DEPARTMENT OF COMPUTER & SYSTEM SCIENCES
Siksha Bhavana, Visva-Bharati, Santiniketan
M.Sc. (Computer Science) Course Structure
(Under Choice Based Credit System)

	Paper Code	Paper	Credits
Semester I	MCSC 11	Theory of Computation	4(3L+1T)
	MCSC 12	Advanced Data Structures	4(3L+1T)
	MCSC 13	Computational Statistics	4(3L+1T)
	MCSC 14	Advanced Software Engineering	4(3L+1T)
	MCSC 15	Operations Research	4(3L+1T)
	MCSC 16	Computing Lab and Viva Voce I	4
Semester II	MCSC 21	Advanced Algorithms	4(3L+1T)
	MCSC 22	Compiler Construction	4(3L+1T)
	MCSC 23	Fuzzy Systems	4(3L+1T)
	MCSC 24	Advanced Computer Architecture	4(3L+1T)
	MCSC 25	Network Systems and Protocols	4(3L+1T)
	MCSC 26	Computing Lab and Viva Voce II	4
Semester III	MCSC 31	Machine Learning	4(3L+1T)
	MCSC 32	Algorithmic Graph Theory	4(3L+1T)
	MCSC 33	Distributed Systems	4(3L+1T)
	MCSO XY	From List 1	4(3L+1T)
	MCSE 3X	From List 2	4(3L+1T)
	MCSP 31	Project Design	2
	MCSV 31	Seminar and Grand Viva I	2
Semester IV	MCSC 41	Image Processing and Computer Vision	4(3L+1T)
	MCSC 42	Advanced Database Management Systems	4(3L+1T)
	MCSC 43	Parallel Algorithms	4(3L+1T)
	MCSO XY	From List 1	4(3L+1T)
	MCSO XY	From List 1	4(3L+1T)
	MCSP 41	Project Implementation	2
	MCSV 41	Seminar and Grand Viva II	2
		Total Credit	**96**

List 1 (MCSO XY)

Paper Code	Paper
MCSO 01	3D Graphics
MCSO 02	Advanced Intelligence
MCSO 03	Approximation Algorithms
MCSO 04	Artificial Neural Network
MCSO 05	Complex Networks
MCSO 06	Computational Geometry
MCSO 07	Cryptography and Network Security
MCSO 08	Data Analytics
MCSO 09	Data Mining
MCSO 10	Human Computer Interaction
MCSO 11	Imprecise Mathematics
MCSO 12	Information and Coding Theory
MCSO 13	Internet of Things
MCSO 14	Natural Language Processing
MCSO 15	Quantum Computation and Information
MCSO 16	Randomized Algorithms
MCSO 17	Wireless Network

List 2 (MCSE 3X)*

Paper Code	Paper
MCSE 31	Bioinformatics
MCSE 32	Cyber Security
MCSE 33	Discrete Event System Simulation
MCSE 34	Evolutionary Computing
MCSE 35	Multimedia Systems

***Only one to be offered and made available to the students of other departments.**

Semester I

MCSC 11: Theory of Computation

Review of Finite and pushdown automata, regular and context free grammar. [6L]
Turing machines and Turing computability: Basic Turing machine model, Turing computability, non-deterministic Turing machines, variants of Turing machines, universal Turing Machines. [6L]
Hierarchy of formal languages and automata: Recursive and recursively enumerable languages, context sensitive grammars and linear bounded automata, Chomsky hierarchy. [6L]
General grammar: Grammatically computable functions, equivalence of grammatically computable functions and Turing computable functions. [6L]
Recursive function theory: Primitive recursive functions, Goeldelization, $\mu-$recursive functions, Turing computability of primitive recursive and $\mu-$recursive functions, Church-Turing thesis. [7L]
Uncomputability: Halting problem, unsolvable problems about Turing machines, $\mu-$recursive functions, and grammars. [8L]
Complexity theory: Complexity classes P, NP and NP-Complete, some NP-Complete problems. [6L]

References

1. An Introduction to Formal Languages and Automata - Peter Linz, Narosa.
2. Elements of Theory of Computation - H R Lewis & C H Papadimitrou, PHI.
3. Introduction of Automata Theory, Languages and Computation - J E Hopcroft, R Mowani, J D Ullman, Pearson.
4. Introduction to the Theory of Computation - M Sipser, Thomson.

MCSC 12: Advanced Data Structures

Hashing: hash functions and tables, collision, overflow, linear probing, hashing with chains, static and dynamic hashing. [4L]
Important basic Data Structures: Priority Queues,Dictionary, Mergable Heaps using binary search trees, Binomial Trees, Binomial Heaps, Fibonacci Heaps. [16L]
Data Structures for set manipulation: Union and Find algorithms. [6L]
Multiway Search Tree. [4L]
Balanced Search Tree: Red-Black, Splay Tree, B-Tree, B+ Tree. [7L]
Digital Search Structures: digital search tree, binary tries, compressed binary tries, patricia, suffix tree. [4L]
Tries and Internet Packet Forwarding: 1-bit trie, fixed and variable strides, IP routing. [4L]

References

1. Fundamentals of Data Structures in C - E. Horowitz, S. Sahni and S. Anderson, Freed University Press.
2. Introduction to Algorithms - T.H. Cormen, C. E. Leiserson and R. L. Rivest, Prentice Hall of India (PHI).

3. Data Structures, Algorithms and Applications in Java - Sartaj Sahni and S. Anderson, Freed University Press.

4. Advanced Data Structure - Cohen.

MCSC 13: Computational Statistics

Data, Types of Data, Data representation – Histogram, Absolute frequency, and Relative frequency. Notion of central tendency – Mean, Median, Mode. Measure of dispersion – Range, standard deviation, Variance. [6L]
Introduction to random variable, Types of random variables, Support, probability function – Mass function, Density function, Distribution function. expectation and its properties. [8L]
Association between two datasets, Dependency of one dataset over other, Measure of degree of association – Pearson correlation, Spearman's rank correlation, Canonical correlation. Problem of regression – Linear, Non-linear. [9L]
Signification of parameter(s) in a probability distribution, Problem of estimation, Properties of good estimates, Different types of estimates – Unbiasedness, Consistency, likelihood function, Minimum likelihood estimate. [14L]
Notions of state transition, Markov chain, Asymptotic characteristics, Concept of entropy. [4L]
Notion of queuing, different types of queues – their properties. [4L]

References

1. Outlines of Statistics, Volume 1 - Goon, Gupta, Dasgupta.

2. Linear Statistical Inference and its Applications, 2^{nd} Edition - C. Radhakrishna Rao.

3. Probability, Random Variables and Stochastic Processes - Athanasios Papoulis and S U Pillai.

MCSC 14: Advanced Software Engineering

Review: Softwares and Hardwares, various types of software, Changing Nature of software. Comparative studies on various software lifecycle models. Software Requirement Specifications (SRS). Case Study with some real life examples. [10L]
Software Project Planning: Lines of Codes(LOC), Person Month(PM), The Constructive Cost Model (COCOMO), COCOMO II, The Putnam Resource Allocation Model, The Norden / Rayleigh Curve, Difficulty Matric, Productivity versus difficulty, Trade off between time versus cost. [4L]
Software Risk management. [10L]
Software Design: Modularity, Module coupling and Module cohesion, Relation between coupling and cohesion. Bottom-up top down and hybrid design. [5L]
Software Matrics: Definitions, Healstead Software matrices, Program Length, Volume, effective volume, Estimated Program level Difficulty, Effort and Time. Software Reliability. [6L]
Software Testing and Maintenance: Functional Testing , Equivalence class partitioning, Boundary value analysis, Decision Table based analysis. Structural Testing: Path testing, cyclomatic complexity, Graph Matrics, Data flow testing, Mutation testing. Levels of testing: Unit testing, Integration testing, System testing and Validation testing. Software maintenance processes, Models , estimation of maintenance cost, Software Reverse Engineering and Software Re-engineering. [10L]

References

1. Software Engineering a Practitioner's Approach - R S Pressman, McGraw Hill.
2. An Integrated Approach to Software Engg - Jalota P, Narosa, Delhi.
3. Fundamentals of Software Engg - Ghezzi C et al, Prentice Hall of India.
4. Fundamentals of Software Engg - Rajib Mal, PHI Learning.

MCSC 15: Operations Research

Introduction: Features of OR Approach, Different Models, Methods for Solving OR Models. Notion of Convex set. [7L]
Linear Programming: Structure of LP Model, LP Model Formulation, Graphical Method - Extreme Point Solution Method, Simplex Method - Maximization case and Minimization case, Two-Phase Method and Big-M Method. [10L]
Duality: Primal and Dual, Rules for Constructing the Dual from Primal, Interpretation of Dual Variables and Constraints, Comparisons of the Solutions, Advantages of Duality. [4L]
Revised Simplex Method: Computational Procedure,Comparison with Simplex Method. [2L]
Dual-Simplex Method: Dual-Simplex Algorithm to Solve some LP Problems. [2L]
Integer Linear Programming: Types of ILP, Cutting Plane Method, Branch and Bound Method, Zero-One ILP. [6L]
Transportation Problem: Balanced and Unbalanced TP, General Mathematical Model of TP, The Transportation Algorithm, North-West Corner Method, Least Cost Method, Vogel's Approximation Method, Optimality Testing, Dual of Trasportation Model, MODI Method, Close-Loop. [8L]
Assignment Problem: Balanced and Unbalanced AP, Mathematical Model of an AP, Hungarian Method,Variations of the AP. [6L]

References

1. Operations Research Theory and Applications - J.K.Sharma, Trinity Press.
2. Operations Research Principles and Applications - G.Srinivasan, PHI Learning Private Limited.
3. Operations Research An Introduction - Hamdy A. Taha, Pearson.
4. Operations Research Principles and Practice - Ravindran,Phillips and Solberg, Wiley India.
5. Operations Research Concepts and Cases - Hillier and Liberman, McGraw-Hill.

MCSC 16: Computing Lab and Viva Voce I

Assignments are based on all theory papers.

Semester II

MCSC 21: Advanced Algorithms

Review: Model of Computation, Notion of worst and average case time complexities. [4L]
Basic techniques: Divide and conquer, Dynamic programming, Greedy techniques including greedy algorithms on matroids. [10L]
Amortized analysis techniques: Aggregate, Accounting, and Potential method. [4L]
Graph Algorithms: Review of BFS, DFS, Connected components, Biconnected Components, Minimum spanning forest, Strongly connected components, Single Source and all pair shortest path. [10L]
Matrix: Strassen's Matrix Multiplication and Inversion algorithms. [4L]
Fast Fourier Transform and Polynomial multiplication. [5L]
NP-Completeness: Decision vs. Optimization problems, formal language framework for decision problems, reducibility, Class P, NP, NP-Hard, NP-Complete problems, Proving NP-Completeness of Basic problems. [8L]

References

1. Design and Analysis of Computer Algorithms - Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, Pearson.
2. Introduction to Algorithms - Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, The MIT Press.
3. Algorithms Design - Jon Klienberg and Eva Tardos, Pearson.
4. Computer Algorithm: Introduction to Design and Analysis - Sara Baase & A.V. Gelder, Pearson.
5. Once upon an Algorithm - How Stories Explain Computing - Martin Erwig, The MIT Press.

MCSC 22: Compiler Construction

Introduction: Compilers and Translators, Structure of a Compiler, Compiler writing tools, Lexical and syntactic structure of a language. [5L]
Lexical analysis: Finite automata, Regular expression, Lexical analyser generator. [5L]
Syntax Analysis: Notion of top-down and bottom-up parsing, LL parsing, Operator-precedence parsing, LR parsing (SLR, LALR, and Canonical LR parsing), Syntax Directed Translation, Parser generator. [16L]
Semantic Analysis: Declaration processing, Type checking, Symbol tables. [5L]
Intermediate Code Generation: Run-time environments, translation of language constructs. [5L]
Code Generation: Flow-graphs, Register allocation, Code-generation algorithms. [5L]
Error handling and recovery. [2L]
Code optimization techniques. [2L]

References

1. Principles of Compiler Design - Alfred V. Aho, Jeffrey D. Ullman, R Sethi Jeffrey D. Ullman, Monica S Lam, Pearson.

2. Compiler Design in C - Allen I.Holub, Prentice Hall of India, 1993.

3. Compiler Construction: Principles & Practice - Kenneth C. Louden, Thomson Learning 2003.

4. The Theory and Practice of Compiler Writing - Jean-Paul Tremblay and Paul G. Sorrenson, McGraw Hill Book Co.

MCSC 23: Fuzzy Systems

Introduction: Classical Sets and Fuzzy Sets: Background, Uncertainty and Imprecision, Statistics and Random Processes, Uncertainty in Information, Fuzzy Sets and Membership, Chance versus Ambiguity. Classical Sets - Operations on Classical Sets, Properties of Classical (Crisp) Sets, Mapping of Classical Sets to Functions Fuzzy Sets - Fuzzy Set operations, Properties of Fuzzy Sets. Sets as Points in Hypercubes. [6L]
Classical Relations and Fuzzy Relations: Cartesian Product, Crisp Relations- Cardinality of Crisp Relations, Operations on Crisp Relations, Properties of Crisp Relations, Composition. Fuzzy Relations - Cardinality of Fuzzy Relations, Operations on Fuzzy Relations, Properties of Fuzzy Relations, Fuzzy Cartesian Product and Composition, Non-interactive Fuzzy Sets. Tolerance and Equivalence Relations - Crisp Equivalence Relation, Crisp Tolerance Relation, Fuzzy Tolerance and Equivalence Relations. Value Assignments - Cosine Amplitude, Max-min Method, Other Similarity methods. [6L]
Membership Functions: Features of the Membership Function, Standard Forms and Boundaries, Fuzzification, Membership Value Assignments – Intuition, Inference, Rank Ordering, Angular Fuzzy Sets, Neural Networks, Genetic Algorithms, Inductive Reasoning. [6L]
Fuzzy-to-Crisp Conversions, Fuzzy Arithmetic: Lambda-Cuts for Fuzzy Sets, Lambda-Cuts for Fuzzy Relations, Defuzzification Methods Extension Principle - Crisp Functions, Mapping and Relations, Functions of fuzzy Sets – Extension Principle, Fuzzy Transform (Mapping), Practical Considerations, Fuzzy Numbers Interval Analysis in Arithmetic, Approximate Methods of Extension - Vertex method, DSW Algorithm, Restricted DSW Algorithm, Comparisons, Fuzzy Vectors. [7L]
Classical Logic and Fuzzy Logic: Classical Predicate Logic – Tautologies, Contradictions, Equivalence, Exclusive OR and Exclusive NOR, Logical Proofs, Deductive Inferences. Fuzzy Logic, Approximate Reasoning, Fuzzy Tautologies, Contradictions, Equivalence and Logical Proofs, Other forms of the Implication Operation, Other forms of the Composition Operation. [6L]
Fuzzy Rule- Based Systems: Natural Language, Linguistic Hedges, Rule-Based Systems - Canonical Rule Forms, Decomposition of Compound Rules, Likelihood and Truth Qualification, Aggregation of Fuzzy Rules, Graphical Techniques of Inference. [5L]
Fuzzy Decision Making: Fuzzy Synthetic Evaluation, Fuzzy Ordering, Preference and consensus, Multiobjective Decision Making, Fuzzy Bayesian Decision Method, Decision Making under Fuzzy States and Fuzzy Actions. [5L]
Fuzzy Clustering: Cluster Analysis, Cluster Validity, c-Means Clustering - Hard c-Means (HCM), Fuzzy c-Means (FCM), Hardening the Fuzzy c-Partition, Similarity Relations from Clustering. [4L]

References

1. Fuzzy Sets and Fuzzy Logic-Theory and Applications - George J. Klir and Bo Yuan, Prentice Hall.

2. Fuzzy Logic with Engineering Applications -Timothy J. Ross, Willey.

3. Fuzzy Logic: Intelligence, Control and Information - John Yen and Reza Langari, Pearson Publications.

MCSC 24: Advanced Computer Architecture

Overview: Basic structure of Computer Hardware and Software: Functional Units, Basic Operational Concepts, Bus structures, Software, performance. [5L]
Memory locations, Addresses and encoding of information, Main memory Operations, Instructions, Addressing Modes, Assembly language, Basic Input-output Operations, A complete CPU: case study. Hardware control and Micro program Control and Microinstructions. [8L]
Memory: Multilevel memory, Memory hierarchy, Cache Memory, cache mapping, Direct mapping, Associative mapping, Set-Associative mapping, Cache replacement algorithms.
Associative memory, Memory interleaving , Virtual Memory, Virtual address , Physical Address, Address space, Memory space , Page table, Memory Management hardware, Address translation, Page fault, Page replacement algorithms. [12L]
Multilevel cache, Primary Cache, secondary cache, Instruction Cache, Cache coherence, Cache Synchronization. [6L]
Pipelining Structure, space time diagram, Speedup ratio, Speed up calculation of a pipeline structure, Pipelining Hazards, data hazards, instruction hazards. [6L]
Amdhal's Law for speedup ratio, various types speedup, explanation with numerical examples.
Parallel architecture: Models of computers, SISD computers, MISD computers, SIMD computers, Shared Memory SIMD computers, MIMD Computers. [5L]
Analyzing Algorithms: Running time, counting steps, lower and upper bounds, Speed up.
Parallel Selection, Merging and sorting. [3L]

References

1. Design and Analysis of Parallel Algorithms - Selim G Akil, Prentice Hall England.

2. Computer Architecture and Organization - J P Hayes, McGraw Hill.

3. Computer Organization - V. Hamacher, McGraw Hill.

4. Computer Organization and Architecture - William Stallings, Pearson Education.

5. Computer Architecture: A Quantitative Approach - John L. Hennessy and David A Patterson, The Morgan Kaufmann Series in Computer Architecture and Design.

MCSC 25: Network Systems and Protocols

Introduction to TCP/IP protocol suite, layering. [2L]
MAC protocols for LAN, MAN and WAN systems - Aloha, CSMA-CD, CSMA-CA, FDDI, DQDB protocols. [10L]
IPv4: IPv4 addressing, subnetting, CIDR and supernetting concepts; header format and functionalities; Dynamic addressing - DHCP, NAT, Proxies; Routing protocols. [6L]
IPv6: Improvements over IPv4, header format and functionalities; QoS handling; DHCPv6; Routing protocols for IPv6. [10L]
Transport layer protocols - UDP, TCP variants; RTP/SCTP. [6L]
DNS [2L]
Real-time Applications: SIP, VoIP [4L]
Secure applications - IPSec, SSL [5L]

References

1. TCP/IP illustrated (Vol-1) - R Stevens, PHI.
2. Computer Networks - A S Tanenbaum; PHI.
3. Relevant RFC's (online).

MCSC 26: Computing Lab and Viva Voce II

Assignments are based on all theory papers.

Semester III

MCSC 31: Machine Learning

Basics: Introduction to machine learning - different forms of learning; Basics of probability theory, linear algebra and optimization. [8L]
Classification Methods: Linear Discriminant Analysis, Large margin classification, Kernel methods, Support Vector Machines. Classification and Regression Trees, Multi-layer Perceptrons and Back propagation. [9L]
Graphical Models: Bayesian Belief Networks, Markov Random Fields, Exact inference methods, approximate inference methods. [4L]
Ensemble Methods: Boosting - Adaboost, Gradient Boosting; Bagging - Simple methods, Random Forest. [4L]
Learning theory: Bias/variance tradeoff. Union and Chernoff/ Hoeffding bounds; VC dimension. Worst case (online) learning; Practical advice on how to use learning algorithms. [8L]
Clustering: Partitional Clustering - k-means, k-medoids; Hierarchical Clustering - Agglomerative, Divisive, Distance measures; Density based clustering - DBScan; Spectral clustering. PCA (Principal components analysis); ICA (Independent components analysis). [5L]
Reinforcement learning and control: MDPs. Bellman equations; Value iteration and policy iteration; Linear quadratic regulation (LQR). LQG; Q-learning. Value function approximation; Policy search. Reinforce. POMDPs. [7L]

References

1. Machine Learning - Tom Mitchell, McGraw-Hill.
2. Pattern Recognition and Machine Learning - C. M. Bishop, Springer, 2006.
3. Pattern Classification - R. O. Duda, P. E. Hart, and D.G. Stork, John Wiley and Sons, 2001.
4. Statistical Learning Theory - Vladimir N. Vapnik, John Wiley and Sons, 1998.
5. An Introduction to Support Vector Machines and Other Kernel-Based Learning Methods - Cristianini, N. and Shawe-Taylor, J., Cambridge University Press, 2000.
6. Introduction to Machine Learning - E. Alpaydin, Prentice Hall of India, 2006.

MCSC 32: Algorithmic Graph Theory

Introduction to Graph Theory: Basic Definitions and Notations, Intersection Graphs, Circular-arc Graphs, Interval Graphs, Line graphs of bipartite graphs, Chromatic number and Chromatic polynomial. [6L]
Perfect and Triangulated Graphs: Definition of perfect graph, Perfect Graph Theorem, p-Critical Graphs, A Polyhedral Characterization of Perfect Graphs, The Strong Perfect Graph Conjecture, Characterizing Triangulated Graphs, Recognizing Triangulated Graphs, Time Complexity, Generating a PEO, Testing an Elimination Scheme, Triangulated Graphs Are Perfect, Some Optimization Algorithms on Triangulated Graphs. [12L]
Comparability Graphs: Implication Classes, The Triangle Lemma, Decomposition of Graphs, Uniquely

Partially Orderable Graphs, Comparability Graph Recognition. [9L]
Some interesting graph families characterized by intersection: Introduction, Permutation graphs, F-Graphs, Tolerance graphs, Bounded and unbounded tolerance graphs. [9L]
Flow Network: Basic properties of a flow, Max Flow - Min Cut theorem, Ford Fulkerson's algorithm, and Edmond Karp's algorithm. [9L]

References

1. Algorithmic Graph Theory and Perfect Graphs - Martin Charles Golumbic, Academic Press.
2. Advanced Topics in Graph Algorithms - Ron Shamir, http://www.cs.tau.ac.il/~rshamir/atga/atga.html.
3. Network Flows: Theory, Algorithms, and Applications - Ravindra K. Ahuja, Thomas L. Magnanti, James B. Orlin, Pearson.

MCSC 33: Distributed Systems

Introduction: Distributed system taxonomy, Client-server computing, Communication models. [6L]
Socket Programming: Network programming using C/Unix, Java. [8L]
Communication: Introduction to RPC, DCE RPC, Multicast Communication, Java RMI. [4L]
Process: Introduction to Threads , Threads in Distributed Systems, Approaches to Code Migration Migration and Local Resources , Migration in Heterogeneous Systems. [4L]
Distributed file system design: NFS, Coda, Google File System (GFS), Hadoop Distributed File System (HDFS), RAID. [9L]
Distributed Synchronization: Logical clocks, vector clocks, clock synchronization, mutual exclusion, election algorithms. [4L]
Fault Tolerance: Basic Concepts, Detecting and Correcting Local Faults, fault tolerant, load balancing and reliability. [4L]
Distributed Web-based Systems: Architecture , Traditional Web-based Systems, Web Services , Hypertext Transfer Protocol, Web Proxy, Replication of Web Applications. [6L]

References

1. Distributed System, Principle and Paradigm - Tanenbaum & Steen , Pearson Education.
2. Distributed Systems: An Algorithmic Approach - Sukumar Ghosh, CRC Press, 2006.

MCSO XY: From List 1

MCSE 3X: From List 2

MCSP 31: Project Design

MCSV 31: Seminar and Grand Viva I

Semester IV

MCSC 41: Image Processing and Computer Vision

Origin of DIP, Digital image representation, fundamental steps in image processing, elements of digital image processing systems, image acquisition, storage, processing, communication and display, Computer Vision, Overview of Diverse Computer Vision Applications-Document Image Analysis, Biometrics, Object Recognition, Tracking Medical Image Analysis, Video Data Processing. [4L]
Structure of the human eye, image formation, brightness adaptation and discrimination, a simple image model, uniform and non-uniform sampling and quantization, some basic relationships between pixels, neighbors of a pixel, connectivity, Labeling. Relations, equivalence and transitive closure, distance measures, imaging geometry. [8L]
Basic gray level transformations, histogram processing, Enhancement using arithmetic/logic operations, Basics of spatial filtering-comparison between smoothing and sharpening spatial filters. [7L]
1D Fourier transform-2D Fourier transform and its Inverse-Smoothing & sharpening frequency domain filters (Ideal, Butterworth, Gaussian)-homomorphic filtering, Introduction to Fourier transform, First Fourier transform, Discrete Fourier Transform. [7L]
Fundamentals-Image compression, Error-free compression, Huffman coding, block coding, constant area coding, variable length coding, bit-plane coding, lossless predictive coding-source and channel encoding-decoding-Lossy compression, lossy predictive coding, transform coding. [9L]
Introduction, definition, Active vision system, Machine vision components, image function and characteristics, segmentation, data reduction, feature extraction, edge detection, image recognition and decisions , Review of Computer Vision applications, Fuzzy Neural algorithms for computer vision applications. [10L]

References

1. Digital Image Processing, 4^{th} Edition - Rafael C. Gonzalez, Richard E. Woods.
2. Computer Vision: Algorithms and Applications - Richard Szeliski.

MCSC 42: Advanced Database Management Systems

Indexing and hashing: Primary and secondary indices, dense and sparse indices, multilevel indices, B+ tree index structure, static and dynamic hash indices. [7L]
Query processing and optimization: evaluation of relational operations, materialization and pipelining approaches of query evaluation, transformation of relational expressions, estimation of statistics about relational expressions, heuristics in optimization. [11L]
Transaction management and recovery: ACID properties, conflict and view serializability, precedence graph, recoverability, two-phase locking protocol, tree protocol, timestamp-based protocols, stable-storage, log-based recovery. [11L]
Parallel databases: Architectures, data partitioning techniques, parallel sort and join. [4L]
Distributed databases: Data replication and fragmentation, distributed transactions, two-phase commit protocol, three-phase commit protocol, distributed query processing. [4L]
Advanced data types: Concepts of temporal, spatial, and multimedia databases. [4L]
Advanced applications: Concepts of data warehousing, OLTP, OLAP, and data mining. [4L]

References

1. Database System Concept - A Silberschatz, H F Korth, S. Sudarshan, McGraw Hill.
2. Database management systems - R. Ramakrishnan and J. Gehrke, McGraw Hill.
3. Fundamentals of Database Systems - R Elmasri, S B Navathe, Pearson.

MCSC 43: Parallel Algorithms

Basic Concepts: Basic definitions and terminologies. [2L]
Models of parallel computation: DAG, PRAM, interconnection networks etc. [4L]
Performance of parallel algorithms, Basic algorithm design techniques. [9L]
Sorting: Odd Even Merge Sort, Bitonic Sort, Parallel merge sort, Sorting in meshes, Hypercubes, Butterfly networks, CCC networks, Cole's Merge Sort. [10L]
Searching Algorithms. [3L]
Optimal List ranking and applications, Tree Traversal and related parallel algorithms, Euler tool technique. [6L]
Graph Algorithms: Connected Components, Minimum Spanning Tree, Shortest paths. [4L]
Limits to parallelizability. Lower bounds. [3L]
Limits to parallelizability. NC-Reductions, P-Completeness. [4L]

References

1. Parallel Algorithms - Joseph Jaja.
2. Design and Analysis of Parallel Algorithms - S G Akl, PHI.
3. Parallel Computing: Theory and Practice - M J Quinn, Tata-McGraw Hill.

MCSO XY: From List 1

MCSO XY: From List 1

MCSP 41: Project Implementation

MCSV 11: Seminar and Grand Viva II

List 1

MCSO 01: 3D Graphics

3D Object Representation: Polyhedra and Different Quadratic Surfaces, Splines. [8L]
3D Viewing: 3D Transformation, Projections: Perspective and Parallel. [10L]
Surface Determination: Visible Surface and Hidden Surface Determination Algorithms, Wireframe Algorithm, Polygon Cully. [10L]
Light and Shading: Light Source, Basic Elimination Models, Ambient Light, Ray Tracing Methods, Different Shading Models. [9L]
Texture Mapping: Linear, Surface and Volumn Texture Graphics. [8L]

References

1. Computer Graphics with OpenGL - Donald Hearn and M. Pauline Baker, Pearson.
2. Procedural Elements for Computer Graphics - David F. Rogers, Tata McGraw Hill.

MCSO 02: Advanced Intelligence

Collective intelligence: General intelligence vs. Collective intelligence, The wisdom of crowds vs. the madness of mobs, AI and Collective Intelligence, Combining Human and Machine Intelligence, The Deliberatorium, Nonlinear Negotiation. [10L]
Swarm Intelligence: Introduction of Swarm Intelligence, Examples from nature, computational principles and artificial swarms including robotic materials, Ant Colony Optimziation, Bee colony Optimization, Particle Swarm Optimization, Wolf pack algorithm. [10L]
Game Theory: Introduction, Theory of rational choice, Interacting decision makers, Strategic games: examples, Nash equilibrium: concept and examples, Best response functions, Dominated Actions, Symmetric games and symmetric equilibria, Illustrations of Nash Equilibrium, Cournot's model of duopoly market, Bertrand's model of duopoly market, Electoral Competition, War of Attrition, Auctions, Accident Laws, Mixed Strategy, Nash Equilibrium. [20L]
Generative Adversarial Networks (GANs): Generative vs. Discriminative Algorithms, Training a GAN, Bidirectional GAN, Application of GAN. [5L]

References

1. Swarm Intelligence: From natural to artificial systems - E. Bonabeau, G. Theraulaz, and M. Dorigo, 1999.
2. Swarm Intelligence - Eberhardt, Shi and Kennedy, 2001.
3. Game Theory - Fudenberg, Drew, and Jean Tirole, MIT Press, 1991. ISBN: 9780262061414.
4. An Introduction to Game Theory - Osborne, M.J., Oxford University Press, 2004.
5. Handbook of Collective Intelligence - Edited by Thomas W. Malone and Michael S. Bernstein, MIT Press.

6. Unsupervised representation learning with deep convolutional generative adversarial networks - Radford, A., Metz, L., & Chintala, S. (2015), arXiv preprint arXiv:1511.06434.

7. Unrolled generative adversarial networks - Metz, L., Poole, B., Pfau, D., & Sohl-Dickstein, J. (2016), arXiv preprint arXiv:1611.02163.

MCSO 03: Approximation Algorithms

Introduction: Review of theory of NP-Completeness. Need for approximation algorithms, Basic definitions and terminologies. [5L]
Design Techniques: Concept of lower bound and its use, Minimum spanning tree based apprroximation algorithms, Greedy method, Recursive greedy method, LP based design techniques, Randomized approximation algorithm design techniques. [16L]
Approximation Schemes: Design techniques of PTAS, FPTAS. [12L]
Hardness of Approximation: Approximation preserving reductions, Classes APX, APX-Hard, APX-Complete, Gap introducing reductions, Gap preserving reductions, PCP theorem. [12L]

References

1. The Design of Approximation Algorithms - Williamson and Shmoys, Cambridge University Press.

2. Approximation Algorithms - V V Vazirani, Springer Verlag.

MCSO 04: Artificial Neural Network

Prerequisite: MCSC 31: Machine Learning
Introduction: Feedforward Neural networks. Gradient descent and the backpropagation algorithm. Unit saturation, aka the vanishing gradient problem, and ways to mitigate it. RelU Heuristics for avoiding bad local minima. Heuristics for faster training. Nestors accelerated gradient descent. Regularization. Dropout. [9L]
Attractor Neural Networks: Associative Learning Attractor Associative Memory, Linear Associative memory, Hopfield Network, application of Hopfield Network. [5L]
Self-organization Feature Map: Maximal Eigenvector Filtering, Extracting Principal Components, Generalized Learning Laws, Vector Quantization, Self-organization Feature Maps, Application of SOM, Growing Neural Gas. [5L]
Convolutional neural networks: CNN Architectures, Convolution, Pooling Layers, Transfer Learning, Image Classification using Transfer Learning. [6L]
Recurrent Neural Networks: LSTM, GRU, Encoder/Decoder Architectures. [5L]
Deep Unsupervised Learning: Autoencoders (standard, sparse, denoising, contractive, etc), Variational Autoencoders, Adversarial Generative Networks, Autoencoder and DBM. [9L]
Applications of Deep Learning to Computer Vision: Image segmentation, object detection, automatic image captioning, Image generation with Generative adversarial networks, video to text with LSTM models. Attention models for computer vision tasks. [6L]

References

1. An Introduction to Neural Networks - James A Anderson, MIT Press, 1995.
2. Introduction to Artificial Neural Systems -Jacek M. Zurada, PWS Publishing Company, 1995.
3. Pattern Recognition and Neural Networks - B. D. Ripley, Cambridge University Press., 1996.
4. Deep learning - Bengio, Yoshua, Ian J. Goodfellow, and Aaron Courville, MIT Press (2017).
5. Learning Deep Architectures for AI - Yoshua Bengio, Foundations and Trends in Machine Learning 2.1 (2009): 1127.
6. Long Short-Term Memory - Sepp Hochreiter and Jargen Schmidhuber, Neural computation 9.8 (1997): 17351780.

MCSO 05: Complex Networks

Introduction: Review of topics in probability and linear algebra, examples of real-world networks and their properties. [4L]
Fundamentals of network theory: Adjacency matrix, weighted graphs, directed graphs, hypergraphs, bipartite graphs, trees, planar graphs, degree, paths, diameter, components, independent paths, connectivity, cut sets, maximum flows and cut sets on weighted graphs, graph Laplacian, random walks, Centrality measures - degree centrality, closeness centrality, betweenness centrality, eigenvector centrality, Katz centrality, hub and authority centrality, Cliques, plexes, cores, clustering coefficient, Similarity measures - cosine similarity, Pearson coefficient, Katz similarity, Assortative and disassortative mixing, Shortest paths and the small-world effect, degree distributions, scale-free and power laws. [12L]
Fundamental network algorithms: degree distributions, clustering coefficients, shortest paths and breadth-first search, betweenness centrality, maximum flows and minimum cuts, spanning trees, independent paths, minimum cut sets. [5L]
Matrix algorithms and graph partitioning: eigenvectors and eigenvector centrality, graph partitioning and community detection/clustering, spectral partitioning. [10L]
Random graphs and network formation: Erdos-Renyi random graphs, tree structure, giant component, fixed degree distributions, configuration model, small-world (Watts-Strogatz) model, exponential random graphs, Markov graphs, network growth, preferential attachment, Barabasi-Albert model, power-law networks. [10L]
Dynamics on networks: Random walks, diffusion, Epidemics/contagion, mean-field models. [4L]

References

1. Networks: An Introduction - M. E. J. Newman, Oxford University Press, Oxford, 2010.
2. Complex Graphs and Networks - F. Chung and L. Lu, CBMS Regional Conference Series in Mathematics, 2006.
3. Scale-Free Networks - Guido Caldarelli, Oxford University Press, Oxford, 2007.
4. Random Graph Dynamics – R. Durrett, Oxford University Press, Oxford, 2007.

MCSO 06: Computational Geometry

Geometric preliminaries, DCEL (Doubly Connected Edge List) data structure, Polygon, Planar Straight Line Graph (PSLG), Area of a triangle, area of a Polygon, Determinant used to test position of a point with respect to a directed line. Convex polygons, Point location in convex polygon, Plane sweep algorithm, Algorithms for Line segment intersection problem. [8L]
Point location in PSLG: Slab method, Chain method and complexity analysis. Range Searching – 1D Range search, KD Trees. [5L]
Polygon Triangulation: Regularization of polygons, Properties of triangulations – Triangulation of monotone polygon. Linear Programming – Half plane intersection, Incremental algorithm and Randomized algorithm. [8L]
Art Gallery Theorem, Guarding Art Gallery, Fisk's proof using three colouring. Arrangements of Lines – Duality, Combinatorics of arrangements, Zone Theorem, Algorithms for constructing arrangements of lines. [6L]
Convex Hulls: Convex Hull Algorithms in the Plane -Graham's Scan, Jarvi's March, Divide and Conquer Algorithms. [8L]
Voronoi Diagrams: Properties and applications in the plane. Construction of Voronoi diagram. Delaunay Triangulation. [10L]

References

1. Computational Geometry: Algorithms and Applications - M. de Berg, M. van Kreveld, M. Overmars, and O. Schwarzkopf , Springer-Verlag.

2. Computational Geometry: An Introduction through Randomized Algorithms - Ketan Mulmuley, Prentice Hall.

3. Computational Geometry: An Introduction - Preparata and Shamos.

MCSO 07: Cryptography and Network Security

Introduction: Basic concepts of confidentiality, integrity, authentication. [3L]
Basic Cryptography: Historical background, transposition/substitution, Caesar cipher, introduction to symmetric crypto primitives, asymmetric primitives and hash functions. [10L]
Secret key cryptography: Applications, DES, Message Digests. [4L]
Public Key cryptography: Euclidean algorithm, Euler theorem, Fermat Theoretical functions, multiplicative and additive inverse; RSA algorithm, Elliptic Curve, Knap-Sack algorithms. [6L]
Authentication: Certification authorities and key distribution centre, digital signatures. [4L]
Hash functions: MD4, MD5 message digest algorithm, Secure Hash algorithm, HMAC digital signatures. [4L]
Network and E-mail Security: Kerberose -X.509 authentication service, PGP, S/MIME, IPSec. [8L]
System level security: Intrusion detection, password management, Viruses and other Malware threats, Firewalls, Trusted Systems, Access Control. [6L]

References

1. Network Security and Cryptography – William Stallings, Pearson Education.

2. Computer Security: Art and Science – Matt Bishop, Pearson Education.

MCSO 08: Data Analytics

Data Definitions and Analysis Techniques: Elements, Variables, and Data categorization, Measurement, Data management and indexing, Introduction to statistical learning and R-Programming. [5L]
Descriptive Statistics: Measures of central tendency, Measures of location of dispersions, Practice and analysis with R. [5L]
Basic analysis techniques: Statistical hypothesis generation and testing, Chi-Square test, t-Test, Analysis of variance, Correlation analysis, Maximum likelihood test, Inferential Statistics through hypothesis tests, Permutation and Randomization Test, Regression, ANOVA (Analysis of Variance), Practice and analysis with R. [12L]
Data analysis techniques: Regression analysis, Classification techniques, Clustering, Association rules analysis, Practice and analysis with R. [5L]
Prescriptive analytics: Creating data for analytics through designed experiments, Active learning, and Reinforcement learning. [5L]
Big Data: Distributed file system, Big Data and its importance, Big data applications, Algorithms using MapReduce, Matrix-Vector, Multiplication by MapReduce, Apache Hadoop and Hadoop EcoSystem, Moving Data in and out of Hadoop, Understanding inputs and outputs of MapReduce - Data Serialization. [7L]
Case studies: Understanding business scenarios, Feature engineering and visualization, Scalable and parallel computing with Hadoop and MapReduce, Sensitivity Analysis. [6L]

References

1. The elements of statistical learning - Trevor Hastie, Robert Tibshirani, Jerome Friedman, Vol. 2. No. 1. New York: Springer, 2009.

2. Applied statistics and probability for engineers - Montgomery, Douglas C., and George C. Runger., John Wiley and Sons, 2010.

MCSO 09: Data Mining

Basic concepts: Knowledge discovery in database, data mining, distinction, basic approaches – association, classification, clustering, networking, soft computing approaches, data cleaning, privacy preservation. [5L]
The Architecture of BI and DW: BI and DW architectures and its types - Relation between BI and DW, OLAP (Online analytical processing) definitions, Difference between OLAP and OLTP, Dimensional analysis, What are cubes? Drill-down and roll-up, slice and dice or rotation, OLAP models, ROLAP versus MOLAP, defining schemas: Stars, snowflakes and fact constellations. [12L]
Preprocessing of data: Reduction of dimensionality, data coding, discovering structural relationships in data: Rules and trees, Descriptive analytics: Density estimation, anomaly detection, Predictive analytics: Regression. [4L]
Association rule discovery: Apriori and FP-growth algorithm, FP-tree algorithm, GA based rule mining, applications in gene expression analysis, genome-wide association studies. [8L]
Classification and Clustering: CART, ensemble classifier, Random-Forest, GA- based clustering, Clustering High- Dimensional Data, Constraint Based Cluster Analysis – Outlier Analysis, bi- and tri-clustering, GA-based biclustering. [10L]
Case Studies: Mining Time-Series and Sequence Data, Mining Text Databases, Mining the World Wide Web, Recommendation System, Data Mining Application. [6L]

References

1. Data Mining: Concepts and Techniques - Jiawei Han, Jian Pei and Micheline Kamber, Elsevier.
2. Introduction to Data Mining - Pang-Ning Tan, Vipin Kumar and Michael Steinbach, Pearson.

MCSO 10: Human Computer Interaction

Introduction: Objective and overview, Historical evolution of the field. [3L]
Interactive system design (theory and practice): Concept of usability definition and elaboration, HCI and software engineering, GUI design and aesthetics, Prototyping techniques. [4L]
Model-based design and evaluation: Basic idea, types of models, GOMS family of models (KLM and CMN-GOMS), Fitts' law and HickHyman's law, Case studies of Model-based design. [8L]
Guidelines in HCI: Shneiderman's eight golden rules, Norman's seven principles, Norman's model of interaction, Nielsen's ten heuristics with example of its use, Heuristic evaluation, Contextual inquiry, Cognitive walkthrough. [8L]
Empirical research methods in HCI: Introduction (motivation, issues, research question formulation techniques), Experiment design and data analysis (with explanation of one-way ANOVA). [4L]
Task modeling and analysis: Hierarchical task analysis (HTA), Engineering task models and Concur Task Tree (CTT). [4L]
Dialog Design: Introduction to formalism in dialog design, design using FSM (finite state machines), State charts and (classical) Petri Nets in dialog design. [4L]
Cognitive architecture: Introduction to CA, CA types,relevance of CA in IS design, Model Human Processor (MHP). [4L]
Object Oriented Programming: OOP- Introduction, OOM- Object Oriented Modeling of User Interface Design. [3L]
Design Case Studies: Case Study 1, Case Study 2. [3L]

References

1. Human Computer Interaction, 3^{rd} Edition - Dix A., Finlay J.,Abowd G. D. and Beale R, Pearson Education, 2005.
2. Human Computer Interaction - Preece J., Rogers Y.,Sharp H.,Baniyon D., Holland S. and Carey T, Addison-Wesley, 1994.
3. Designing the User Interface - B.Shneiderman, Addison Wesley 2000 (Indian Reprint).

MCSO 11: Imprecise Mathematics

Fuzzy logic: Review of fuzzy mathematics, Higher type fuzzy sets, applicability. [9L]
Rough mathematics: Introduction, Information system, Indiscernibility, Rough sets, Rough set theory, Set approximation, Rough membership, Attributes, Dependency of attributes, Rough equivalence, Reducts, Rough Reducts based on SVM. [16L]
Vague mathematics: Vague set theory, Vague set approximation, Vague membership, Attributes, Rough equivalence. [10L]
Hybridization: Introduction to Hybrid AI systems, Neuro-Fuzzy, Coactive Neuro Fuzzy Modeling,

Fuzzy-rough set systems, Topological structures of rough sets over fuzzy lattices, Neuro-Fuzzy-GA systems and case studies of Hybrid systems. [10L]

References

1. Rough set data analysis: A Road to Non-invasive Knowledge Discovery - Duntsch,I and Gediga, G., Methodos Publishers (2006).

2. Fuzzy Sets and Fuzzy Logic, Theory and Applications - Klir, G. J., Yuan, Bo, Prentice Hall of India Private Limited (2007).

3. Fuzzy Set Theory and its Application - H. J. Zimmermann.

4. Vague sets - W.L. Gau, D.J. Buehrer, IEEE Transactions on Systems, Man and Cybernetics, 23 (2) (1993), pp. 610-614.

MCSO 12: Information and Coding Theory

Objectives of source coding and channel coding, examples in contemporary systems.
Definitions of entropy, joint entropy, conditional entropy and mutual information. [5L]
Source coding:
a) Lossless and lossy compression: Entropy of a discrete memoryless source, theoretical limit of lossless compression. [2L]
b) Prefix codes: Kraft inequality, Shannon-Fano and static Huffman encoding as examples of prefix coding, adaptive Huffman encoding and Vitter's algorithm. [6L]
c) Arithmetic coding and decoding. [2L]
d) Dictionary-based encoding and decoding: LZ77, LZ78 and LZW. [4L]
Channel coding:
a) Channel models: Discrete Memoryless Channel and Binary Symmetric Channels, Channel Capacity, Shannon's channel capacity theorem. [4L]
b) Error-correcting codes: Block and convolution coding, Hamming distance, minimum free distance; Block codes - Hamming code, BCH code and RS code; encoding and decoding. [8L]
c) Convolution encoding and decoding: Viterbi algorithm, Puncturing. [6L]
d) Turbo encoding and decoding: MAP, log-MAP and max-log-MAP decoding. [8L]

References

1. Coding Theory: A First Course - San Ling and Chaoping, Cambridge University Press, 2004.

2. Information and Coding Theory - A Jones and J M Jones, Springer Verlog, 2004.

3. Communication Systems, 4^{th} Edition - John Wiley, 2001.

MCSO 13: Internet of Things

Overview of Wireless Sensor Networks: Challenges and enabling technologies, Types of sensors, Hardware components, Network architecture, Design principles. [5L]
Communication Protocols: L1 and MAC protocols for WSNs, Low duty cycle protocols and wakeup concepts, contention based protocols (CSMA, PAMAS), Schedule based protocols (LEACH, SMACS, TRAMA), MAC addresses and energy-efficient routing protocols. [10L]
Architecture and Design Principles: M2M communication, modified layering for IoT/M2M systems, IPv6/6LoWPAN protocol, IoT/M2M gateway, Usage of Web (HTTP/HTTPS/FTP/TELNET) and message communication protocols (CoAP-SMS, CoAP-MQ, MQTT, XMPP). [10L]
Prototyping and Designing Software: Programming in Arduino platform, Data exchange between sensors and actuator devices, Programming in Raspberry-PI, Developing web/cloud services, Programming MQTT client and MQTT server. [15L]
Issues in IoT privacy and security. [5L]

References

1. Internet of Things: Principles, Paradigms and Applications of IoT - Kamal Kant Hiran, Dr. Kamlesh Lakhwani, Dr. Hemant Kumar Gianey, Joseph Kofi Wireko.

2. The Internet of Things: Key Applications and Protocols - Olivier Hersent.

3. Internet of Things - Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram.

MCSO 14: Natural Language Processing

Regular Expressions and Automata: Introduction to NLP, Regular Expression, Finite State Automata. [5L]
Tokenization: Word Tokenization, Normalization, Sentence Segmentation, Named Entity Recognition, Multi Word Extraction, Spell Checking – Bayesian Approach, Minimum Edit Distance. [6L]
Morphology: Morphology – Inflectional and Derivational Morphology, Finite State Morphological Parsing, The Lexicon and Morpho-tactics, Morphological Parsing with Finite State Transducers, Orthographic Rules and Finite State Transducers, Porter Stemmer. [8L]
Language Modeling: Introduction to N-grams, Chain Rule, Smoothing – Add-One Smoothing, Witten-Bell Discounting; Backoff, Deleted Interpolation, N-grams for Spelling and Word Prediction, Evaluation of language models. [8L]
Hidden Markov Models and POS Tagging: Markov Chain, Hidden Markov Models, Forward Algorithm, Viterbi Algorithm, Part of Speech Tagging – Rule based and Machine Learning based approaches, Evaluation. [8L]
Information Retrieval: Boolean Retrieval, Term-document incidence, The Inverted Index, Query Optimization, Phrase Queries, Ranked Retrieval – Term Frequency – Inverse Document Frequency based ranking, Zone Indexing, Query term proximity, Cosine ranking, Combining different features for ranking, Search Engine Evaluation, Relevance Feedback. [6L]
Text Classification: Text Classification, Naïve Bayes' Text Classification, Evaluation, Sentiment Analysis – Opinion Mining and Emotion Analysis, Resources and Techniques. [4L]

References

1. Speech and Language Processing - Jurafsky and Martin, Pearson Education.

2. Foundation of Statistical Natural Language Processing - Manning and Schutze, MIT Press.

3. Natural Language Processing with Python - Steven Bird, Ewan Klein and Edward Loper, O'Reilly Media.

MCSO 15: Quantum Computation and Information

Introduction: history of quantum computation and quantum information, Very brief Introduction in Quantum Mechanics, Quantum Mechanics versus Classical Mechanics, latest status of quantum computer and quantum information. [5L]
What is Quantum bits(qubits)? Representation of qubit, qubits versus classical bits, multiple qubits. Introduction to Quantum Mechanics: Bases and linear independence, Linear operator and Matrices, Pauli matrices, Inner product, Eigenvectors and Eigen values, Hermitian operators, Properties of Hermitian operators. [8L]
The postulates of Quantum Mechanics, State Space, Superposition of states, Schrodinger CAT; Evolution, Quantum Measurement; EPR Bell sates, Bell inequality. [5L]
Entangle sates Quantum entanglement, No cloning theorem, Quantum Teleportation and super dense coding. [6L]
Quantum Gates: Classical Gates and Quantum Gates, Quantum Gates, Matrix representation of Quantum Gates, Unitarity, Universal Quantum Gates, Quantum Circuits and its matrix representation, Quantum Registers, entangle registers. [5L]
Fourier Transform, Quantum Fourier Transform and circuit representation of quantum Fourier Transformation order finding, factoring. [5L]
Quantum Algorithm: Single qubit operation, controlled operations, Grover's Search algorithms, discussion on complexity, Shor algorithm, discussion on complexity. [6L]
Quantum Cryptography: Quantum Cryptography and Classical cryptography, Quantum Key distributions, comparison with RSA cryptosystems, quantum communication , BB84 Protocol, E91 protocol, Post quantum cryptography. [5L]

References

1. Quantum Computation and Quantum Information - M.A Nielsen & I L Chuang, Cambridge Univ. Press.

2. Quantum Computing - J Gruska, McGraw Hill.

MCSO 16: Randomized Algorithms

Introduction: Las Vegas Algorithm, Monte Carlo Algorithm, Computation Models and Probabilistic Classes. [5L]
Game-Theoretic Techniques: Game Tree Evaluation, Minmax Principle. [5L]
Moments and Deviations: Markov and Chebyshov's Inequality, Randomized Selection,Two-point Sampling, Stable Marriage Problem. [6L]
Probabilistic Methods: Max Satisfiability, Lovasz Local Lemma,
Method of Conditional Probability. [6L]
Markov Chains: Markov Chains and Random Walk on Graphs. [6L]
Algebraic Techniques: Finger Printing and Freivalds' Technique, Polynomial Identity Verification,Perfect

Matching, Verifying Equality of Strings, Comparison of Fingerprinting Techniques, Pattern Matching, PCP and Efficient Proof Verification. [10L]
Graph Algorithms: All pair Shortest Paths, Min-cut, Minimum Spanning Trees. [7L]

References

1. Randomized Algorithms - Rajeev Motwani and Prabhakar Raghavan.
2. Design and Analysis of Randomized Algorithms - Hromkovic.

MCSO 17: Wireless Network

Prerequisite: Network Systems and Protocols, Information and Coding theory.
Evolution of Cellular Networks: Standards, Generic architecture of PLMN, CN and RAN split within PLMN; overview of network selection, registration, IP packet flow, idle mode mobility, connected mode mobility and handovers. [5L]
GPRS CN and RAN Architecture over GSM and UMTS: PMM, SM and RABM procedures in CN; QoS classes; RAN architecture and functions, channel structures. [6L]
Evolution of LTE systems from UMTS: Optimizations in CN and RAN architectures, CN procedures for mobility and bearer service managements, inter-system handovers. [12L]
Basics of LTE RAN: OFDMA in downlink and SC-FDMA in uplink, physical resource blocks; physical channels, transport channels and RB mapping; MAC and RLC functions; RRC procedures - cell acquisition, RRC connection management, bearer services, handovers. [12L]
LTE-Advanced features and evolution towards 5G systems. [5L]
Wi-Fi systems - 802.11x standards, air interface, authentication. [5L]

References

1. WCDMA for UMTS: HSPA Evolution and LTE, 5^{th} Edition - Harri Holma, Antti Toskala, John-Wiley.
2. LTE – The UMTS Long Term Evolution - From Theory to Practice - Stefania Sesia, Issam Toufik, Matthew Baker, John-Wiley.

List 2

MCSE 31: Bioinformatics

Introduction, branches, aim, scope, research areas. [2L]
The genetic material: nucleotides, orientation, base pairing, central dogma. [5L]
Gene Structure: Promoter sequence, Genetic code, Introns and exons. [3L]
Pairwise Alignment: Gaps, dynamic programming, Needleman and Wunsch Algorithm, Smith-Waterman algorithm. [6L]
Databases in Bioinformatics: Structures - sequence and molecular file formats, conversion tools, databases, classification schema, retrieval systems. [6L]
Sequence Databases: Nucleotide sequence databases, secondary nucleotide, protein sequence databases, secondary and specialized protein sequence databases. [10L]
Data Analysis Tools: Introduction to BLAST, PSI-BLAST. [8L]
Data visualization in proteins using RasMol/Chime. [5L]

References

1. Bioinformatics: Databases, Tools and Algorithms - O Basu and S K Thukral.
2. Bioinformatics: Principle and Applications - Z Ghosh and B Ballick.
3. Fundamental Concepts of Bioinformatics - D E Krane and M L Raymer.
4. Bioinformatics: A Modern Approach - V R Srinivas.

MCSE 32: Cyber Security

Introduction: Overview of Cyber Security, Challenges and Constraints , Cyber of internet governance; Cyber Warfare, Cyber Crime, Cyber terrorism, Cyber Espionage; Need for a Comprehensive Cyber Security Policy. [6L]
Cyber Security Vulnerabilities: Vulnerabilities in software, System administration, Complex Network Architectures, Open Access, Weak Authentication, Unprotected Broadband communications. [6L]
Cyber Security Safeguards: Overview, Access control, Audit, Authentication, Biometrics, Cryptography, Deception, Denial of Service Filters, Ethical Hacking, Firewalls, Intrusion Detection Systems, Response, Scanning, Security policy, Threat Management. [12L]
Securing Web Application, Services and Servers: Basic security for HTTP Applications and Services, Basic Security for SOAP Services Identity Management and Web Services, Authorization Patterns, Security Considerations, Challenges. [10L]
Application Layer security: PGP, S/MIME. [6L]
Cyber Laws: Cyber Security Regulations, Roles of International Law, Cyber Security Standards, Cyber Security Policy 2013; overview of cyber forensics. [5L]

References

1. Cyber Security and Cyber Laws - Alfred Basta, Nadine Basta, et al.
2. Cyber Security - Nina Godbole and Sunit Belapure.
3. Introduction to Information Security and Cyber Laws - Surya Prakash Tripathi, Ritendra Goel, et al.

MCSE 33: Discrete Event System Simulation

System concepts: Components of a system, Discrete and continuous systems, System modeling - Types of models - System simulation - Steps in a simulation study. [4L]
Concepts in discrete event system simulation - Event scheduling/time advance algorithm. [4L]
Random number generation: Techniques for generating random numbers, tests for random numbers, random variate generation. [8L]
Simulation of Queuing models: Characteristics of queuing systems, steady-state behavior of different types of queues, network of queues. [10L]
Input Modeling: Data Collection; Identifying the distribution with data, parameter estimation, Goodness of Fit Tests, estimation of absolute performance. [6L]
Output analysis: Measures of performance and estimations, confidence intervals for fixed number of replication, confidence intervals for specified precision, output analysis for steady-state simulations, sample-size determination for a specified precision. [6L]
Monte Carlo Simulation, Examples of queuing systems. [7L]

References

1. Simulation Modeling and Analysis - A.M. Law, W.D. Kelton, McGraw Hill.

MCSE 34: Evolutionary Computing

Introduction to Evolutionary Computation: Biological and artificial evolution, Evolutionary computation and AI, Different historical branches of EC, e.g., GAs, EP, ES, GP, etc. Swarm Optimization: PSO and ACO, Tabu Search, Stochastic Hill Climbing, Simulated Annealing. [14L]
Evolutionary Combinatorial Optimization: Evolutionary algorithms for TSPs, Evolutionary algorithms for lecture room assignment, Hybrid evolutionary and local search algorithms. [5L]
Co-evolution: Cooperative co-evolution, Competitive co-evolution. [3L]
Niching and Speciation: Fitness sharing, Crowding and mating restriction. [3L]
Constraint Handling: Common techniques, e.g., penalty methods, repair methods, etc. Analysis. [4L]
Genetic Programming: Trees as individuals, Major steps of genetic programming, e.g., functional and terminal sets, initialisation, crossover, mutation, fitness evaluation, etc. Search operators on trees, Issues in genetic programming, e.g., bloat, scalability, etc. [6L]
Multiobjective Evolutionary Optimisation: Pareto optimality and Algorithms. [5L]
Theoretical Analysis of Evolutionary Algorithms: Convergence of EAs, Computational time complexity of EAs, No free lunch theorem. [5L]

References

1. Handbook on Evolutionary Computation - T. Baeck, D. B. Fogel, and Z. Michalewicz (eds.), IOP Press, 1997.

2. Genetic Programming: An Introduction - W Banzhaf, P Nordin, R E Keller and Frank D Francone, Morgan Kaufmann, 1999.

3. Evolutionary Computation: Theory and Applications - X. Yao (ed), World Scientific Publ. Co., Singapore, 1999. (ISBN 3-540-65907-2).

MCSE 35: Multimedia Systems

Fundamentals of multimedia, Media and data streams, Basics of Sound/audio, image, graphics, video processing and animation. [4L]
Overview of digitization and compression techniques: Characteristics of image, audio and video stream, sampling and quantization, PCM, ADPCM and DM techniques, Lossless and lossy compression mechanisms. [8L]
Audio and Speech processing: Basics, Analog and digital audio representation, companding, Adaptive Multirate coding, Noise filtering. [8L]
Digital Image Processing: Elements of Visual Perception , Image Sensing and Acquisition , Image Sampling and Quantization, Relationships between pixels, Image Enhancement, Spatial domain Filters, Frequency domain filters, lossy (Transform based) and lossless compressions, JPEG and giff compression steps. [8L]
Video processing: Stream-based and File based encoding/decoding, H.263/H.264/H.265 compression on video streams, audio-video synchronization, MPEG 1/2/4 file-based encoding steps. [8L]
File structure of media streams: JPEG, giff, flac, mp3 audio, MPEG 1/2/4 video files.encoding standards. [4L]
Multimedia Network Fundamentals, Multimedia Protocols for the Internet, Multimedia Networking Services, RTP/RTCP protocol basics, VoIP fundamentals. [5L]

References

1. Networked Multimedia Systems: Concepts, Architecture and Design - S V Raghavan and S K Tripathi, Prentice-Hall.

2. Multimedia Communications: Applications Networks, Protocols and Standards - Fred Halsall, Pearson.

3. Fundamentals of Multimedia - Z-N. Li, M.S. Drew, Pearson Prentice Hall.

4. Multimedia Systems - John F, Koegel Buford.

5. Multimedia Systems - Ralf Steinmetz, Klara Nahrstedt.