DEPARTMENT OF COMPUTER SCIENCE
UNIVERSITY OF DELHI
DELHI

Structure of M.Sc. Computer Science Course

The students would be required to register for the courses in the first year as follows:

Semester I

Course No.	Title	L – T – P*	Credits	Total Marks
MCS - 101	Algorithms	3 - 1 - 0	4	100
MCS – 102	Artificial Intelligence	3 - 0 - 2	4	100
MCS – 103	Computer Security	3 - 0 - 2	4	100
MCS – 104	Data Mining	3 - 0 - 2	4	100
MCS – 105	Computational Intelligence	3 - 0 - 2	4	100

Semester II

Course No.	Title	L – T – P*	Credits	Total Marks
MCS – 201	Compiler Design	3 - 0 - 2	4	100
MCS – 202	Operating System Design & Practice	3 - 0 - 2	4	100
MCS – 203	Database Systems & Implementation	3 - 0 - 2	4	100
MCS – 204	Advanced Computer Networks	3 - 0 - 2	4	100
MCS – 205	Modeling & Simulation	3 - 0 - 2	4	100

*** L – T – P : Lectures - Tutorials - Practicals**

The students would be required to register for the courses in the second year as follows:

Semester III

(i) At least three electives out of those offered by the Department as mentioned below, or those offered by other Departments as approved by the Department. For each of the courses MCS 313 – MCS 320, the choice of topics shall be determined by the Department at the beginning of every semester.

(i) MCS – 301 Minor Project : 8 credits

Semester IV

MCS – 401 Major Project : 20 credits

Elective Courses

Course No.	Title	L – T – P*	Credits	Total Marks
MCS-302	Electronic Commerce	3 - 0 - 2	4	100
MCS-303	Digital Image Processing & Multi-media	3 - 0 - 2	4	100
MCS-304	Neural Networks	3 - 0 - 2	4	100
MCS-305	Numerical Computing	3 - 0 - 2	4	100
MCS-306	Combinatorial Optimization	3 - 0 - 2	4	100
MCS-307	Computational Linguistics	3 - 1 - 0	4	100
MCS-308	Software Quality Assurance & Testing	3 – 0 – 2	4	100
MCS-309	Machine Learning	3 – 0 - 2	4	100
MCS-310	Real-Time Systems	3 – 0 - 2	4	100
MCS-311	Cryptography	3 - 0 - 2	4	100
MCS-312	Distributed Computing	3 – 0 – 2	4	100
MCS-313	Special Topics in Computer Networks	3 - 0 - 2	4	100
MCS-314	Special Topics in Data Mining	3 - 0 - 2	4	100
MCS-315	Special Topics in Software Engineering	3 - 0 - 2	4	100
MCS-316	Special Topics in Theoretical Computer Science	3 - 1 - 0	4	100
MCS-317	Special Topics in Information Security	3 - 0 - 2	4	100
MCS-318	Special Topics in Soft Computing	3 - 0 - 2	4	100
MCS-319	Special Topics in Software Systems	3 - 0 - 2	4	100
MCS-320	Special Topics in Artificial Intelligence	3 - 0 - 2	4	100

*** L – T – P : Lectures - Tutorials - Practicals**

DETAILED DESCRIPTION OF COURSES OF STUDIES

MCS – 101 : Algorithms

Review of algorithm design techniques like divide and conquer.

Advanced Techniques to Design Algorithms: Dynamic programming , greedy , randomization and parallel algorithms, backtracking , on-line algorithms.

Advanced Techniques to Analyze Algorithms : Use and study of advanced data structures: union-find (disjoint set structure), fibonacci heaps, dynamic trees, dynamic graph structures, self-adjusting data structures (lists, splay trees); search trees (red-black trees), persistent data structures, hashing, amortized analysis.

Lower Bounding Techniques : Decision trees, adversary approach, etc.

Advanced study of sorting, searching, text processing algorithms, graph problems.

Introduction to number theoretic and cryptographic algorithms, Fast Fourier Transforms, matrix operations, computational geometry problems, combinatorial optimization problems, complexity classes, approximation algorithms.

MCS – 102 : Artificial Intelligence

Introduction: Introduction to AI applications and AI techniques.

Problem Solving: Production systems, control strategies, reasoning - forward & backward chaining.

Search Strategies: Breadth first search, depth first search, iterative deepening, uniform cost search, hill climbing, graph search, heuristic search.

Intelligent Searching: Best first search, A^* algorithm, AO^* algorithm.

Game Playing: Minmax & game trees, refining minmax, Alpha – Beta pruning.

Knowledge Representation: First order predicate calculus, resolution, unification, natural deduction system, refutation, logic programming, PROLOG, semantic networks, frame system, value inheritance, conceptual dependency.

Constraint Programming: Constraints, simplification, optimization and implication of constraints, constraint logic programming, simple modelling and controlling search, CLP systems.

Expert Systems: Definition, structure, uncertainty handling, learning and applications of expert systems.

MCS-103 : Computer Security

Overview of Security: Protection versus security; aspects of security–data integrity, data availability, privacy; security problems, user authentication.

Security Threats: Program threats-trojan horse, trap door, stack and buffer overflow; system threats- intruders, worms, viruses; communication threats- tapping and piracy.

Security Mechanisms: Intrusion detection, auditing and logging, tripwire, system-call monitoring; cryptography-substitution, transposition ciphers, symmetric-key algorithms-Data Encryption Standard, advanced encryption standards, public key algorithms- RSA; digital signatures- symmetric key signatures, public key signatures, message digests, public key infrastructures, authentication protocols – authentication based on shared secret key, Diffie-Hellman key exchange, key distribution center, Kerberos, operating system security mechanisms.

MCS – 104 : Data Mining

Introduction: The process of knowledge discovery in databases, predictive and descriptive data mining techniques, supervised and unsupervised learning techniques.

Techniques of Data Mining: Link analysis, predictive modeling, database segmentation, score functions for data mining algorithms, Bayesian techniques in data mining.

Issues in Data Mining: Scalability and data management issues in data mining algorithms, parallel and distributed data mining, privacy, social, ethical issues in Knowledge Discovery in Databases (KDD) and data mining, pitfalls of KDD and data mining.

MCS – 105 : Computational Intelligence

Fuzzy Logic Systems: Notion of fuzziness, fuzzy modeling, operations on fuzzy sets, T-norms and other aggregation operators, basics of approximate reasoning, compositional rule of inference, fuzzy rule based systems, (Takagi-Sugeno and Mamdani-Assilian models), schemes of fuzzification, inferencing, defuzzificatin, fuzzy clustering, fuzzy rule based classifier.

Genetic Algorithms: Genetic operators, building block hypothesis, evolution of structure, genetic algorithms based on tree and linear graphs, applications in science and engineering.

Artificial Neural Networks: The neuron as a simple computing element, the perceptron, multilayer neural networks, accelerated learning in multilayer neural networks.

MCS – 201 : Compiler Design

Compiler Structure: Analysis-synthesis model of compilation, various phases of a compiler, tool based approach to compiler construction.

Lexical Analysis: Interface with input, parser and symbol table, token, lexeme and patterns; difficulties in lexical analysis; error reporting; regular definition, transition diagrams, Lex.

Syntax Analysis: CFGs, ambiguity, associatively, precedence, top down parsing, recursive descent parsing, transformation on the grammars, predictive parsing, bottom up parsing, operator precedence grammars, LR parsers, Yacc.

Syntax Directed Definitions: Inherited and synthesized attributes, dependency graph, evaluation order, bottom up and top down evaluation of attributes, L- and S-attributed definitions.

Type Checking: Type system, type expressions, structural and name equivalence of types, type conversion.

Run Time System: Storage organization, activation tree, activation record, parameter passing, symbol table, dynamic storage allocation.

Intermediate Code Generation: Intermediate representations, translation of declarations, assignments, control flow, boolean expressions and procedure calls, implementation issues.

Code Generation and Instruction Selection: Issues, basic blocks and flow graphs, register allocation, code generation, dag representation of programs, code generation from dags, peep hole optimization, code generator generators, specifications of machine.

MCS – 202 : Operating Systems Design and Practice

Operating Systems Overview: Overview of processor management, memory management, device management, file management of LINUX or UNIX system V operating systems.

Operating Systems Architecture: Monolithic architecture, virtual machine architecture, micro-kernel architecture, client-server architecture.

Operating Systems Key Design Issues: Operating systems portability, machine dependent code, machine independent code, lower half of kernel design issues, upper half of kernel design issues.

Design Issues in Different Operating Systems: Core design issues of time sharing, real-time, network and distributed operating systems – kernel, memory, device, file-management design issues.

Operating System Design and Implementation: Design and implementation of a small operating system kernel/device driver/file systems.

MCS – 203 : Database Systems & Implementation

Review of basic database concepts, investigating database implementation techniques, storage management, access path and indexing, buffer management, query processing, concurrency control, transactions management, logging and recovery, bench marking and performance; practical implementation of a database system

MCS – 204 : Advanced Computer Networks

Wireless Communication Principles: Wireless propagation characteristics, multiple access techniques, modulation techniques, mobility and handoff, circuit mode and packet mode voice/data transfer.

Wireless Network Technologies: Mobile cellular network, wireless LAN , Wireless Local Loop (WLL).

Optical Communication Fundamentals and Optical Network Elements: Wavelength Division Multiplexing (WDM), optical line terminals, optical line amplifier, optical add drop multiplexor, optical crossconnects .

WDM Network Design: Light path topology design, routing and wavelength assignments, wavelength conversion, dimensioning wavelength routing network,

Multi Protocol Label Switching (MPLS), Multi Protocol Lambda Switching (MPλS), concept of IP/ATM/SONET over WDM.

MCS – 205 : Modelling and Simulation

System: Types of systems- continuous and discrete; modeling process, computer workload and preparation of its models, verification and validation modeling procedures, comparing model data with real system data, differential and partial differential equation models; combining discrete event and continuous models, (example of a computer system should be used for illustration and discussion purposes).

Stochastic Processes: Queing Theory, M/M/1, M/G/1, Markov processes, multi-variate normal distribution, continuous time processes, time series, Erlangs model for Telecommunication systems.

Simulation Process: Use of simulation, discrete and continuous simulation procedures, simulation of a time-sharing computer system.

Simulation Languages: A brief introduction to important discrete and continuous simulation languages.

MCS – 302 : Electronic Commerce

Building Blocks of Electronic Commerce: Internet and networking technologies, Internet and network protocols, web server scalability, software technologies for building E-commerce applications, distributed objects, object request brokers, component technology, web services, web application architectures, security of E-commerce transactions, review of cryptographic tools, authentication, signatures, observers, anonymity, privacy, traceability, key certification, management and escrow, payment protocols and standards, smart card, e-cash, e-wallet technologies, electronic money and electronic payment systems, business models for electronic commerce, electronic marketplaces, auctions and other market mechanisms, design of auctions, optimization algorithms for marketplaces, multi-agent systems.

MCS – 303 : Digital Image Processing and Multimedia

Fundamental Steps in Image Processing: Element of visual perception, a simple image model, sampling and quantization, some basic relationships between pixel, image geometry in 2D, image enhancement in the spatial domain, introduction to spatial and frequency methods, basic gray level transformations, histogram equalization, local enhancement, image subtraction, image averaging, basic spatial, filtering, smoothing spatial filters, sharpening spatial filters, introduction to the

fourier transformation, discrete fourier transformation, fast fourier transformation, filtering in the frequency domain, correspondence between filtering in the spatial and frequency domain smoothing frequency-domain filters, sharpening frequency-domain filters, homomorphic filtering, dilation and erosion, opening and closing, hit-or-miss transformation, some basic morphological algorithms, line detection, edge detection, gradient operator, edge linking and boundary detection, thresholding, region-oriented segmentation, representation schemes like chain codes, polygonal approximations, boundary segments, skeleton of a region, recognition and interpretation patterns and pattern classes, decision-theoretic methods, introduction to neural network.

Introduction to Image Compression: JPEG, MPEG, operating system issues in multimedia, real time OS issues, interrupt latency etc., network management issues Like QOS guarantee, resource reservation, traffic specification etc., security issues like digital watermarking, partial encryption schemes for video stream encryption.

Latest developments in field of multimedia like VOIP, video on demand and video conferencing.

MCS – 304 : Neural Networks

Supervised learning, linear discriminant functions, unsupervised learning, perceptron learning algorithm, the multilayer perceptron, radial-basis function nets, Kohonen's self-organizing networks, Hopfield networks, the Boltzmann machine, adaptive resonance theory, associative memory, support-vector machines and applications to speech and image understanding.

MCS – 305 : Numerical Computing

Solution to Transcendental and Polynomial Equations: Iterative methods, bisection method, secant method, Newton-Raphson method, fixed point iteration, methods for finding complex roots.

Interpolation: Polynomial interpolation, Newton-Gregory, Stirling's, Bessel's and Lagrange's interpolation formula, Newton's divided differences interpolation formulae.

Matrices and Linear System of Equations: LU decomposition method for solving systems of equations, Symmetric positive definite matrices and least square approximation, iterative algorithms for linear equations.

Curve fitting, B-spline and Approximation: Fitting linear and non-linear curves, weighted least square approximation, method of least square for continuous functions.

Numerical Differentiation and Intergration: Numerical differentiation and errors in numerical differentiation, Newton-Cotes formulae, trapezoidal rule, Simpson's rule, Gaussian integration.

Numerical Solutions of Ordinary Differential Equations: Picard's and Taylor's series, Euler's and Runge-Kutta (RK) methods, Predictor-corrector's, Milne-Simpson's, Adams-Bashford, Adams-Moulton methods.

Finite Element Method: Boundary value problems, Rayleigh and Galerkin methods of approximation, applications.

Course would introduce the parallel algorithms for numerical computing.

MCS – 306 : Combinatorial Optimization

Introduction: Optimization problems, neighborhoods, local and global optima, convex sets and functions, simplex method, degeneracy; duality and dual simplex algorithm, computational considerations for the simplex and dual simplex algorithms-Dantzig-Wolfe algorithms.

Graph Algorithms: Parimal-Daul algorithm and its application to shortest path, Max-flow problems (Ford and Fulkerson labeling algorithms, Dijkstra's algorithm, Ford-Warshall Algorithm), networking labeling and digraph search, Max-flow problem, matching problem, bipartite matching algorithm, non-bipartite matching algorithms, weighted matching-hungarian method for the assignment problem, non-bipartite weighted matching problem, efficient spanning tree algorithms, algorithm, matroid intersection problem.

Integer Linear Programming: Upper bounds for solution, fractional dual algorithm, approximation algorithms for traveling saleperson problem, branch and bound technique and its applications to integer linear programming and combinational optimization.

MCS – 307 : Computational Linguistics

Man-Machine Interface: Concept of Artificial Intelligence (AI), information system and information processing, concept of formal language, Natural Language (NL) and real language, natural language as man-machine interface.

Natural Language Processing: Basic characteristic of NL, knowledge representation, level of representation in NL, function of natural language.

Computational Linguistics: Relationship between linguistics and NLP, computational models for phonology, unphology, lexicography, syntax, semantics and discourse.

Processes and Methods: Pursuing applications – machine translation, information retrieval, information extraction, natural language in multimodal and multimedia systems, computer assisted language learning, multilingnal on-line natural language processing.

MCS – 308 : Software Quality Assurance & Testing

Process and product quality, building effective SQA organization, techniques and contents of a SQA plan, software quality standards, overview of test cycles, test planning, software inspections, basic concepts of measurements, software development, total quality management and risk management

MCS – 309 : Machine Learning

Role of learning in intelligent behaviour; genesis of a learning system, learning from example, pattern recognition and function supervised and reinforcement learning, statistical learning theory, VC dimensional learning, role of optimization in learning, empirical risk minormization, overview of approximations and learning automata, learning of rules, decision trees, neural network and markovian decision processes and Q-learning.

MCS – 310 : Real-Time Systems

Typical applications, embedded controllers, multimedia, on-board computers, business systems, real-time system specifications, modeling techniques, design schedulability analysis, scheduling preemptive, on-line, distributed; had and soft constraints, periodic tasks with precedence relationships, task replication, reconfigurations, load adjustment and processor utilization, dependable communication, primary backup channels, router architecture, quality of service and criticality, operating systems, development and testing of real-time software.

MCS – 311 : Cryptography

Elementary number theory, finite fields, arithmetic and algebraic algorithms, secret key and public key cryptography, pseudo random bit generators, block and stream ciphers, hash functions and message digests, public key encryption, probabilistic

encryption random oracles, authentication, digital signatures, zero knowledge interactive protocols, introduction to elliptic curve cryptosystems, formal verification, cryptanalysis, hard problems.

MCS – 312 : Distributed Computing

NFS, communication models, mutual exclusion algorithms, process allocation, file systems, AMOBEA systems.

MCS – 313 : Special Topics in Computer Networks

The course shall cover a combination of the following topics: Traffic management, flow control, advisory control, signaling, network management and performance analysis techniques, optical network control and management, photonic packet switching.

MCS – 314 : Special Topics in Data Mining

The course shall cover a combination of the following topics: Heuristic, Bayesian and soft computing approaches to data mining, web mining, text mining, intrusion mining, privacy issues.

MCS – 315 : Special Topics in Software Engineering

The course shall cover a combination of the following topics: Software metrics, software quality, testing, verification.

MCS – 316 : Special Topics in Theoretical Computer Science

The course shall cover a combination of the following topics: Design and analysis of sequential and parallel algorithms, theory of computability, formal languages, approximation algorithms, graph theory, computational geometry, randomized algorithms.

MCS – 317 : Special Topics in Information Security

The course shall cover a combination of the following topics: Privacy models, elliptic cryptography, steganography, web security.

MCS – 318 : Special Topics in Soft Computing

The course shall include a combination of the following topics: fuzzy modelling, rough sets, neural network modelling, evolutionary computing.

MCS – 319 : Special Topics in Software Systems

The course shall cover a combination of the following topics: Design, implementation and issues of semantics of programming languages, distributed programming and operating systems.

MCS – 320 : Special Topics in Artificial Intelligence

The course shall cover a combination of the following topics: Distributed artificial intelligence, multiagent systems, expert systems, human interfaces, natural language processing.

UNIVERSITY OF DELHI

M.Sc. COMPUTER SCIENCE

2004 – 05

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