization.

Unit No 7: Transaction Management:

Transaction Concepts, Concurrency Control, Database Recovery Techniques

Unit No 8: Database System Architecture:

Database System Architecture, Parallel databases and Distributed databases

Unit No 9: Data warehousing Information Retrieval and Data Mining:

Data Warehouse Architecture, Data Warehouse Business Requirements, Data Warehouse Design, Dimensional Modeling, Advanced Issues in Dimensional Modeling, ETL, Information Access & Delivery, OLAP, Web & Business Strategy, Data Mining Strategies, Model Evaluation Techniques,k-Nearest Neighbour Algorithm, Decision Trees, Association Rules, Fraud Detection, Neural Networks, Knowledge Discovery of Databases, Web Mining.

Reference Text Book(s):

Silberschatz, Korth and Sudarshan, “Database System Concepts”, 5th Edition, 2006, McGraw Hill Jiawei Han, MichelineKamber, “Data Mining, Concepts and Techniques” 2nd Edition, Morgan Kaufmann Publishers, 2006

Ralph Kimball, Margy Ross, “The Data Warehouse Toolkit”, 2nd Edition, Wiley, 2002 Inmon, “Building the DataWarehouse”, 4th Edn., Wiley, 2005 Linoff and Berry, “Data Mining Techniques”, 3rd Edn., Wiley, 2011

Data Mining Lab

Data mining - introduction , association rules mining - basics , naïve algorithm , apriori algorithm , direct hashing and pruning(DHP) , Dynamic Itemset counting(DIC) , Mining frequent pattern without candidate generation(FP-growth), performance evaluation of algorithms , software for association rule mining;

Classification – introduction , decision tree , tree induction algorithm – split algorithm based on information theory , split algorithm based on Gini index; naïve bayes method; estimating predictive accuracy of classification method; classification software;

Cluster analysis – introduction ,partitional methods , hierrarchical methods , density- based methods , dealing with large databases ,cluster software;

Laboratory work:

Implementation of association rule mining algorithm – naïve ,apriori , direct hashing and pruning , dynamic itemset counting , mining without candidate generation(FP- growth) , performance evaluation of algorithms ; classification algorithm –tree induction algorithm –based on information theory and Ginni index , bayesian method, estimating predictive accuracy of classification methods; cluster analysis method – K-means method, hierarchical method; Usage of any data mining software;

Text Book(s):

Jiawei Han, MichelineKamber, “Data Mining, Concepts and Techniques” 2nd Edition, Morgan Kaufmann , Publishers, 2006

3. Image Information Processing Research Group

Digital Image Processing

Unit No 1: Introduction to Digital Image Processing

Introduction to images and its processing, Components of image processing systems, image representations and formations, Image file formats, Applications of digital image processing, image sampling and quantization, Image Analysis, Intensity transformations, contrast stretching, Correlation and convolution, Smoothing filters, sharpening filters, gradient and Laplacian.

Unit No 2: Image Transformation Techniques

Need for transform, Fourier, Cosine transforms, Haar, KL Transform, Singular value decomposition, Wavelet transform, Different properties of image transform techniques.

Unit No 3: Image Compression Basics

Concept of image compression, lossless techniques (Huffman Coding, Arithmetic and Lempel-Ziv Coding, Other Coding Techniques) and lossy compression techniques (Transform Coding & K-L Transforms, Discrete Cosine Transforms, and BTC), Multi-Resolution Analysis, and Still Image Compression Standards (JBIG, JPEG, JPEG 2000)

Unit No 4: Image Enhancement

Enhancement in spatial and transform domain, histogram equalization DirectionalSmoothing, Median, Geometric mean, Harmonic mean, Contraharmonic mean filters, Homomorphic filtering,Color image enhancement.

Unit No 5: Image Restoration and Denoising

Image degradation, Type of image blur, Classification of image restoration techniques, ,image restoration model, Linear and non linear restoration techniques, Image denoising, Median filtering

Unit No 6: Image Segmentation

Classification of image segmentation techniques, Boundary detection based techniques, Point, line detection, Edge detection, Edge linking, local processing, regional processing, Hough transform, Thresholding, Iterative thresholding, Otsu's method, Moving averages, Multivariable thresholding, Region-based segmentation, Watershed algorithm, Use of motion in segmentation

Unit No 7: Binary and Color image processing

Binarization, Basic Set theory, Binary morphological operations and its properties, Color Image Representation in MATLAB, Converting Between Color Spaces, The Basics of Color Image Processing, Color Transformations, Spatial Filtering of Color Images, Working Directly in RGB Vector Space

Unit No 8: Image Processing Applications: Case studies

Suggested Resources

1. Digital Image Processing, R.C. Gonzalez and R.E. Woods, 2nd edition, Pearson Prentice Hall, 2008

2. Anil K. Jain, Fundamentals of Digital Image Processing, Prentice Hall, 1989.

3. Digital Image processing, S Jayaraman, TMH, 2012

4. William K. Pratt, Digital Image Processing, 3rd Edition, John Wiley, 2001.

Computer Graphics

Unit No 1: Introduction

Computer graphics Hardware and Software, Introduction to OpenGL, Display-Window Management Using GLUT, Graphics Output Primitives, Attributes of Graphics Primitives.

Unit No 2: Algorithms

Line-Drawing Algorithms, Parallel Line Algorithms, Setting Frame-Buffer Values, Circle- Generating Algorithms, Midpoint Circle Algorithm, Ellipse-Generating Algorithms, Parallel Curve Algorithms, Pixel Addressing and Object Geometry, General Scan-Line Polygon-Fill Algorithm, Scan-Line Fill of Convex Polygons, Scan-Line Fill for Regions with Curved Boundaries, Boundary-Fill and Flood-Fill Algorithm.

Unit No 3: 2D Geometric Transformations and Viewing

Basic Two-Dimensional Geometric Transformations, Matrix Representations and Homogeneous Coordinates, Inverse Transformations, Two-Dimensional Composite Transformations, Raster Methods for Geometric Transformations, OpenGL Raster Transformations, OpenGL Functions for Two-Dimensional, The Two-Dimensional Viewing Pipeline, Normalization and Viewport Transformations, OpenGL Two- Dimensional Viewing Functions, Clipping Algorithms, Point Clipping, Line Clipping Curve Clipping, Text Clipping.

Unit No 4: 3D Geometric Transformations and Viewing

3D Translation and rotation, 3D scaling, Composite 3D transformations, OpenGL Geometric-Transformation Functions, 3D viewing concepts and pipeline, Coordinate parameters, Projection Transformations, Orthogonal Projections, Oblique Parallel Projections, Perspective Projections, OpenGL 3D Viewing Functions and Clipping algorithms.

Unit No 5: Computer Animation

Raster Methods for Computer Animation, Animation sequences and techniques, Motion Specifications, Character Animation, Periodic Motions, Polyhedra, OpenGL Polyhedron Functions, Curved Surfaces, Quadric Surfaces.

Unit No 6: Spline Representations

Interpolation and Approximation Splines, Parametric Continuity Conditions, Geometric Continuity Conditions, Spline Specifications, Spline Surfaces, Trimming Spline Surfaces, Cubic-Spline Interpolation Methods, B-Spline Surfaces, Rational Splines,

Unit No 7: Surface rendering and Surface-detail methods

Surface Lighting Effects, Basic Illumination Models, Transparent Surfaces, Shadows, Polygon Rendering Methods, OpenGL Illumination and Surface-Rendering Functions, Modeling Surface Detail with Polygons, Texture Mapping, Bump Mapping, Frame Mapping, OpenGL Texture Functions,

Unit No 8: Global Illumination and Programmable Shaders

Ray-Tracing Methods, Radiosity Lighting Model, Environment Mapping, Photon Mapping, Shading Languages, The OpenGL Pipeline, The OpenGL Shading Language, Shader Effects

Reference Books:

1. Computer Graphics with Open GL, 4th ed., Hearn and Baker, Prentice hall,

Pearson, 2011.

Image Processing Algorithms/Techniques (To Be Conducted as a Lab Examination)

Unit No 1: Image Transformation Techniques

Implementation of discrete Fourier transform (DFT) , discrete Cosine transforms (DCT), Haar, KL Transform, Singular value decomposition (SVD), Wavelet transforms using image databases/standard images

Unit No 2: Lossy and lossless Image Compression Techniques

Huffman Coding, Arithmetic and Lempel-Ziv Coding, K-L Transforms, Discrete Cosine Transforms (DCT), and Block Truncation Coding (BTC), Wavelet compression, and detail study of Still Image Compression Standards (JBIG, JPEG, JPEG 2000)

Unit No 3: Image Enhancement algorithms

Histogram equalization, DirectionalSmoothing, Median, Geometric mean, Harmonic mean, Contraharmonic mean filters, Homomorphic filtering,Color image enhancement.

Unit No 4: Image Restoration and Denoising algorithms

Implement image restoration techniques, Linear and non linear restoration techniques, Image denoising techniques, Median filtering

Unit No 5: Image Segmentation algorithms

Boundary detection based techniques, Point, line detection, Edge detection, Edge linking, local processing, regional processing, Hough transform, Thresholding, Iterative thresholding, Otsu's method, Moving averages, Multivariable thresholding, Region-based segmentation, Watershed algorithm, Use of motion in segmentation

Unit No 6: Binary and Color image processing algorithms

Binarization, Basic Set theory, Binary morphological operations and its properties, Color Image Representation in MATLAB, Converting between Color Spaces, The Basics of Color Image Processing, Color Transformations, Spatial Filtering of Color Images, Working Directly in RGB Vector Space

Unit No 7: Image Processing Applications:

Case studies and work on standard image/medical databases

Major References

1. Digital Image Processing using MATLAB, R.C. Gonzalez and R.E. Woods, 2nd edition, Pearson Prentice Hall, 2008

2. Algorithms for Image Processing and Computer Vision, 2nd ed., J. R. Parker, Wiley.

4.Parallel and Distributed Computing Research Group

Parallel and Distributed Computing

Unit No 1: Basics

Parallel Programming Platforms, Principles of Parallel Algorithm Design ,Analytical Modeling of Parallel Programs, Basic Communication Operations.

Unit No 2: Parallel Programming

Parallel Programming Paradigms, Programming Shared Address Space Platforms, Programming Message Passing Platforms.

Unit No 3:Parallel Algorithms and Applications.

Dense Matrix Algorithms, Sorting, Graph Algorithms, Discrete Optimization Problems Dynamic Programming, Fast Fourier Transform, Solving Sparse Systems of Linear Equations.

Reference Books:

“An Introduction to Parallel Computing : Design and Analysis of Algorithms 2 Edition”, Vipin Kumar, AnanthGrama, Anshul Gupta, George Karypis

Advanced Data Structures (To Be Conducted as a Lab Examination)

Unit No 1:

Physical organisation of Databases, Index Trees (BST, IBST, TBST, AVL, B Tree, B+ Tree, B* Tree) , Files, Hashing, integration and applications

Unit No 2:

Decision Trees, Game trees, BFS, DFS, DLS, Min-Max and alpha-beta pruning search strategies

Unit No 3:

Set, Dictionary, Priority Queue, Tries, Heaps, integration and applications Algorithmic Thinking, Analysis and Design of Algorithms: Divide and Conquer, Greedy Approach, Dynamic Programming, Introduction to Intractable Problems.

Unit No 4:

Graph representation and algorithms, integration and applications

Unit No 5:

Domain specific Data structures : Case studies

Reference Book:

Corman et al: Introduction to Algorithms, 3rd Edn., 2009”

Operating Systems

Unit No 1: Computer System Overview

Basic Elements, Processor Registers, Instruction Execution, Interrupts, The Memory Hierarchy, Cache Memory, I/O Communication Techniques,

Unit No 2: Operating System Overview

Operating System Objectives and Functions, The Evolution of Operating Systems, Characteristics of Modern Operating Systems, Windows Vista Overview, Traditional UNIX Systems, Modern UNIX Systems, Linux.

Unit No 3: Process Description and Control

Process, Process States, Process Description, Process Control, UNIX FreeBSD, Process Management

Unit No 4: Threads, SMP, and Microkernels

Processes and Threads, Symmetric Multiprocessing (SMP), Microkernels WindowsVista Thread and SMP Management, Solaris Thread and SMP Management, Linux Process and Thread Management

Unit No 5: Concurrency: Mutual Exclusion and Synchronization

Principles of Concurrency, Mutual Exclusion: Hardware Support, Semaphores, Monitors Message Passing, Readers/Writers Problem.

Unit 6: Concurrency: Deadlock and Starvation

Principles of Deadlock, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, An Integrated Deadlock Strategy, Dining Philosophers Problem, UNIX Concurrency, Mechanisms, Linux Kernel Concurrency Mechanisms, Solaris Thread Synchronization Primitives, Windows Vista Concurrency Mechanisms.

Unit No 7: Memory Management

Memory Management Requirements, Memory Partitioning, Paging, Segmentation

Unit No 8: Virtual Memory

Hardware and Control Structures, Operating System Software, UNIX and Solaris, Memory Management, Linux Memory Management, Windows Vista Memory Management

Unit No 9: Uniprocessor Scheduling

Types of Scheduling, Scheduling Algorithms, Traditional UNIX Scheduling

Unit No 10: Multiprocessor and Real-Time Scheduling

Multiprocessor Scheduling, Real-Time Scheduling, Linux Scheduling, UNIX FreeBSD Scheduling, Windows Vista Scheduling

Unit No 11: I/O Management and Disk Scheduling

I/O Devices, Organization of the I/O Function, Operating System Design Issues, I/O Buffering, Disk Scheduling, RAID, Disk Cache, UNIX FreeBSD I/O, Linux I/O, Windows Vista I/O.

Unit No 12: File Management

Overview, File Organization and Access, File Directories, File Sharing, Record Blocking, Secondary Storage Management, UNIX File Management, Linux File Management, Windows Vista File System

Text Book:

"Operating Systems: Internals and Design Principles, 6/E"

5.Software Engineering & Information Systems Research Group

Advanced Data Structures (To Be Conducted as a Lab Examination)

Unit No 1:

Physical organisation of Databases, Index Trees (BST, IBST, TBST, AVL, B Tree, B+ Tree, B* Tree) , Files, Hashing, integration and applications

Unit No 2:

Decision Trees, Game trees, BFS, DFS, DLS, Min-Max and alpha-beta pruning search strategies

Unit No 3:

Set, Dictionary, Priority Queue, Tries, Heaps, integration and applications Algorithmic Thinking, Analysis and Design of Algorithms:

Divide and Conquer, Greedy Approach, Dynamic Programming, Introduction to Intractable Problems.

Unit No 4:

Graph representation and algorithms, integration and applications

Unit No 5:

Domain specific Data structures : Case studies

Reference Book:

Corman et al: Introduction to Algorithms, 3rd Edn., 2009”

Introduction to Algorithms

Unit No 1:

Physical organisation of Databases, Index Trees (BST, IBST, TBST, AVL, B Tree, B+ Tree, B* Tree) , Files, Hashing, integration and applications

Unit No 2:

Decision Trees, Game trees, BFS, DFS, DLS, Min-Max and alpha-beta pruning search strategies

Unit No 3:

Set, Dictionary, Priority Queue, Tries, Heaps, integration and applications Algorithmic Thinking, Analysis and Design of Algorithms: Divide and Conquer, Greedy Approach, Dynamic Programming, Introduction to Intractable Problems

Unit No 4:

Graph representation and algorithms, integration and applications

Unit No 5:

Domain specific Data structures : Case studies

Reference Book:

Corman et al: Introduction to Algorithms, 3rd Edn., 2009”

Advanced Software Engineering

Unit No 1:

Review of Software Engineering, Software Product, Process Improvement Framework

Unit No 2:

Software Process Models, Software Engineering Practice, Requirements Engineering, Design Engineering.

Unit No 3:

Software Architecture, Component based Software Engineering, User Interface Design

Unit No 4:

Software Construction, Software Verification, Validation & Testing, Software Metrics and Cost Estimation

Unit No 5:

Software Project Management, Design Patterns & Agile Software Development, Application Frameworks, Aspect Oriented Software Development, Service Oriented Architecture

Reference Book:

R.S. Pressman, “Software Engineering: A Practitioner's Approach”, 7th Edition, McGraw Hill, 2010

6. Algorithms Research Group

Data Structures and Algorithms (To Be Conducted as a Lab Examination)

Unit No 1:Introduction to Data Structures:

Abstract Data Type (ADT), Arrays and Strings, Structures, Recursion, Pointers, Dynamic memory allocation.

Unit No 2: Algorithm Design:

Scalability, Introduction to Complexity Analysis, Big O Notation, Relationship between time complexity and hardware performance.

Unit No 3: Linked Lists:

ADT type, Linear List , Linear Linked list, doubly linked list, circular linked list, header Linked list, various implementations and applications of Linked Lists.

Unit No 4: Stack:

ADT type, specifications, array based and linked list based, recursion and its removal with stack, stack as buffer, searching, matching, integration and other applications, managing multiple stacks, various implementations and applications of Stacks.

Unit No 5: Queues:

ADT type, array based and linked list based,, queue as buffer, searching, Circular queues, Deque, Managing multiple queues, , various implementations and applications of Queues.

Unit No 6: Binary Trees:

Introduction to non-linear data structures, ADT type, array based and linked list based, binary tree, binary search tree, AVL tree, tree traversal, various implementations and applications of Trees.

Unit No 7: Sorting Algorithms:

Bubble Sort, Selection Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort, Shell Sort, Radix Sort, various implementations and applications of Sorting.

Unit No 8: Searching, Hashing, Graphs:

Linear and Binary Search, Hash table, Various implementations and applications of Searching and Hashing, Graphs ADT type, array based and linked list based, graph traversal algorithms i.e. Breadth First & Depth First, various implementations and applications of graphs.

Theory of Computation

Unit No 1:

Introduction & Motivation, Infinite Sets, Closures, Alphabets, Languages & Representation,

Unit No 2:

Deterministic finite automata, Non-Deterministic finite automata, Closure Properties & Equivalences, Regularity, State Minimization, Moore and Mealy Machine,

Unit No 3:

Context Free Grammars, Parse Trees & Ambiguity, Chomsky and Greibach Normal Forms, Push Down Automata, Equivalence of PDA and CFG, Properties of Context Free Languages, Determinism & Parsing DCFG, Top-down & Bottom-up Parsing,

Unit No 4:

Turing Machine-Introduction, Turing Machine-Notations, Recursive and Recursively Enumerable Language, Extensions of Turing machines, Random Access Turing machines, Non-deterministic Turing machines, Grammars, Primitive Recursive

Functions, Mu-recursive functions, Church-Turing Thesis & Universal Turing machines, Halting problem, Undecidable problems,

Unit No 5:

Properties of Recursive languages, The Complexity Class P, Satisfiability, The Complexity Class NP, NP Completeness and Reducibility NP complete problems, Cook's Theorem, NP Complete Problems.

Parallel Algorithms

Unit No 1:

Sequential model, need of alternative model, parallel computational models such as PRAM, LMCC, Hypercube, Cube Connected Cycle, Butterfly, Perfect Shuffle Computers, Tree model, Pyramid model, Fully Connected model, PRAM-CREW, EREW models, simulation of one model from another one.

Unit No 2:

Performance Measures of Parallel Algorithms, speed-up and efficiency of PA, Cost optimality, An example of illustrate Cost-optimal algorithms- such as summation, Min/Max on various models.

Unit No 3:

Parallel Sorting Networks, Parallel Merging Algorithms on CREW/EREW/MCC/, Parallel Sorting Networks on CREW/EREW/MCC/, linear array

Unit No 4:

Parallel Searching Algorithm, Kth element, Kth element in X+Y on PRAM, Parallel Matrix Transportation and Multiplication Algorithm on PRAM, MCC, Vector-Matrix Multiplication, Solution of Linear Equation, Root finding.

Unit No 5:

Graph Algorithms - Connected Graphs, search and traversal, Combinatorial Algorithms- Permutation, Combinations, Derrangements.

Reference Text Books:

Michael J. Quinn Parallel Programming in C with MPI and OpenMP, McGraw Hill Higher Education, 2003

7. Computer Systems Architecture Research Group

Cloud Computing

Unit No 1: Introduction

Introduction to cloud computing, history of cloud computing, characteristics of cloud computing, types of cloud, SaaS, PaaS, IaaS, cloud providers, advantages and disadvantages of cloud computing, challenges and risks of cloud computing, cloud applications

Unit No 2: Enabling Technologies of Cloud Computing

Virtualization, hypervisors, map-reduce, Hadoop, web services- RPC, SOA, REST, Mashup

Unit No 3: Cloud Computing Architecture

Cloud computing stack, Service Models (XaaS)-Infrastructure as a Service(IaaS), Platform as a Service(PaaS), Software as a Service(SaaS), Deployment Models- Public cloud, Private cloud, Hybrid cloud, Community cloud

Unit No 4: Cloud Security

Infrastructure security, data security and storage, identity and access management, security management in cloud, privacy, audit and compliance

Unit No 5: Cloud Management and Case Study

Administrating the cloud, cloud management products, emerging cloud management standards

Reference Books:

1. Cloud Computing Bible, Barrie Sosinsky, Wiley-India, 2010

2. Cloud Computing: Principles and Paradigms, Editors: RajkumarBuyya, James Broberg, Andrzej M. Goscinski, Wile, 2011

3. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Tim Mather, SubraKumaraswamy, ShahedLatif, O'Reilly Media, 2009

4. Cloud Computing: Principles, Systems and Applications (Computer Communications and Networks), Editors: Nikos Antonopoulos, Lee Gillam, Springer, 2010

Computer Network Programming (To Be Conducted as a Lab Examination)

Unit No. 1: Introduction and TCP/IP

Introduction, A Simple Daytime Client, Protocol Independence, Error Handling: Wrapper Functions, A Simple Daytime Server, Road Map to Client-Server Examples in the Text, OSI Model, BSD Networking History, Test Networks and Hosts, Unix Standards, 64-bit Architectures

Unit No. 2: The Transport Layer: TCP and UDP

Introduction, UDP, TCP, Stream Control Transmission Protocol, TCP Connection Establishment and Termination, TIME_WAIT State, SCTP Association Establishment and Termination, Port Numbers, TCP Port Numbers and Concurrent Servers, Buffer Sizes and Limitations, Standard Internet Services, Protocol Usage by Common Internet Applications

Unit No. 3: Sockets Introduction

Introduction, Socket Address Structures, Value-Result Arguments, Byte Ordering Functions, Byte Manipulation Functions, inet_aton, inet_addr, and inet_ntoa Functions, inet_pton and inet_ntop Functions, sock_ntop and Related Functions, readn, writen, and readline Functions

Unit No.4: Elementary TCP Sockets

Introduction, Socket Function, Connect Function, Bind Function, Listen Function, Accept Function, Fork, Exec Functions, Concurrent Servers, Close Function, Getsockname, Get peername Functions

Unit No. 5: TCP Client-Server Example

Introduction, TCP Echo Server: main Function, Str_echo Function, TCP Echo Client: main Function, Str_cli Function, Normal Startup, Normal Termination, Posix Signal Handling, Handling SIGCHLD Signals, Wait and waitpid Functions, Connection Abort before accept Returns, Termination of Server Process, SIGPIPE Signal, Crashing of Server Host, Crashing and Rebooting of Server Host, Shutdown of Server Host

Unit No. 6: I/O Multiplexing: The select and poll Functions

Introduction, I/O Models, Select Function, Str_cli Function, Batch Input', Shutdown Function, Str_cli Function, TCP Echo Server, Pselect Function, Poll Function, TCP Echo Server

Unit No. 7: Socket Options

Introduction, Getsockopt, Setsockopt Functions, Checking If an Option Is Supported and Obtaining the Default, Socket States, Generic Socket Options, IPv4 Socket Options, ICMPv6 Socket Option, IPv6 Socket Options, TCP Socket Options, SCTP Socket Options, Fcntl Function

Unit No. 8: Elementary UDP Sockets

Introduction, Recvfrom, Sendto Functions, UDP Echo Server: main Function, Dg_echo Function, UDP Echo Client: main Function, Dg_cli

Function, Lost Datagrams, Verifying Received Response, Server Not Running, Connect Function with UDP, Dg_cli Function, Lack of Flow Control with UDP, Determining Outgoing Interface with UDP, TCP and UDP Echo Server Using select

Unit No. 9: Elementary SCTP Sockets

Introduction, Interface Models, sctp_bindx Functions, sctp_connectx Function, sctp_getpaddrs Function, sctp_freepaddrs Function, sctp_getladdrs Function, sctp_freeladdrs Function, sctp_sendmsg Function, sctp_recvmsg Function, sctp_opt_info Function, sctp_peeloff Function, shutdown function

Unit No. 10: SCTP Client/ Server Example

Introduction, SCTP One-to-Many-Style Streaming Echo Server & client: main function SCTP Streaming Echo Client: str_cli Function, Exploring Head-of-Line Blocking, Controlling the Number of Streams, Controlling Termination

Unit No. 11: Name and Address Conversions

Introduction, Domain Name System (DNS), gethostbyname Function, gethostbyaddr Function, getservbyname and getservbyport Functions, getaddrinfoFuncation, gai_strerror Functions, freeaddrinfo Function, getaddrinfo Function: IPv6, getaddrinfo Function: Examples, host_serv Function, tcp_connect Function, tcp_listen Function, udp_client Function, udp_connect Function, udp_server Function, Re-entrant Function, gethostbyname_r and gethostbyaddr_f Function, Obsolete IPv6 Address Lookup Function

Reference Book:

1. Unix Network Programming, Volume 1, Third Edition, “W. Richard Stevens, Bill Fenner, Andrew M. Rudoff”

Computer Architecture

Unit No 1:

Introduction, Classes of Computers, Defining Computer Architecture, Trends in Technology, Trends in Power in Integrated Circuits, Trends in Cost, Dependability, Measuring, Reporting, and Summarizing Performance, Quantitative Principles of Computer Design, Putting It All Together: Performance and Price- Performance, Fallacies and Pitfalls, Concluding Remarks, Historical Perspectives and References, Case Studies with Exercises.

Unit No 2:

Instruction-Level Parallelism: Concepts and Challenges, Basic Compiler Techniques for Exposing ILP, Reducing Branch Costs with Prediction,Overcoming Data Hazards with Dynamic Scheduling,Dynamic Scheduling: Examples and the Algorithm,Hardware-Based Speculation,Exploiting ILP Using Multiple Issue and Static Scheduling,Exploiting ILP Using Dynamic Scheduling, Multiple Issue, and Speculation, Advanced Techniques for Instruction Delivery and Speculation Putting It All Together: The Intel Pentium 4, Fallacies and Pitfalls, Concluding Remarks, Historical Perspective and References, Case Studies with Exercises.

Unit No 3:

Studies of the Limitations of ILP, Limitations on ILP for Realizable Processors, Crosscutting Issues: Hardware versus Software Speculation, Multithreading: Using ILP Support to Exploit Thread-Level Parallelism, Putting It All Together: Performance and Efficiency in Advanced Multiple-Issue Processors, Fallacies and Pitfalls, Concluding Remarks, Historical Perspective and References, Case Study with Exercises.

Unit No 4:

Symmetric Shared-Memory Architectures, Performance of Symmetric Shared-Memory Multiprocessors, Distributed Shared Memory and Directory-Based Coherence, Synchronization: The Basics, Models of Memory Consistency: An Introduction, Crosscutting Issues, Putting It All Together: The Sun T1 Multiprocessor, Fallacies and Pitfalls, Concluding Remarks, Historical Perspective and References,Case Studies with Exercises.

Unit No 5:

Eleven Advanced Optimizations of Cache Performance,Memory Technology and Optimizations, Protection: Virtual Memory and Virtual Machines, Crosscutting Issues: The Design of Memory Hierarchies, Putting It All Together: AMD Opteron Memory Hierarchy, Fallacies and Pitfalls, Concluding Remarks, Historical Perspective and References,Case Studies with Exercises.

Unit No 6:

Advanced Topics in Disk Storage, Definition and Examples of Real Faults and Failures, I/O Performance, Reliability Measures, and Benchmarks, A Little Queuing Theory, Crosscutting Issues, Designing and Evaluating an I/O System—The Internet Archive Cluster, Putting It All Together: NetApp FAS6000 Filer, Fallacies and Pitfalls, Concluding Remarks, Historical Perspective and References,Case Studies with Exercises.

Reference Text Book

Computer Architecture: A Quantitative Approach (The Morgan Kaufmann Series in Computer Architecture and DesignJohn L. Hennessy , David A. Patterson

8.Wireless Sensor and Advance Computer Networks Research Group

Wireless Sensor Networks Protocols and Applications

Unit-1: Introduction and Overview:

Challenges in WSN, Why are sensor networks different, enabling technologies for wireless sensor networks (WSNs)

Unit-2: WSN Single Node Architecture:

WSN Hardware Components, Energy Consumption of sensor nodes, Operating systems and execution environments, some examples of sensor nodes

Unit-3: Network Architectures:

Sensor Network scenario, Optimization goals and figure of merit, Design Principles for WSNs, Service interfaces of WSNs, Gateway Concepts

Unit-4: Communication Protocols:

Introduction to Physical Layer, WSN Channel and communication fundamentals, Physical Layer and Transceiver design considerations in WSNs.

Unit-5: MAC protocols:

Fundamentals of MAC Protocols, Contention based protocols, schedule based protocols, IEEE 802.15.4 MAC protocol.

Unit 6: Link Layer Protocols:

Fundamentals, tasks and requirements, Error Control, Framing and Link Management.

Unit-7: Naming and Addressing:

Fundamentals, Address and Name management in WSN, Assignment of MAC addresses, Content based and geographic addressing

Unit-8: Time Synchronization:

Time Synchronization problem, Protocols based on sender/ receiver synchronization, Protocols based on receiver/ receiver synchronization

Unit-9: Localization and Positioning:

Properties of Localization and Positioning, Single hop localization and Positioning in multi-hop environments.

Unit-10: Routing Protocols:

Energy efficient unicast, broadcast and multicast, geographic routing, mobile nodes.

Reference Books:

1. Protocols and Architectures for Wireless Sensor Networks,Holger Karl, Technical University of Berlin Andreas Willig, University of Potsdam ,Wiley, ISBN: 0-470-09510-5, June 2005

2. Wireless Sensor Networks,Cauligi S. Raghavendra, University of Southern California Krishna Sivalingam, University of Maryland Baltimore County ,Taieb M. Znati, University of Pittsburg ,Springer, ISBN: 1-4020-7883-8, August 2005

Wireless Adhoc and Sensor Networks

Unit 1: Mobile Adhoc Networks (MANET):

Introduction, Self-organizing behaviour, Co-operation in MANET

Unit 2: MANET Protocols:

MAC Protocols Introduction, Categories of MAC Protocols, Routing Types in MANET, Role of Routing in MANET

Unit 3: MANET Models:

MANET Multicast routing, Mobility model, Transport layer, Opportunistic Mobile Networks

Unit 4: Opportunistic Mobile Networks in MANET:

Introduction to Opportunistic Mobile Networks in MANET, Requirements of Opportunistic Mobile Networks in MANET, UAV networks, Wireless Sensor Networks

Unit 5: WSN and MANET:

Introduction to WSN, WSN and MANET, Coverage, Topology management, Mobile Sensor Networks

Unit 6: WSN Medium Access Control:

Introduction to MAC, Congestion control, Routing in WSN

Unit 7: Congestion and Flow Control in WSN:

Issues with the Routing, Congestion and Flow Control in WSN, Underwater WSN

Unit 8: Advanced Topics:

Security in WSN, Structure of sensor nodes, Hardware Design of Sensor Node, Real Life Deployment in WSN.

References:

1. Principles of Wireless Sensor Networks, Book by Mohammad S. Obaidat and SudipMisra, Cambridge University Press.

2. NPTEL Course: http://nptel.ac.in/courses/106105160/21

Computer Network Programming (To Be Conducted as a Lab Examination)

Unit No. 1: Introduction and TCP/IP

Introduction, A Simple Daytime Client, Protocol Independence, Error Handling: Wrapper Functions, A Simple Daytime Server, Road Map to Client-Server Examples in the Text, OSI Model, BSD Networking History, Test Networks and Hosts, Unix Standards, 64-bit Architectures

Unit No. 2: The Transport Layer: TCP and UDP

Introduction, UDP, TCP, Stream Control Transmission Protocol, TCP Connection Establishment and Termination, TIME_WAIT State, SCTP Association Establishment and Termination, Port Numbers, TCP Port Numbers and Concurrent Servers, Buffer Sizes and Limitations, Standard Internet Services, Protocol Usage by Common Internet Applications

Unit No. 3: Sockets Introduction

Introduction, Socket Address Structures, Value-Result Arguments, Byte Ordering Functions, Byte Manipulation Functions, inet_aton, inet_addr, and inet_ntoa Functions, inet_pton and inet_ntop Functions, sock_ntop and Related Functions, readn, writen, and readline Functions

Unit No.4: Elementary TCP Sockets

Introduction, Socket Function, Connect Function, Bind Function, Listen Function, Accept Function, Fork, Exec Functions, Concurrent Servers, Close Function, Getsockname, Get peername Functions

Unit No. 5: TCP Client-Server Example

Introduction, TCP Echo Server: main Function, Str_echo Function, TCP Echo Client: main Function, Str_cli Function, Normal Startup, Normal Termination, Posix Signal Handling, Handling SIGCHLD Signals, Wait and waitpid Functions, Connection Abort before accept Returns, Termination of Server Process, SIGPIPE Signal, Crashing of Server Host, Crashing and Rebooting of Server Host, Shutdown of Server Host

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Introduction, I/O Models, Select Function, Str_cli Function, Batch Input', Shutdown Function, Str_cli Function, TCP Echo Server, Pselect Function, Poll Function, TCP Echo Server

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Unit No. 8: Elementary UDP Sockets

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Unit No. 9: Elementary SCTP Sockets

Introduction, Interface Models, sctp_bindx Functions, sctp_connectx Function, sctp_getpaddrs Function, sctp_freepaddrs Function, sctp_getladdrs Function, sctp_freeladdrs Function, sctp_sendmsg Function, sctp_recvmsg Function, sctp_opt_info Function, sctp_peeloff Function, shutdown function

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1. Unix Network Programming, Volume 1, Third Edition, “W. Richard Stevens, Bill Fenner, Andrew M. Rudoff”