Syllabus of M.Tech.(CSE) (2014 onward)
SEMESTER – 1

Course No.	**Course Name**	**L-T-P-C**
CS501	Advanced data structure and algorithms	3-0-0-6
CS502	Mathematics for Computer Science	4-0-0-8
CS503	Computer Systems & Networks	3-0-0-6
CSxxx	Elective – 1	3-0-0-6
CS511	Programming Lab	0-0-3-3
	Total	**13-0-3-29**

SEMESTER – 2

Course No.	**Course Name**	**L-T-P-C**
CS504	Theory of Computation	3-0-0-6
CSxxx	Elective – 2	3-0-0-6
CSxxx	Elective – 3	3-0-0-6
CSxxx	Elective – 4	3-0-0-6
CS512	Computer System Lab	0-0-3-3
	Total	**12-0-3-27**

SEMESTER – 3

Course No	**Course Name**	**L-T-P-C**
CS611	Thesis	0-0-24-24
	Total	**0-0-24-24**

SEMESTER – 4

Course No	**Course Name**	**L-T-P-C**
CS612	Thesis	0-0-24-24
	Total	**0-0-24-24**

Total Credit = 104

Department Electives

Course ID	**Course Name**	**Credit**
CS 521	Parallel algorithms	6
CS 522	Computational geometry	6
CS 523	Structural complexity	6
CS 524	Hierarchial memory algorithm	6
CS 525	Logic in computer science	6

CS 526	Optimization methods	6
CS 527	Computation number theory & cryptography	6
CS 528	Information & randomness	6
CS 529	Learning with Kernals	6
CS 530	Computational topology	6
CS 531	Advanced computer architecture	6
CS 532	Formal methods for system verification	6
CS 533	Semantics for programming languages	6
CS 534	Functional & logic programming	6
CS 535	Advanced compilers	6
CS 536	Advanced operating systems	6
CS 537	Distributed systems	6
CS 538	Information transmission & security	6
CS 539	Topics in networks	6
CS 540	Web development technologies	6
CS 541	Computer & network security	6
CS 542	Wireless networks	6
CS 543	Internet protocols	6
CS 544	Wireless sensor networks	6
CS 545	Linux Kernals: Implementation & security	6
CS 546	Enterprise systems	6
CS 547	Performance modelling of communication & computer systems	8
CS 548	Artificial intelligence	6
CS 549	Machine learning	6
CS 550	Principles of robotics	6
CS 551	Intelligences systems & interfaces	6
CS 552	Pattern recognition	6
CS 553	Data mining	6
CS 554	Multimedia systems	6
CS 555	Fundamental of information retrieval	8

CS 556	Human computer interaction	8
CS 557	Computational system biology	6
CS 558	Digital Watermarking	6
CS 559	Steganography	6
CS 560	Digital Image Processing	6
CS 562	Mobile robotics	6
CS563	Video Processing	6
CS564	Natural Language Processing	6
CS565	Cloud Computing	6
CS566	Big Data	6

CS501 ADVANCED DATA STRUCTURES & ALGORITHMS 3-0-0-6

Pre-requisites : CS205

Syllabus : Performance of algorithms: space and time complexity, asymptotics; Fundamental Data structures: linked lists, arrays, matrices, stacks, queues, binary trees, tree traversals; Algorithms for sorting and searching: linear search, binary search, insertion-sort, selection sort, bubble-sort, quicksort, mergesort, heapsort, shellsort; Priority Queues: lists, heaps, binomial heaps, Fibonacci heaps; Graphs: representations, depth first search, breadth first search; Hashing: separate chaining, linear probing, quadratic probing; Search Trees: binary search trees, red-black trees, AVL trees, splay trees, B-trees; Strings: suffix arrays, tries; Randomized data structures: skip lists.

Texts :

1. T H Cormen, C E Leiserson, R L Rivest and C Stein, Introduction to Algorithms, MIT Press, 2001.
2. M A Weiss, Data Structures and Problem Solving Using Java, Addison-Wesley, 1997.

References :

1. A M Tannenbaum, Y Langsam and M J Augenstein, Data Structures Using C++, Prentice Hall India, 1996.
2. A H Aho, J E Hopcroft and J Ullman, Data Structures and Algorithms, Addison-Wesley, 1987.
3. Robert Sedgewick, Algorithms in C++ Parts 1-4, Pearson Education, Third Edition, 1998.
4. Robert Sedgewick, Algorithms in C++ Part 5, Pearson Education, Third Edition, 2002.

CS502 MATHEMATICS FOR COMPUTER SCIENCE 4-0-0-8

Pre-requisites :

Syllabus : Review of sets, functions, relations; Logic: formulae, interpretations, methods of proof in propositional and predicate logic; Number theory: division algorithm, Euclid's algorithm, fundamental theorem of arithmetic, Chinese remainder theorem; Combinatorics: permutations, combinations, partitions, recurrences, generating functions; Graph Theory: isomorphism, complete graphs, bipartite graphs, matchings, colourability, planarity; Algebraic Structures: semigroups, groups, subgroups, homomorphisms, rings, integral domains, fields, lattices and boolean algebras; Linear algebra: system of linear equations, matrices, vector spaces, linear transformations, Eigen vectors, diagonalization; Probability: conditional probability, random variables, probability distributions, Markov's inequality, Chebyshev and Chernoff Bounds.

Texts :

1. C L Liu, Elements of Discrete Mathematics, 2/e, Tata McGraw-Hill, 2000.
2. R C Penner, Discrete Mathematics: Proof Techniques and Mathematical Structures, World Scientific, 1999.

References :

1. R L Graham, D E Knuth, and O Patashnik, Concrete Mathematics, 2/e, Addison-Wesley, 1994.
2. K H Rosen, Discrete Mathematics & its Applications, 6/e, Tata McGraw-Hill, 2007.

3. J L Hein, Discrete Structures, Logic, and Computability, 3/e, Jones and Bartlett, 2010.
4. N Deo, Graph Theory, Prentice Hall of India, 1974.
5. S Lipschutz and M L Lipson, Schaum's Outline of Theory and Problems of Discrete Mathematics, 2/e, Tata McGraw-Hill, 1999.

CS503 COMPUTER SYSTEMS AND NETWORKS 3-0-0-6

Pre-requisites :

Syllabus : Review of concepts of operating systems: Processes, threads, interprocess communication, scheduling, memory management. Review of concepts of computer networks: link layer protocols, local area networks (Ethernet and variants), interconnecting networks with IP, routing, transport layer protocols. Advanced concepts of distributed networked systems: Virtualization, distributed file systems, mass storage systems, recovery and fault tolerance, content networking including multimedia delivery.

Texts :

1. A. Silberschatz, P. B. Galvin and G. Gagne, Operating System Concepts, 7th Ed, John Wiley and Sons, 2004.
2. J. Kurose and K. W. Ross, Computer Networking: A Top down approach, 3rd Ed, Pearson India, 2004.
3. M. Singhal and N. Shivratri, Advanced Concepts in Operating Systems, McGraw Hill, 1994.
4. A. S. Tanenbaum and Van Steen, Distributed Systems: Principles and Paradigms, Prentice Hall India, 2007.

References :

CS511 PROGRAMING LAB 0-0-3-3

Pre-requisites :

Syllabus : Experiments would be designed to provide hands-on experience in programming data structures and algorithms, to learn a few systems programming tools, and scripting.

Texts :

References :

1. T H Cormen, C E Leiserson, R L Rivest and C Stein, Introduction to Algorithms, MIT Press, 2001.
2. Jon Kleinberg and Eva Tardos, Algorithm Design, Addison Wesley, 2005.
3. M. A. Weiss, Data Structures and Algorithm Analysis in C++, Addison-Wesley, 2007.

CS504 THEORY OF COMPUTATION 3-0-0-6

Pre-requisites :

Syllabus : Automata and Languages: finite automata and regular expressions, pushdown automata and context-free grammars, pumping lemmas and closure proprties of regular and context-free languages, non-context-free languages; Computability theory: the Church-Turing thesis, Hilbert's problem, decidability, halting problem, reducibility; Complexity theory: time and space complexity, Classes P, NP, NP-complete, PSPACE, and PSPACE-complete; Intractability: hierarchy theorem, Relativization, Circuit complexity.

Texts :

1. M. Sipser, Introduction to the Theory of Computation, Thomson, 2004.
2. H. R. Lewis, C. H. Papadimitriou, Elements of the Theory of Computation, PHI, 1981.

References :

1. J. E. Hopcroft, J. D. Ullman, Introduction to Automata Theory, Languages and Computation, Narosa, 1979.
2. S. Arora, B. Barak, Computational Complexity: A Modern Approach, Cambridge University Press,2009.
3. C. H. Papadimitriou, Computational Complexity, Addison-Wesley Publishing Company, 1994.
4. D. C. Kozen, Theory of Computation, Springer, 2006.
5. D. S. Garey, G. Johnson, Computers and Intractability: A Guide to the Theory of NP-Completeness, Freeman, New York, 1979.

CS512 COMPUTER SYSTEMS LAB 0-0-3-3

Pre-requisites :

Syllabus : Experiments would be designed to provide hands-on experience in computer systems, to learn unix system calls, posix threads, operating system concepts, network programming and simulations.

Texts :

1. W. R. Stevens, UNIX Network Programming, Volume 1: Networking APIs: Sockets and XTI, Prentice Hall, 1998.

2. W. R. Stevens, UNIX Network Programming, Volume 2: Interprocess Communications, Prentice Hall, 1999.
3. W. R. Stevens, Advanced Programming in the UNIX Environment, Addison Wesley, 1992.

References :

CS521 PARALLEL ALGORITHMS 3-0-0-6

Pre-requisites : CS203

Syllabus : Theoretical models of parallel computation: variants of the PRAM model, interconnection networks, synchronous and asynchronous models. Performance of parallel algorithms. Basic techniques: balanced trees, recursive doubling, divide and conquer, partitioning, pipelining, accelerated cascading, symmetry breaking.List ranking, the Euler tour technique, tree contraction. Algorithms for searching, merging and sorting. Graph algorithms: Connected Components, Colouring. Parallel algorithms on interconnection networks and other architectures. Algorithms on asynchronous models. Limits to parallelizability. NC-reductions, P-completeness.

Texts :

1. J. Jaja, An Introduction to Parallel Algorithms, Addison Wesley, 1992.
2. F. T. Leighton, Introduction to Parallel Algorithms and Architectures: Arrays,Trees,Hypercubes,Morgan Kaufmann Publishers,San Mateo,California,1992.

References :

1. J. H. Reif, Synthesis of Parallel Algorithms, Morgan Kaufmann Publishers, San Mateo, California.
2. S. G. Akl, Parallel Computation: Models and Methods, Prentice Hall, 1996.

CS522 COMPUTATIONAL GEOMETRY 3-0-0-6

Pre-requisites : CS302

Syllabus : Algorithmic design paradigms (divide and conquer, incremental, sweep line, and prune and search) and basic data structures (segment and interval trees). Geometric searching: point locations (slab and chain methods) and range searching (kD and range trees); Convex hull: Graham's scan, gift wrapping, quick hull, divide-and-conquer; Voronoi diagram and Delaunay triangulation: properties and construction algorithms (sweep line and divide-and-conquer algorithms). Visibility and Art gallery problems, motion planning and shortest paths. Arrangements and duality; Line segments intersection problem; closest pair computation.

Texts :

1. F. P. Preparata and M. I. Shamos, Computational Geometry: An Introduction, Springer-Verlag, 1985.

References :

1. J. O'Rourke, Computational Geometry in C, 2nd Ed, Cambridge University Press, 1998.
2. M. Laszlo, Computational Geometry and Computer Graphics in C++, Prentice-Hall, 1996.
3. M. De Berg, M. van Kreveld, M. Overmars, O. Schwarzkopf, Computational Geometry: Algorithms and Applications, Springer -Verlag, 1997.

CS523 STRUCTURAL COMPLEXITY 3-0-0-6

Pre-requisites : CS204

Syllabus : Models of computation: automata, Turing machines, oracle Turing machines. Time and space bounded computations. Central complexity classes: invertibility, honesty, NP-Complete Sets, PSPACE-complete sets, padding arguments, space bounded reducibility. Time bounded reducibility: relativized classes, tally and sparse sets, self-reducibility. Nonuniform complexity: Boolean circuit complexity, polynomial advice. logarithmic advice. Self-producible circuits. probabilistic complexity classes. Uniform diagonalization. The polynomial time hierarchy. Alternation, Kolmogorov complexity.

Texts :

References :

1. J. L. Balcazar, J. Diaz and J. Gabarro, Structural Complexity, Vols 1 & 2, EATCS Monographs, Springer-Verlag, 1987.
2. J. Van Leeuwen, Handbook of Theoretical Computer Science, Vol A, Elsevier and MIT Press, 1990.

CS524 HIERARCHICAL MEMORY ALGORITHMS 3-0-0-6

Pre-requisites : CS205

Syllabus : Hierarchical memory levels; performance characteristics; Parallel disk model. Fundamental I/O operations. Design and analysis of efficient external memory algorithms for some representative problems.

Sorting, permutation, searching. Depth first search, breadth first search, Minimum spanning forest, connected components, single source shortest path, transitive closure. hashing, string matching. External Memory Data Structures. Cache efficient algorithms. Applications in various areas, for example, Computational geometry.

Texts :

References :

1. J. S. Vitter. External Memory Algorithms and Data Structures: Dealing with MASSIVE DATA, ACM Computing Surveys, 33(2), June 2001, 209-271.
2. Course Material on External Memory Algorithms and Data Structures: http://www.brics.dk/~gerth/emF99/
3. Other research papers.

CS525 LOGIC IN COMPUTER SCIENCE 3-0-0-6

Pre-requisites : CS203, CS302

Syllabus : Propositional Logic: Syntax, Proof System, Semantics, Soundness and completeness, Compactness, Normal Forms, Resolution, Horn Clauses, propositional satisfiability solvers, Complexity. First Order Logic: Syntax, Proof System, Semantics, Soundness and Completeness, Compactness, Herbrand Models, Unification and Resolution, Logic Programming and SLD Resolution, Decidability and Undecidability, Expressiveness, Ehrenfeucht-Fraisse Games, Applications. Modal Logic: Possibility and Necessity, Knowledge or Belief, Frames and Forcing, Modal Tableaux, Soundness and Completeness, Modal Axioms and Special Accessibility Relations, Logics of knowledge. Applications.

Texts :

1. A. Nerode and R. A. Shore, Logic for Applications, Springer-Verlag, 1997, 2nd edition.

References :

1. M. Huth and M. Ryan, Logic in Computer Science: Modelling and Reasoning about Systems, 2nd Ed, Cambridge University Press, 2004.
2. M. Fitting, First-order Logic and automated theorem proving, Springer-Verlag, 1990.
3. J. H. Gallier, Logic for Computer Science: Foundations of Automatic Theorem Proving (Harper & Row Computer Science and Technology Series), John Wiley & Sons, 1986.

CS526 OPTIMIZATION METHODS 3-0-0-6

Pre-requisites :

Syllabus : Introduction to Linear Programming: Connections with Geometry. Simplex Method: Duality Theorem. Complementary Slackness. Farkes' Lemma. Revised Simplex Method. General LP Problems: Infeasibility. Sensitivity Analysis. Primal-Dual Algorithm: Applications to Network Flow and Matching. Efficient Algorithm: Linear Programming in fixed dimensions. Randomized Linear Programming. Integer Linear Programming: Total Unimodularity. Semidefinite Programming: Application to MAXSAT problems.

Texts :

1. V. Chavtal, Linear Programming, W. H. Freeman and Company, New York, 1983.
2. C. H. Papadimitriou and K. steiglitz, Combinatorial optimization: Algorithms and Complexity, Dover Publications, Inc., New York, 1998.

References :

1. M. Grotschel, L. Lovasz and A. Schrijver, Geometric Algorithms and Combinatorial Optimization, John Wiley & Sons, Inc., New York, 1998.
2. W. Cook, W. H. Cunningham, W. R. Pulleyblank and A. Schrijver, Combinatorial Optimization, John Wiley & Sons, Inc., New York, 1998.
3. R. Motwani and P. Raghavan, Randomized Algorithms, Cambridge University Press, 1995.
4. Related publications in Journals/Conferences

CS527 COMPUTATIONAL NUMBER THEORY AND CRYPTOGRAPHY 3-0-0-6

Pre-requisites : Nil

Syllabus : Modular Arithmetic: Solving Modular Linear Equations, the Chinese Remainder Theorem, Modular Exponentiation, and Discrete Logarithm Problem; GCD Computation: Euclid's Algorithm, Extended Euclid's Algorithm; Key Exchange: Diffie Hellman, ElGamal, Massey-Omura, Computation of Generators of Primes; Public Key Cryptosystem: RSA, Different Attacks & Remedies; Primality Testing: Pseudoprimality Testing, Quadratic Residues, Randomized Primality Test & Deterministic Polynomial Time Algorithm; Factorization: Quadratic-Sieve Factoring Algorithm, Pollard-Rho Method; Elliptic Curve Cryptosystem: Theory of Elliptic Curves, Elliptic Curve Encryption & Decryption Algorithms, Security of Elliptic Curves Cryptography, Elliptic Curve Factorization; Cryptographic Hash Functions: MD5 Message Digest Algorithm, Secure Hash Algorithm

(SHA-1), Security of Hash Functions & Birthday Attack; Digital Signatures: Authentication Protocols, Digital Signature Standards (DSS).

Texts :

1. T. H. Cormen, C. E. Leiserson, R. Rivest and C. Stein, Introduction to Algorithms, 2nd Edition, Prentice Hall, 2002.
2. Neal Koblitz, A Course in Number Theory and Cryptography, Springer-Verlag, New York, May 2001.

References :

1. Oded Goldrich, Foundations of Cryptography-Basics, vol-1, Cambridge Univ. Press, 2005.
2. Oded Goldrich, Foundations of Cryptography-Applications, vol-2, Cambridge Univ. Press, 2005.
3. R. Motwani and P. Raghavan, Randomized Algorithms, Cambridge University Press, 1995.
4. William Stallings, Cryptography and Network security: Principles and Practice, 3rd Ed, Prentice Hall, 2003.

CS528 INFORMATION AND RANDOMNESS 3-0-0-6

Pre-requisites : Nil

Syllabus : Definitions of randomness: statistical (Martin-Loef, Solovay), based on program size complexity (Chaitin). Equivalence of the definitions. Random numbers: Properties of random and pseudo-random sequences. Provably secure pseudo-random generators. Examples of pseudo-random generators: Fake One-Time Pads, Period of a pRNG, Congruential Generators, Feedback Shift Generators, Blum-Blum-Shub Generator, Naor-Reingold Generator. Statistical tests for random numbers: Chi-square test, Kolmogorov-Smirnov test, empirical / theoretical / spectral tests. Non-uniform random sequences. Randomized algorithms. Derandomization techniques. Pseudo-random functions and permutations. Sequences of families of PSFs and PSPs. Applications: cryptographically strong hashing, prediction, learning, identify friend or foe, private-key encryption.

Texts :

References :

1. G. J. Chaitin, Algorithmic Information Theory, Cambridge University Press, 2004.
2. G. J. Chaitin, Information, Randomness and Incompleteness, 2nd edition, World Scientific, 1990.
3. G. J. Chaitin, Exploring Randomness, Springer-Verlag, 2001.
4. S. Goldwasser and M. Bellare, Lecture Notes in Cryptography, http://www-se.ucsd.edu/~mihir/papers/gb.pdf, 2001.
5. P. Garrett, Making and Breaking Codes: Introduction to Cryptology, Prentice-Hall, 2000.
6. R. Motwani and P. Raghavan, Randomized Algorithms, Cambridge University Press, 1995.
7. D. E. Knuth, The Art of Computer Programming, 3rd Ed, Vol 2, Seminumerical Algorithms, Addison-Wesley, 1998.
8. W. Feller, An Introduction to Probability Theory and its Applications, Vol 1, Wiley Eastern, 1968.

CS529 LEARNING WITH KERNELS 3-0-0-6

Pre-requisites :

Syllabus : Introduction: Data representation, similarity, statistical learning theory, hyper-plane classifiers, support vector classification, support vector regression, kernel principal component analysis; Kernels: Product features, representation of similarities in linear spaces, examples and properties of kernels; Risk and loss functions: Loss functions, test error, expected risk, statistical perspective, robust estimators; Regularization: Regularized risk functional, representer theorem, regularization operators, translation invariant kernels, dot product kernels; Optimization: Convex optimization, unconstrained problems, constrained problems; Support vector machines: Separating hyper-planes, role of margin, optimal margin hyper-planes, nonlinear support vector classifiers, soft margin hyper-planes, multi-class hyper-planes; Single class problems: introduction, algorithms, optimization, theory; Regression estimation: Linear regression with insensitive loss function, dual problems, ν-SV regression; Implementation: Tricks of the trade, sparse greedy matrix approximation, subset selection methods, sequential minimal optimization, iterative methods; Designing kernels: Tricks for constructing kernels, string kernels, natural kernels.

Texts :

1. Bernhard Schlkopf and Alexander J. Smola. Learning with Kernels - support vector machines, regularization, optimization and beyond, The MIT Press, Cambridge, Massachusetts, London, England, 2002.

References :

1. John Shawe-Taylor and Nello Cristianini, Kernel Methods for Pattern Analysis, Cambridge University Press, 2004.
2. Nello Cristianini and John Shawe-Taylor , Introduction to Support Vector Machines, Cambridge University Press,

2000.

CS530 COMPUTATIONAL TOPOLOGY 3-0-0-6

Syllabus : This course is a combination of Algorithms, Geometry, and Topology. The course starts with a broad introduction to basic notions in Topology for a Computer Scientist. Then it primarily focuses on designing efficient Algorithms and data structures for the problems from Topology. The relevant topics ranging from point set topology to algebraic topology are presented. The course is motivated with the applications from computational structural biology, geometric modeling, meshing, curve and surface reconstruction, clustering, 3d-printing, orthodontics, and VLSI routing.

Introduction to topological spaces with motivating examples; Geometric topology: searching a triangulation, surface simplification, triangulations, and complexes; Manifolds: homeomorphism, Jordan separation Theorem, Conway's ZIP proof, imbedding graphs in the plane, and Euler characteristics; Homotopy: deformation retraction, topological equivalence, categories, functors, homotopic paths in the plane, and homotopy of curves on surfaces; Topological Graph Theory: Connected components in surface graphs, min-cuts in surface graphs, and tree decomposition; designing algorithms based on Homology and Duality Theories.

Texts:

1. Computational Topology by Herbert Edelsbrunner, First Edition, American Mathematical Society, 2010.
2. Topology by James R. Munkres, Second Edition, Prentice Hall, 2000.

References :

1. Algebra by Artin, Second Edition, Addison Wesley, 2010.
2. Introduction to Topology by Bert Mendelson, Third Edition, Dover Publications Inc., 1990.
3. Basic Topology by M. A. Armstrong, Springer, 2010.
4. Algebraic Topology by Allen Hatcher, First Edition, Cambridge University Press, 2001.
5. An Introduction to Morse Theory by Y. Matsumoto, First Edition, American Mathematical Society, 2001.

CS531 ADVANCED COMPUTER ARCHITECTURE 3-0-0-6

Pre-requisites : CS206

Syllabus : Pipeline processor principles and design, Instruction set architecture; Memory addressing; Instruction composition; Instruction-level parallelism; Hazards: dynamic scheduling, branch prediction; Memory hierarchy; Processor case studies; Multiprocessor introduction: Shared-memory architectures and their synchronisation and consistency issues, Advanced multi-core topics; Transactional Memory; Interconnection networks.

Texts :

1. J. L. Hennessy and D. A. Patterson, Computer Architecture: A Quantitative Approach, Morgan Kaufmann, fourth edition, 2006.
2. David Culler, J.P. Singh and Anoop Gupta, Parallel Computer Architecture: A Hardware/Software Approach, Morgan Kaufmann, first edition, 1998.
3. Kai Hwang, Advanced Computer Architecture: Parallelism, Scalability, Programmability, McGraw-Hill, first edition, 1992.

References :

CS532 FORMAL METHODS FOR SYSTEM VERIFICATION 3-0-0-6

Pre-requisites : Nil

Syllabus : Introduction to formal methods and hardware verification. Review of logics: Propositional Calculus and Predicate Calculus. Axioms and rules of Floyd-Hoare Logic. Application of Floyd-Hoare logic to verify hardware circuits. Describing hardware directly in higher order logic. Combinational and sequential behaviour of circuits. Specification of hardware systems. Introduction to Binary Decision Diagram (BDD) and modelling hardware with BDDs. Algorithms for BDD operations. Concept of OBDDs and ROBDDs and operation on ROBDDs. Introduction to Temporal Logic. Linear and Branching time temporal logic. Expressing properties in CTL and CTL*. CTL model checking algorithm. State space explosion problem: Symbolic data structure and symbolic model checking algorithms. Concept of on-the-fly model checking and automata-theoretic model checking. Study of verification tools: SMV and PVS.

Texts :

References :

1. M. Huth and M. Ryan, Logic in Computer Science: Modelling and Reasoning about Systems, 2nd Ed, Cambridge University Press, 2004.

2. T. F. Melham, Higher Order Logic and Hardware Verification, Cambridge University Press, 1993.
3. E. M. Clarke, O. Grumberg and D. Peled, Model Checking, MIT Press, 1999.
4. K. L. McMillan, Symbolic Model Checking, Kluwer Academic Publisher, 1993.
5. Z. Manna and A. Pnueli, The Temporal Logic of Reactive and Concurrent System Specification, Springer-Verlag, 1992.

CS533 SEMANTICS OF PROGRAMMING LANGUAGES 3-0-0-6

Pre-requisites : CS201

Syllabus : Overview of programming language constructs like procedures, jumps, non-determinism, continuations. Introduction to semantic systems. Operational semantics: Labelled transition systems, semantics of a simple language. Denotational semantics: lambda-calculus, semantics of a simple language with loops. Axiomatic semantics: Hoare logic, semantics of a subset of Pascal. Reasoning about concurrent features in programming languages using modal logic.

Texts :

1. G. Winskel, Formal Semantics of Programming Languages: An Introduction, MIT Press, Cambridge, 1993.

References :

1. M. J. C. Gordon, The Denotational description of programming languages: An Introduction, Springer-Verlag, 1979.
2. D. Gries, Science of Programming, Springer-Verlag, 1981.
3. D. Friedman, M. Wand and C. Haynes, Essentials of programming languages, 2nd Ed, MIT Press, 2001.
4. J. R. Hindley and H. P. Seldin, Introduction to Combinators and Lambda-calculus, Cambridge University Press, 1988.

CS5334 FUNCTIONAL AND LOGIC PROGRAMMING 3-0-0-6

Pre-requisites : Nil

Syllabus : Functional programming: Functions as first class objects, laziness, data-types and pattern matching, classes and overloading, side-effects etc. Languages like ML and Haskell will be used to describe the concepts. Lambda calculus: Syntax, conversions, normal forms, Church-Rosser theorem, combinators. Implementation issues: Graph reduction, Three Instruction Machine. Logic programming: Horn clauses, resolution, SLD-refutation, Prolog. Negation in logic programs and implementation issues.

Texts :

1. R. Bird and P. Wadler, Introduction to Functional Programming, 2nd Ed, Prentice-Hall, 1998.
2. S. L. Peyton-Jones, The Implementation of Functional Programming Languages, Prentice-hall, 1987.
(Full text available online: http://research.microsoft.com/Users/simonpj/Papers/slpj-book-1987/index.htm)

3. J. W. Lloyd, Foundations of Logic Programming, Springer-Verlag, 2nd Ed. 1987.

References :

1. J. D. Ullman, Elements of ML Programming, ML 97 Edition, 2nd Ed, Prentice-Hall, 1998.
2. L. Sterling and E. Shapiro, The Art of Prolog, 2nd Ed, MIT Press, 1994.
3. J. R. Hindley and H. P. Seldin, Introduction to Combinators and Lambda-calculus, Cambridge University Press, 1988.

CS535 ADVANCED COMPILERS 3-0-0-6

Pre-requisites : CS308

Syllabus : Introduction to code optimization, efficient code generation and parallelizing compilers. Data-flow analysis : Classical theory, bi-directional flows, unified algorithms etc. Efficient code generation: Algorithms, register allocation heuristics and automated tools. Parallelism detection : Data dependence, control dependence, various restructuring transformations on loops. Inter-procedural analysis : Constant propagation, data dependence etc. Selected case studies.

Texts :

1. S. Muchnick, Advanced Compiler Design and Implementation, Morgan Kaufmann, 1997.
2. M. J. Wolfe, High Performance Compilers for Parallel Computing, Addison-Wesley, 1995.

References :

1. V. Sarkar, Partitioning and Scheduling Parallel Programs for Multiprocessors, MIT Press, 1989.
2. A. Aho, R. Sethi and J. D. Ullman, Compilers: Principles, Techniques and Tools, Addison Wesley, 1986.
3. Selected research papers.

CS536 ADVANCED OPERATING SYSTEMS 3-0-0-6

Pre-requisites : CS303

Syllabus : Study of major Operating System issues such as Memory Management, Process Management and Scheduling, File Systems, Networking by looking at the internals of actual systems such as Unix, Linux, NT etc. Issues in design of distributed operating systems. Selected case studies such as Amoeba, Chorus, Mach etc

Texts :

References :

1. B. Goodheart and J. Cox, The Magic Garden Explained: The Internals of Unix System V Release 4, Prentice Hall 1994.
2. M. K. McKusick et al., The Design and Implementation of the 4.4 BSD Operating System, Addison Wesley, 1996.
3. U. Vahalia, Unix Internals: The New Frontiers, Prentice Hall, 1996.
4. P. K. Sinha, Distributed Operating Systems, Wiley-IEEE Press, 1996.
5. H. Custer, Inside Windows NT, 2nd Ed, Microsoft Press, 1998.
6. Selected papers and reports and source code.

CS537 DISTRIBUTED SYSTEMS 3-0-0-6

Pre-requisites : CS303

Syllabus : Introduction to distributed computing models. Issues in distribution of data and control: Clock synchronization, agreement, deadlock detection, termination detection etc. Distributed file servers: Concurrency control and recovery, resiliency etc. Distributed programming environments: Communication primitives, selected case studies. (Note: Some topics may be added/deleted to suit specific offerings of the course)

Texts :

1. G. F. Coulouris, J. Dollimore and T. Kindberg, Distributed Systems: Concepts and Design, 4th Ed, Addison-Wesley, 2005.

References :

1. S. Mullender (Ed), Distributed Systems, 2nd Ed, Addison-Wesley, 1994.
2. M. Singhal and N. Shivratri, Advanced Concepts in Operating Systems, McGraw Hill, 1994.
3. Selected research papers.

CS538 INFORMATION TRANSMISSION AND SECURITY 3-0-0-6

Pre-requisites : Nil

Syllabus : Information theory Fundamentals: Error Correcting Codes: Mathematical Preliminaries; Linear Block Codes; Cyclic Codes; BCH Codes; Arithmetic Codes; Convolutional Codes; Unidirectional Error Correcting Codes; Applications of Error Correcting Codes. Cryptography: Cryptographic techniques; Mathematical Preliminaries; Symmetric Key cryptography; Block Cipher and Stream Cipher; Public Key Cryptography; Attacks; Message Authentication: Digital signatures, MD5, SHA etc.; Key Exchange Schemes; E-cash/Money. Data Compression: Compression Techniques; Mathematical Preliminaries; Hoffman Coding; Arithmetic Coding; Dictionary Techniques; Static Dictionary, Adaptive Dictionary; Lossless Image Compression; Scalar and Vector Quantization; Differential Encoding; MPEG; JPEG; Video Compression

Texts :

1. T. R. N. Rao and E. Fujiwara, Error Control Coding for Computer Systems, Englewood Cliffs, NJ: Prentice Hall, 1989.
2. B. Schneier, Applied Cryptography, 2nd Ed, John Willey and Sons, 1996.
3. K. Sayood, Introduction to Data Compression, 2nd Ed, Morgan Kaufmann, 2000.

References :

1. M. Y. Rhee, Cryptography and Secure Data Communications, McGraw Hill, 1994.
2. S. Lin and D. J. Costello, Error Control Coding, 2nd Ed, Prentice Hall, 2005.
3. S. B. Wicker, Error Control systems for Digital Communication System and Storage, Prentice Hall, 1995.
4. T. C. Bell, J. G. Cleary and I. H. Witten, Text Compression, Advanced Reference Series, Englewood Cliffs, NJ: Prentice Hall, 1990.
5. R. M. Gray, Entropy and Information Theory, New York: Springer-Verlag, 1990.
(Full text available at http://www-ee.stanford.edu/~gray/it.pdf)

CS540 WEB DEVELOPMENT TECHNOLOGIES 3-0-0-6

Pre-requisites : Nil

Syllabus : Introduction to the world wide web - servers, clients, browsers editors and languages; web technologies like HTML, Java, Javascript, Perl, CGI; web databases. The course will involve programming assignments and research projects using HTML, Java, Perl etc.

Texts :

References :

1. K. Arnold, J. Gosling and D. Holmes, The Java Programming Language, 3rd Ed, Addison Wesley, 2000.
2. P. Deitel and H. Deitel, Java - How to Program, 6th Ed, Prentice-Hall, 2005.
3. B. Breedlove, Web Programming Unleashed, Sams Net Publishing, 1996.
4. C. Musciano and B. Kennedy, HTML: The Definitive Guide, 2nd Ed, O'Reilly, May 1997.
5. L. Wall, T. Christiansen and R. L. Schwartz, Programming Perl, O'Reilly, 1996; also published by Shroff Publishers and Distributors Pvt. Ltd.
6. S. Gundavaram, CGI Programming on the World Wide Web, O'Reilly, March 1996.
7. D. Flanagan, Java in a Nutshell, O'Reilly, 1997 (also published by Shroff Publishers and Distributors Pvt. Ltd., Mumbai)
8. Other references and whitepapers on Java, HTML etc.

CS541 COMPUTER AND NETWORK SECURITY 3-0-0-6

Pre-requisites :

Syllabus : Overview, vulnerabilities, risk assessment, incidents. Cryptography: Classical Cryptography, Symmetric Cryptography, Public Key (Asymmetric cryptography), Modern Cryptography, Hash Functions, Key Exchange. Review: Installing Unix and common service daemons (Unix Security, Windows NT Security, Ping, traceroute, TCP Dump, sniffer etc.), Networking. Security issues: Terminology (Integrity, Availability, Confidentiality, Non-repudiation, Authentication, Authorization/Access Control, accounting, auditing, Passive and Active Attacker, Interruption, Interception, Modification, Fabrication, Social Engineering), Vulnerabilities and Counter Measures (Viruses, worms, Trojan horses, backdoors, unused services, buffer overflows, RPC), Exploits (Buffer overflow, Port Scanning etc). Applications Security (System Security, Audit Logs Intrusion Detection, Wrappers, Password and remote authorization tools e.g. PGP, S/MIME, SSH, Netscape/SSL, SET, IPsec, Kerberos, Firewalls, VPN etc, Secure (commerce) Transaction over a network, Network Anonymity.

Texts :

1. W. Stallings, Cryptography and Network Security: Principles and Practice, 3rd Ed, Prentice Hall, 2003.

References :

1. B. Schneier, Applied Cryptography, 2nd Ed, John Wiley & Sons, Inc., 1996.
2. A. Menezes, P. van Oorshot and S. Vanstone, Handbook of Applied Cryptogrphy, CRC Press, 1997.
3. C. Kauffman, R. Perham and M. Speciner, Network Security: Private Communication in a Public World, Prentice-Hall, 1994.
4. H. C. A. van Tilborg, Fundamentals of Cryptology, Kluwer Academic Publishers, 2000.
5. P. Garrett, Making and Breaking Codes: An Introduction to Cryptology, Prentice-Hall, 2001.
6. P. Wayner, Disappearing Cryptography, 2nd Ed, Morgan Kaufmann, 2002.
7. W. Cheswick, S. Bellovin and A. Rubin, Firewalls and Internet Security. Repelling the Wiley Hacker, 2nd Ed, Addison-Wesley, 2003.
8. Related publications in Journals/Conferences.

CS542 WIRELESS NETWORKS 3-0-0-6

Pre-requisites : CS301

Syllabus : Introduction to wireless communication systems and networks; Wireless technologies: Cellular wireless networks and systems principles. Antennas and radio propagation. Signal encoding and modulation techniques. Spread spectrum. Coding and error control. Wireless Networking: Multiple access techniques. Mobile IP and WAP. Wireless systems and standards. Wireless LANs: Wireless LAN technology. Wireless standard (IEEE 802.11 etc.). Ad-hoc Networks. Bluetooth

Texts :

1. W. Stallings, "Wireless Communications and Networks", Pearson Education, 2002.

References :

1. T S Rappaport, "Wireless Communications: Principles & Practice", Second Edition, Pearson Education, 2002.
2. J Schiller, "Mobile Communications", Addison Wesley, 2000.

3. V K Garg, "IS-95 CDMA and CDMA2000", Prentice Hall PTR, 2000.
4. Research papers.

CS543 INTERNET PROTOCOLS 3-0-0-6

Pre-requisites : CS301

Syllabus : Overview of IPv4, TCP, IPv6, ICMP, ARP, DHCP; Routing Protocols: OSPF, RIP, BGP, Ad hoc network routing (AODV, DSR); IP Security: NAT, IPSEC, Socks, SSL; Quality of Service related protocols: Intserv, diffserv, Queuing techniques (WFQ, RED, etc.); Multi-Protocol Label Switching (MPLS) and GMPLS; Virtual Private Network (VPN) Protocols: L2TP, PPTP; Overview of Application Layer Protocols: DNS, LDAP, SMTP, POP3, IMAP4, SNMP; Voice over IP Protocols (VOIP) and videoconferencing: SIP, H323. Server Load Balancing Techniques.

Texts :

1. Adolfo Rodriguez, et. al, TCP/IP Tutorial and Technical Overview, IBM Redbook, available online at http://www.redbooks.ibm.com/pubs/pdfs/redbooks/gg243376.pdf, 2001.

References :

1. Charles. M.Kozierek, TCP/IP Guide, Shroff Publishers, Mumbai, 2005.
2. Uyless Black, MPLS and Label Switching Networks, Pearson Education (LPE), 2002.
3. Request for Comments (RFC) from www.ietf.org.

CS544 WIRELESS SENSOR NETWORK 3-0-0-6

Pre-requisites :

Syllabus : Introduction to ad hoc networks. Routing- Proactive routing protocols, Reactive routing protocols, backbone, Position based routing, power efficient routing; Introduction to sensor networks and its applications: Architecture and factors influencing the sensor network design. Routing protocols- data centric routing protocols, hierarchical routing protocols, location based routing, energy efficient routing etc; Node Scheduling and coverage issues, topology control. Querying, data collection and processing, Collaborative information processing and group connectivity. Target tracking and identity management using sensor networks. Localization . Application & future research Challenges.

Texts :

1. Wireless Sensor Networks : A systems perspective By Nirupama Bulusu and Sanjay Jha, editors Artech House, August 2005.
2. F. Zhao and L. Guibas. Wireless Sensor Networks: An Information Processing Approach. Elsevier/Morgan-Kaufmann, 2004.
3. Wireless Sensor Networks : Architecture and Protocols By Jr., Edgar H. Callaway.
4. Wireless Sensor Networks, An Edited Book Editors : C.S Raghavendra, Krishna M. Sivalingam and Taieb Znati.

References :

CS546 ENTERPRISE SYSTEMS 3-0-0-6

Pre-requisites :

Syllabus : Overview of Database Management Systems. Overview of Model - View - Control (MVC) method of software development in a 3 tier environment. Tools and Technologies - Brief overview of the following : Java server pages and related Java Technologies, Microsoft .NET framework, PHP, Ruby on Rails, Javascript, Ajax. Service Oriented Architecture (SOA) - Principles of loose coupling, encapsulation, inter-operatibility; Web Services as the implementation vehicle protocols, usage. Enterprise Resource Planning (ERP) systems and their architecture; overview of SAP and Oracle Applications - Generic ERP Modules : Finance, HR, Materials Management, Investment, etc; Examples of Domain Specific Modules; Electronic Data Exchange; Customer Relationship Management (CRM); Supplier Relationship Management (SRM). Security Issues - Authentication, authorisation, access control; roles; single-sign-on, directory servers; audit trails; digital signatures; Encryption: review of IPSec, SSL and other technologies; Overview of : MPLS, Virtual Private Networks (VPN), firewalls, network monitoring and enforcement of policies. Software Acquisition Process - tendering; conditions of contract; commercial off the shelf software (COTS) versus Bespoke Implementations; total cost of ownership; Issues on using Open source software or free software or licensed software. Hardware Architectures for Enterprise Systems - Servers, clustering, storage area networks, storage units, back-up strategies; Local Area Network (LAN) technologies and products; Data Centres; Disaster recovery site design and implementation issues; Hardware Acquisition Issues.

Texts :

References :

1. Material as available on the Internet. Wikipedia Articles will be the starting point for many of the topics.
2. Material in the web sites of some the leading vendors.

* www.oracle.com/technology
* www.sap.com, www.sdn.sap.com
* www.ibm.com, www.redbooks.ibm.com
* www.sun.com,, java.sun.com/developer/
* www.cisco.com, www.hp.com

CS547 PERFORMANCES MODELLING OF COMMUNICATION AND COMPUTER SYSTEMS 3-0-0-6

Pre-requisites :

Syllabus : Modelling philosophy and Principles: Discussion of several techniques of modelling; Introduction to Queuing theory and Markov chains: Queuing theory applied to study single and multiple server systems, statistical equilibrium, stationary processes, and ergodic processes; Monte Carlo simulation: Build simulation models from first principles, Discussion of the technique and theory of simulation, Start the simulation model as lab work; Mean Value analysis applied to multiprocessor systems; Workload Characterization: System dependent characterization, System independent characterization; Lagrangian and Eulerian views of job flow in systems; Communication Networks: Relation between bandwidth and latency; Sizing of Systems; Capacity Planning of systems; Software performance and Tuning; Software and Hardware monitors; Controlled experiments: Benchmarking and extrapolation of results to uncontrolled environment; Cloud Computing systems: performance framework.

Texts :

References :

1. Kai Hwang, Advanced Computer Architecture, McGraw Hill,Computer Science Series, 1993.
2. Krishna Kant, Introduction to Computer System Performance Evaluation, McGraw Hill International Science series, 1992.
3. Gunter Bolch, Stefan Greimer, Herman de Meer,and Kishore S. Trivedi, Queuing Networks and Markov Chains, John Wiley, Interscience, 1998.
4. Jean Walrand, Kallol Bagchi and George W. Zobrist, editors, Network Performance Modeling and Simulation, Gordon and Breach Science Publishers, 1998.
5. Domenico Ferrari, Computer Systems Performance Evaluation, Prentice Hall, 1978.
6. J. L. Hennessy and D. A. Patterson, Computer Architecture: A Quantitative Approach, Morgan Kaufmann, fourth edition, 2006.

. Peter G. Harrison, Naresh M. Patel, Performance Modeling of Communication Networks and Computer Architectures, Addison Wesley Longman Publishing Co, 1992.

CS548 ARTIFICIAL INTELLIGENCE 3-0-0-6

Pre-requisites :

Syllabus : Introduction to intelligent agents. Problem Solving: Searching, Intelligent search methods, Game Playing. Knowledge and Reasoning: Building a Knowledge Base. Inference in First Order Logic, Logical reasoning systems. Planning. Uncertain Knowledge and Reasoning, Probabilistic Reasoning Systems. Learning from Observations: Inductive Learning, Learning Decision Trees, Computational Learning Theory, Explanation Based Learning. Genetic algorithms, Artificial Neural Networks and Fuzzy Approaches. Introduction to Natural Language Processing. The course will include programming projects involving programming in Lisp, Prolog and C++.

Texts :

1. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 2nd Ed, Prentice Hall, 2003.

References :

1. E. Rich and K. Knight, Artificial Intelligence, McGraw Hill, 1991.
2. P. H. Winston and B. K. P. Horn, Lisp, 3rd Ed, Addison-Wesley, 1989.
3. P. Norvig, Paradigms of Artificial Intelligence Programming: Case studies in Common Lisp, Morgan Kauffman, 1991.
4. I. Bratko, Prolog Programming for Artificial Intelligence, 3rd Ed, Addison-Wesley, 2001.

CS549 MACHINE LEARNING 3-0-0-6

Pre-requisites :

Syllabus : Definitions, goals and history of Machine Learning. Taxonomies of methods and research paradigms. Knowledge-level vs. symbol-level learning. Major approaches of learning: Inductive concept acquisition (version-space, ID3, and AQ algorithms); inductive bias, minimum description length principle. Formal models of learnability. learning in the limit. PAC learnability. Ockham's razor. Learning by observation and discovery (e.g., conceptual clustering in CLUSTER and COBWEB) Scientific and mathematical discovery (e.g., AM and BACON) Explanation-based learning: macro-operators (STRIPS), explanation generalization (as in EBG, EGGS, and SOAR); Connectionist (i.e. neural network) learning (perception and back-propagation), Analogy and case-based reasoning (exemplars, structure mapping).

Texts :

1. J. Shavlik and T. Dietterich (Ed), Readings in Machine Learning, Morgan Kaufmann, 1990.
2. P. Langley, Elements of Machine Learning, Morgan Kaufmann, 1995.

References :

CS550 PRINCIPLES OF ROBOTICS 3-0-0-6

Pre-requisites :

Syllabus : Introduction to robot manipulation. Forward and inverse kinematics of robots and some case studies. Manipulator dynamics. Basics of robot control. Task planning with emphasis on computational geometry methods for robot path finding,robot arm reachability, grasp planning etc. Overview of robot vision.

Texts :

1. R. J. Schilling, Fundamentals of Robotics: Analysis and Control, Prentice-Hall India 1996.

References :

1. K. S. Fu, R. C. Gonzalez and C. S. G. Lee, Robotics: Control, Sensing, Vision and Intelligence, McGraw-Hill, 1987.
2. R. P. Paul, Robot Manipulators: Mathematics, Programming and Control, MIT Press, 1981.
3. J. C. Latombe, Robot Motion Planning, Kluwer Academic Publishers, 1991.

CS551 INTELLIGENT SYSTEMS AND INTERFACES 3-0-0-6

Pre-requisites :

Syllabus : Language Processing: Computational Phonology: Issues, Phonological rules, Mapping text to phones, Prosody in TTS, Probabilistic models of pronunciation and Spelling, N-Grams. Syntax: Word classes and POS tagging, CFG for English, Lexicalized and Probabilistic Parsing. Semantics: Semantic representation, Semantic and Lexical analysis and Word sense disambiguation, IR. Pragmatics: Discourse, Dialogue agents, Natural Language Generation and Machine translation. Machine Learning: Data Mining: Association rules, Clustering, Decision Trees. Text Mining. Synergetic techniques: Genetic algorithms and ANN techniques for machine learning. Applications to bioinformatics. Intelligent Interfaces: Incorporating Intelligence: Requirements, design issues. Applications: Development of Intelligent interfaces for systems - Stand-alone systems like OS, Databases, Physical machines including robots. Web based applications like Tutoring systems, Web Mining, e-shopping.

Texts :

References :

1. D. Jurafsky and J. H. Martin, Speech and language Processing, Pearson Education, 2000.
2. E. Reiter and R. Dale, Building Natural Language Generation Systems, Cambridge University Press, 2000.
3. T. M. Mitchell, Machine learning, McGraw-Hill 1997.
4. J. Han and M. Kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann, 2000.

CS552 PATTERN RECOGNITION 3-0-0-6

Pre-requisites :

Syllabus : Introduction to Pattern Recognition: Learning paradigms, Supervised and unsupervised learning; Bayesian decision theory: Minimum error rate classifier; Parameter estimation: Maximum likelihood and Bayesian Estimation; Hidden Markov models; Nonparametric techniques: Nearest neighbor rules, Parzen windows; Decision trees: Axis-parallel, Oblique, Impurity measures; Feature selection: Forward, backward search; Component analysis and discriminant functions: Principal component analysis, Fisher linear discriminant, Perceptron, Support vector machines; Generalization ability of learning methods: Bias and variance, Regularization; Bootstrapping, Boosting, Bagging; Unsupervised learning and clustering: k-Means

methods.

Texts :

1. R. O. Duda, P. E. Hart and D. G. Stork, Pattern classification, John Wiley & Sons, 2002.

References :

1. C. M. Bishop, Neural Networks for Pattern Recognition, Oxford University Press, 1995.
2. V. N. Vapnik, The Nature of Statistical Learning Theory, Springer, 2000.
3. N. Cristianini and J. Shawe-Taylor, An Introduction to Support Vector Machines, Cambridge University Press, 2000.
4. Selected Research Papers.

CS553 DATA MINING 3-0-0-6

Pre-requisites :

Syllabus : Types of data mining problems. The process of data mining. Statistical evaluation of big data: statistical prediction, performance measures, pitfalls in data-mining evaluation. Data preparation: data models, data transformations, handling of missing data, time-dependent data, textual data. Data reduction: feature selection, principal components, smoothing data, case subsampling. Predictive modeling: mathematical models, linear models, neural nets, advanced statistical models, distance solutions, logic solutions, decision trees, decision rules, model combination. Solution analyses: graphical trend analyses, comparison of methods. Case studies. Future trends: text mining, visualization, distributed data. Practical sessions using open-source software.

Texts :

1. S. Weiss and N. Indurkhya, Predictive Data-Mining: A Practical Guide, Morgan Kaufmann, 1998.

References :

1. S. Weiss, N. Indurkhya, T. Zhang and F. Damerau, Text Mining: Predictive Methods for Analyzing Unstructured Information, Springer, 2004.

CS554 MULTIMEDIA SYSTEMS 3-0-0-6

Pre-requisites :

Syllabus : Introduction to Multimedia, DSP Preliminaries: Fundamentals of Signal and Systems, Transformations, Image Representations and Transformations, Elements of Image Compression and Coding: Lossy and Lossless Image Compressions, Fixed-length and Variable-length Coding, Discrete Cosine Transforms and Coding, Wavelet Transform and Coding, Multimedia Standards: Still Image Compression Standards: JPEG and JPEG 2000, Elements of Video Compression System: DPCM, Motion Estimation, Video Compression Standards: Overview, H.261, H.263, H.264, MPEG-1: Specification, continuity and synchronization, MPEG-2: Overview, scalability, Audio Compression: Overview, MPEG Audio Coder

Texts :

1. K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, Multimedia Communication Systems: Techniques, Standards, and Networks, Prentice Hall PTR, 2000.
2. Yun Q Shi,, Huifang Sun, Image and Video Compression for Multimedia Engineering: Fundamentals, Algorithms, and Standards, second edition, CRC Press, 2008.

References :

1. John G. Proakis and Dimitris K Manolakis, Digital Signal Processing (4th Edition), Prentice Hall, 2006.
2. Iain Richardson, Iain E. G. Richardson, " H.264 and MPEG-4 Video Compression: Video Coding for Next Generation Multimedia,"John Willey 2004.
3. A. K. Jain, "Fundamentals of Digital Image Processing", Prentice-Hall, 1989.
4. Oge Marques, Practical Image and Video Processing Using MATLAB, Wiley-IEEE Pres, 2009.
5. Andreas Spanias, Ted Painter, Venkatraman Atti, Audio Signal Processing and Coding, John Wiely, 2007.
6. W. Pennebaker, J. Mitchell, "JPEG Still Image Data Compression Standard", Van Nostrand Reinhold, New York, 1993.

Visit Amazon's Dzung Tien Hoang Pagesearch results. Learn about Author Central Jeffrey Scott Vitter, Jeffrey S Vitter, Dzung Tien Hoang Efficient Algorithms for MPEG Video Compression, John Wiley & Sons, 2002.

CS555 FUNDAMENTALS OF INFORMATION RETRIEVAL 3-0-0-6

Pre-requisites :

Syllabus : This course is intended for both undergraduate and postgraduate students. The domain of Information Retrieval (IR) is concerned with the extraction of relevant information from large collections of documents. It has applications to proprietary retrieval systems as well as the WWW, Digital Libraries and commercial recommendation systems. The objective of the course is to introduce students to the theoretical underpinnings of IR and practical experience in the construction of IR systems through a series of programming assignments.

Introduction: concepts and terminology of information retrieval systems, Information Retrieval Vs Information Extraction; Indexing: inverted files, encoding, Zipf's Law, compression, boolean queries; Fundamental IR models: Boolean, Vector Space, probabilistic, TFIDF, Okapi, language modeling, latent semantic indexing, query processing and refinement techniques; Performance Evaluation: precision, recall, F-measure; Classification: Rocchio, Naive Bayes, k-nearest neighbors, support vector machine; Clustering: partitioning methods, k-means clustering, hierarchical; Introduction to advanced topics: search, relevance feedback, ranking, query expansion.

Texts :

1. Christopher D. Manning, Prabhakar Raghavan and Hinrich Schtze, Introduction to Information Retrieval, Cambridge University Press. 2008
2. Ricardo Baeza-Yates and Berthier Ribeiro-Neto, Modern Information Retrieval, Addison Wesley, 1st edition, 1999.

References :

1. Soumen Chakrabarti, Mining the Web, Morgan-Kaufmann Publishers, 2002.
2. Bing Liu, Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data, Springer, Corr. 2nd printing edition, 2009.
3. David A. Grossman, Ophir Frieder, Information Retrieval: Algorithms and Heuristics, Springer, 2nd edition, 2004.
4. William B. Frakes, Ricardo Baeza-Yates, Information Retrieval Data Structures and Algorithms, Prentice Hall, 1992.
5. G. Salton, M. J. McGill, Introduction to Modern Information Retrieval, McGraw-Hill, 1986.
6. C. J. Van Rijsbergen, Information Retrieval, Butterworth-Heinemann; 2nd edition, 1979.

CS556 HUMAN COMPUTER INTERACTION 3-0-0-6

Pre-requisites :

Syllabus : HCI foundation: history, human abilities, state of the art in computing technology, interaction styles and paradigms; Design process: interaction design basics, HCI in software process, design rules and guidelines, implementation support (UI software), universal design; Interaction styles: direct manipulation, WIMP, web interface, natural language interaction; Evaluation techniques; Models in HCI: formal models, linguistic models, cognitive models (KLM/GOMS), cognitive architectures, hybrid models; Task analysis; Dialogue design; Advanced topics (overview) pervasive computing, CSCW, virtual reality, tangible user interface, multimedia.

Texts :

1. A. Dix, J. Finlay, G. D. Abowd and R. Beale, Human Computer Interaction, 3rd edition, Pearson Education, 2005.

References :

1. J. Preece, Y. Rogers, H. Sharp, D. Baniyon, S. Holland and T. Carey, Human Computer Interaction, Addison-Wesley, 1994.
2. C. Stephanidis (ed.), User Interface for All: Concepts, Methods and Tools. Lawrence Erlbaum Associates, 2001.
3. J. M. Caroll (ed.), HCI Models, Theories and Frameworks: Towards a Multidisciplinary Science (Interactive Technologies), Morgan Kauffman, 2003.
4. W. O Galitz, The Essential Guide to User Interface Design, John Wiley & Sons, Inc, 2002 (Indian Edition).
5. B. Shneiderman, Designing the User Interface, Addison Wesley, 2000 (Indian Reprint).

CS557 COMPUTATIONAL SYSTEMS BIOLOGY 3-0-0-6

Pre-requisites :

Syllabus : Cellular components interact with each other to carry out their specific functions. One way to understand cellular processes at system level is to model them as networks of interactions. The Objective of the course is to understand underlying computational challenges posed by such models. Algebraic graph theory, machine learning and statistics have been widely used for inference and analysis of such networks. This course aims to discuss state-of-the-art algorithms, demonstrate their use in understanding molecular mechanism at systems levels along with limitations. The course would not require any biological background and all relevant biological concepts would be introduced in the course.

Introduction: Molecular Cell Biology, Systems Biology, Networks; Biological Networks: Transcriptional Regulatory Networks, Protein-protein interaction networks, Metabolic Networks, Genetic Networks, Disease Networks; Networks Measures; Inference of Networks: Graphical Models, Kernel based method, Regression based method, Information Theory based models; Network Analysis: Generic organizing principles of biological

networks; Network integration; Application of networks in disease diagnosis and drug target prediction. Application of model verification and formal methods.

Texts :

1. Edda Klipp, Wolfram Liebermeister, Christoph Wierling, Axel Kowald, Hans Lehrach, and Ralf Herwig. Systems Biology: A Textbook, Wiley-Blackwell, 2009.

References :

1. Uri Alon. An Introduction to Systems Biology - Design Principles of Biological Circuits, CRC Press, 2007.
2. Mark E. J. Newman. Networks: An Introduction, Mark Newman, Oxford University Press, 2010.
3. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Molecular Biology of the Cell, Garland Science (Taylor & Francis Group), 2007.

CS562 MOBILE ROBOTICS 3-0-0-6

Pre-requisites : Nil

Syllabus : Introduction to Mobile robot architectures, Control Paradigms, Sensors and actuators. Learning Approaches for robots. Navigation Strategies, Detecting and handling Novelty. Behavior-based robotics, AlE and their application to robots. Case studies of learning robots, Laboratory sessions will include study and implementations of the above methodologies using real robots.

Texts :

1. U. Nehmzow, Mobile Robotics - A Practical Introduction, 2nd Ed, Springer, 2003.
2. L. N. de Castro and J. Timmis, Artificial Immune Systems: A New Computational Intelligence Approach, Springer, 2002.
3. D. Dasgupta, Artificial Immune Systems and Their Applications, Springer, 1999.
4. R. C. Arkin, Behaviour Based Robotics, MlT Press, 1998.

References :

CS 558 Digital Watermarking 3-0-0-6

Pre-requisites : Nil

Digital Watermarking Fundamentals - Spatial-Domain Watermarking, Substitution Watermarking in the Spatial Domain, Additive Watermarking in the Spatial Domain, Frequency-Domain Watermarking, Substitution Watermarking in the Frequency Domain, Multiplicative Watermarking in the Frequency Domain, Watermarking Based on Vector Quantization, The Rounding Error Problem, The Fragile Watermark, The Block-Based Fragile Watermark, Weaknesses of the Block-Based Fragile Watermark, The Hierarchical Block-Based Fragile Watermark, The Robust Watermark, The Redundant Embedding Approach, The Spread Spectrum Approach. Watermarking Attacks and Tools - Image Processing Attacks, Attacks by Filtering, Attack by Remodulation, Attack by JPEG Coding Distortion, Attack by JPEG 2000 Compression, Geometric Transformation, Attack by Image Scaling, Attack by Rotation, Attack by Image Clipping, Attack by Linear Transformation, Attack by Bending, Attack by Warping, Attack by Perspective Projection, Attack by Collage, Attack by Template, Cryptographic Attach, Protocol Attacks, Watermarking Tools.

Text/References

1 Information Hiding (Steganography and Watermarking - Attacks and Countermeasures), Johnson, Neil F./ Duric, Zoran/ Jajodia, Sushil , luwer Academic Pub, 2001

2 Information Hiding Techniques for Steganography and Digital Watermarking ,Katzenbeisser, Stefan (Edt)/ Petitcolas, Fabien, A.P. (Edt) , Artech House, 2000

3 Intelligent Watermarking Techniques, J-S Pan, H-C Huang, L.C. Jain, World Scientific Pub. Co., 2004

4 Aliroo Home page, "www.aliroo.com

5 "ImageLock Home page", www.imagelock.com

6 "Digimarc Home page", www.digimarc.com

CS 559 Steganography 3-0-0-6

Pre-requisites : Nil

Origins & Overview of Steganography - History of Use, Covert Messaging, Null Cipher Messages, Steganography vs. Encryption, Threats Posed by Steganography Use, Steganography in the Media, Availability & Production. Digital Carriers - Used to Exploit Human Weaknesses, Digital Images - Palette, True Color, Compressed Lossy, lossless, Formats: BMP, JPG, GIF, PNG, Digital Audio, Converters, Signal Processors, Wav files MP3, Dangers. Steganography Embedding Tools - Steganography Methods, Data Appending, Formatting Modification, Word Substitution, Color Palette Substitution, 24 Bit LSB Encoding, DCT Modification, PNS Modification, Covert Channels. Steganalysis - An Overview, The Statistical Properties of Images, The Visual Steganalytic System, IQM-Based Steganalytic System, Learning Strategies, Introduction of the Support Vector Machine, Neural Networks, Principle Component Analysis, Frequency-Domain Steganalytic System.

Texts

1 Information Hiding (Steganography and Watermarking - Attacks and Countermeasures), Johnson, Neil F./ Duric, Zoran/ Jajodia, Sushil , luwer Academic Pub, 2001
2 Information Hiding Techniques for Steganography and Digital Watermarking ,Katzenbeisser, Stefan (Edt)/ Petitcolas, Fabien, A.P. (Edt) , Artech House, 2000
3 Intelligent Watermarking Techniques, J-S Pan, H-C Huang, L.C. Jain, World Scientific Pub. Co., 2004
4 Aliroo Home page, "www.aliroo.com
5 "ImageLock Home page", www.imagelock.com
6 "Digimarc Home page", www.digimarc.com

CS 560 Digital Image Processing 3-0-0-6

Pre-requisites : Nil

Introduction - Elements of digital image processing systems, Elements of visual perception, brightness, contrast, hue, saturation, machband effect, Color image fundamentals - RGB, HSI models, Image sampling, Quantization, dither, Two-dimensional mathematical preliminaries, 2D transforms - DFT, DCT, KLT, SVD. Image Enhancement - Histogram equalization and specification techniques, Noise distributions, Spatial averaging, Directional Smoothing, Median, Geometric mean, Harmonic mean, Contraharmonic mean filters, Homomorphic filtering, Color image enhancement. Image restoration - Degradation model, Unconstrained restoration - Lagrange multiplier and Constrained restoration, Inverse filtering-removal of blur caused by uniform linear motion, Wiener filtering, Geometric transformations-spatial transformations. Image segmentation - Edge detection, Edge linking via Hough transform – Thresholding - Region based segmentation – Region growing – Region splitting and Merging – Segmentation by morphological watersheds – basic concepts – Dam construction – Watershed segmentation algorithm. Compression - Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, Vector Quantization, Transform coding, JPEG standard, MPEG. Image. Morphology - Preliminaries, dilation, erosion, open and closing, hit or miss transformation, basic morphologic algorithms.

Texts

1. Digital Image Processing, Rafael C.Gonzalez, Richard E.Woods, Second Edition, Pearson Education/PHI, 2000.
2. . W.K.Pratt, Digital Image Processing ,3/e Edn., John Wiley & sons, Inc. 2006.
3. K. R. Castleman, Digital Image Processing, Pearson, 2006.
4. Anil K. Jain, Fundamental of image processing, Pearson, 2002.

References

1. Image Processing, Analysis, and Machine Vision, Milan Sonka, Vaclav Hlavac and Roger Boyle, Second Edition, Thomson Learning, 2008.
2. Introduction to Digital Image Processing with Matlab, Alasdair McAndrew, Thomson Course Technology,2001.
3. Computer Vision and Image Processing, Adrian Low, Second Edition, B.S. Publications, 2005.
4. Digital Image Processing using Matlab, Rafael C.Gonzalez, Richard E.Woods, Steven L. Eddins, Pearson Education, 2007.

CS563 Video Processing 3-0-0-6

Basic Steps of Video Processing: Analog Video, Digital Video. Time-Varying Image Formation models: Three-Dimensional Motion Models, Geometric Image Formation, Photometric Image Formation, Sampling of Video signals, Filtering operations. 2-D Motion Estimation: Optical flow, General Methodologies, Pixel Based Motion Estimation, Block- Matching Algorithm, Mesh based Motion Estimation, Global Motion Estimation, Region based Motion Estimation, Multi resolution motion estimation, Waveform based coding, Block based transform coding, Predictive coding, Application of motion estimation in Video coding.

TEXTS:

1. Digital Image Processing – Gonzaleze and Woods, 3rd Ed., Pearson.
2. Video Processing and Communication – Yao Wang, Joem Ostermann and Ya–quin Zhang. 1st Ed., PH Int.

REFRENCES:

1. Digital Image Processing and Analysis-Human and Computer Vision Application with CVIP Tools – Scotte Umbaugh, 2nd Ed, CRC Press, 2011.
2. Digital Video Processing – M. Tekalp, Prentice Hall International.
3. Digital Image Processing – S.Jayaraman, S.Esakkirajan, T.Veera Kumar – TMH, 2009.
4. Multidimentional Signal, Image and Video Processing and Coding – John Woods, 2nd Ed, Elsevier.
5. Digital Image Processing with MATLAB and Labview – Vipula Singh, Elsevier.
6. Video Demystified – A Hand Book for the Digital Engineer – Keith Jack, 5th Ed., Elsevier.

CS564 Natural Language Processing 3-0-0-6

Lexical Functional Grammar, Tree Adjoining Grammar, Government & Binding, Paninian Grammar. Comparison of Paninian Grammar with others. Logical Semantics, Script, Conceptual Dependency. Paragraph, Story, Dialogue understanding. Anaphora Resolution. Machine Translation with special reference to Indian Languages. Natural language interfaces to databases. Introduce more new research oriented topics, topics of current research which will focus on the state- of-the-art in various areas of Natural Language Processing.

TEXTS:

1. Grasz, Jones & Webber (Ed.): Readings in Natural Language Processing, Morgan Kaufmann, 1986.
2. Gazdar & Mellish: Natural Language Processing in PROLOG, Addision Wesley, 1989.
3. Leonard Bolc. (Ed.): Natural Language Parsing Systems, Springer Verlag, 1987.
4. McDonald & Bolc. (Ed.): Natural Language Generation Systems, Springer Verlag, 1987.
5. W. J. Hutchins: Machine Translation - Past, Present & Future, Ellis Horwood, 1986.
6. Bharati, Chaitanya and Sangal: Natural Language Processing- a Paninian perspective, PHI, 1985.

CS565 Cloud Computing 3-0-0-6

Business and IT perspective, Cloud and virtualization, Cloud services requirements, cloud and dynamic infrastructure, cloud computing characteristics, cloud adoption. Cloud characteristics, Measured Service, Cloud models, security in a public cloud, public verses private clouds, cloud infrastructure self service. Gamut of cloud solutions, principal technologies, cloud strategy, cloud design and implementation using SOA, Conceptual cloud model, cloud service demand. Cloud ecosystem, cloud business process management, cloud service management, cloud stack, computing on demand, cloud sourcing. Cloud analytics, Testing under cloud, information security, virtual desktop infrastructure, Storage cloud. Resiliency, Provisioning, Asset management, cloud governance, high availability and disaster recovery, charging models, usage reporting, billing and metering. Virtualization defined, virtualization benefits, server virtualization, virtualization for x86 architecture, Hypervisor management software, Logical partitioning, VIO server, Virtual infrastructure requirements**.** Storage virtualization, storage area networks, network attached storage, cloud server virtualization, virtualized data center. SOA journey to infrastructure, SOA and cloud, SOA defined, SOA defined, SOA and IAAS, SOA based cloud infrastructure steps, SOA business and IT services.

TEXTS:

1. Cloud Computing by Dr. Kumar Saurabh, Wiley India, 2011.

References

1. Michael Miller, Cloud Computing: Web based applications that change the way you work and collaborate online, Que publishing , August 2009
2. Haley Beard, Cloud Computing Best Practices for Managing and Measuring Processes for On Demand computing applications and data Centers in the Cloud with SLAs, Emereo Pty Limited, July 2008.

CS566 Big Data 3-0-0-6

Introduction to Big Data Analytics - Big Data Overview, State of the Practice in Analytics, The Data Scientist, Big Data Analytics in Industry Verticals, Data Analytics Lifecycle, Review of the Basic Data Analytic Methods using R, Introduction to R – look at the data, Analyzing and Exploring the Data, Statistics for Model Building and evaluation. Advanced Analytics - K-means clustering, Association rules, Linear Regression, Logistic Regression, Naïve Bayes, Decision Trees, Time Series Analysis, Text Analysis, Analytics for Unstructured Data (MapReduce and Hadoop), The Hadoop Ecosystem, In-database Analytics – SQL Essentials, Advanced SQL and MADlib for in-database.

Texts

1. "Big Data" by Viktor Mayer-Schönberger, Kenneth Cukier, ISBN:978- 0544002692, Eamon Dolan/Houghton Mifflin Harcourt 2013
2. "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence" by Pramod J. Sadalage, Martin Fowler, ISBN:978- 0321826626, Addison-Wesley, 2012

References:

1. “Hadoop Operation”, by Eric Sammer, ISBN: 978-1449327057, O’Reilly 2012
2. “MapReduce Design Patterns: Building Effective Algorithms and Analytics for Hadoop and Other Systems”, by Donald Miner, Adam Shook, ISBN: 978-1449327170, O’Reilly 2012
3. “Big Data Now”, by O’Reilly Media Inc., ASIN: B0097E4EBQ, O’Reilly 2012