M.Sc. (Computer Science)

2-YEAR FULL TIME PROGRAMME

RULES, REGULATIONS AND COURSE CONTENTS

DEPARTMENT OF COMPUTER SCIENCE
FACULTY OF MATHEMATICAL SCIENCES
UNIVERSITY OF DELHI
DELHI-110007
2009
COURSE: M. Sc. (COMPUTER SCIENCE)

Check List of New Course Evaluation for AC Consideration

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M. Sc. (COMPUTER SCIENCE)
2 - YEAR FULL TIME PROGRAMME

1. AFFILIATION

The proposed programme shall be governed by the Department of Computer Science, Faculty of Mathematical Sciences, University of Delhi, Delhi-110007.

2. PROGRAMME STRUCTURE

The M.Sc.(Computer Science) Programme is divided into two parts as under. Each part will consist of two semesters to be known as Semester-I and Semester-II.

<table>
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<tr>
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<th>Semester-I</th>
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<tr>
<td>Part-I</td>
<td>First Year</td>
<td>Semester-I</td>
</tr>
<tr>
<td>Part-II</td>
<td>Second Year</td>
<td>Semester-II</td>
</tr>
</tbody>
</table>

3. CODIFICATION OF PAPERS

The schedule of papers prescribed for various semesters shall be as follows:

Part-I Semester I

<table>
<thead>
<tr>
<th>Paper No.</th>
<th>Title</th>
<th>L - T - P*</th>
<th>Credits</th>
<th>Total Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCS - 101</td>
<td>Design &amp; Analysis of Algorithms</td>
<td>3- 1 - 0</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>MCS - 102</td>
<td>Artificial Intelligence</td>
<td>3- 0 - 2</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>MCS - 103</td>
<td>Information Security</td>
<td>3- 0 - 2</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>MCS - 104</td>
<td>Database Systems &amp; Implementation</td>
<td>3- 0 - 2</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>MCS - 105</td>
<td>Computational Intelligence</td>
<td>3- 0 - 2</td>
<td>4</td>
<td>100</td>
</tr>
</tbody>
</table>

Part-I Semester II

<table>
<thead>
<tr>
<th>Paper No.</th>
<th>Title</th>
<th>L - T - P*</th>
<th>Credits</th>
<th>Total Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCS - 201</td>
<td>Compiler Design</td>
<td>3- 0 - 2</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>MCS - 202</td>
<td>Advanced Operating Systems</td>
<td>3- 0 - 2</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>MCS - 203</td>
<td>Data Mining</td>
<td>3- 0 - 2</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>MCS - 204</td>
<td>Advanced Computer Networks</td>
<td>3- 0 - 2</td>
<td>4</td>
<td>100</td>
</tr>
</tbody>
</table>

EL1 One elective out of the following
i) Any one elective from the list of electives offered by the Department
ii) Outside Department Elective (preferably Departments of Mathematics, Statistics& Operational Research)

** 4/5 100

List of Electives for Part I Semester II

<table>
<thead>
<tr>
<th>Paper No.</th>
<th>Title</th>
<th>L - T - P*</th>
<th>Credits</th>
<th>Total Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCS-205</td>
<td>Electronic Commerce</td>
<td>3– 0 - 2</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>MCS-206</td>
<td>Numerical Computing</td>
<td>3– 0 - 2</td>
<td>4</td>
<td>100</td>
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<tr>
<td>MCS-207</td>
<td>Combinatorial Optimization</td>
<td>3– 1 - 0</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>MCS-208</td>
<td>Computational Linguistics</td>
<td>3– 0 - 2</td>
<td>4</td>
<td>100</td>
</tr>
</tbody>
</table>
Part-II Semester III

<table>
<thead>
<tr>
<th>Paper No.</th>
<th>Title</th>
<th>L - T - P*</th>
<th>Credits</th>
<th>Total Marks</th>
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</thead>
<tbody>
<tr>
<td>MCS 301</td>
<td>Minor Project</td>
<td>8</td>
<td>200</td>
<td></td>
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<tr>
<td>EL2</td>
<td>Elective within the Department</td>
<td>* * *</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>EL3</td>
<td>Elective within the Department</td>
<td>* * *</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>EL4</td>
<td>Elective within/outside the Department (preferably Departments of Mathematics, Statistics &amp; Operational Research)</td>
<td>* * *</td>
<td>4/5</td>
<td>100</td>
</tr>
</tbody>
</table>

List of Elective Courses for Part-II Semester III

<table>
<thead>
<tr>
<th>Paper No.</th>
<th>Title</th>
<th>L - T - P*</th>
<th>Credits</th>
<th>Total Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCS-302</td>
<td>Digital Image Processing &amp; Multi-media</td>
<td>3- 0 - 2</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>MCS-303</td>
<td>Neural Networks</td>
<td>3- 0 - 2</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>MCS-304</td>
<td>Software Quality Assurance &amp; Testing</td>
<td>3- 0 - 2</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>MCS-305</td>
<td>Machine Learning</td>
<td>3- 0 - 2</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>MCS-306</td>
<td>Embedded Systems</td>
<td>3- 0 - 2</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>MCS-307</td>
<td>Cryptography</td>
<td>3- 0 - 2</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>MCS-308</td>
<td>Distributed Computing</td>
<td>3- 0 - 2</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>MCS-309</td>
<td>Modeling and Simulation</td>
<td>3- 0 - 2</td>
<td>4</td>
<td>100</td>
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<tr>
<td>MCS-310</td>
<td>Special Topics in Computer Networks</td>
<td>3- 0 - 2</td>
<td>4</td>
<td>100</td>
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<tr>
<td>MCS-311</td>
<td>Special Topics in Data Mining</td>
<td>3- 0 - 2</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>MCS-312</td>
<td>Special Topics in Theoretical Computer Science</td>
<td>3- 1 - 0</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>MCS-313</td>
<td>Special Topics in Information Security</td>
<td>3- 0 - 2</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>MCS-314</td>
<td>Special Topics in Soft Computing</td>
<td>3- 0 - 2</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>MCS-315</td>
<td>Special Topics in Database System</td>
<td>3- 0 - 2</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>MCS-316</td>
<td>Special Topics in Artificial Intelligence</td>
<td>3- 0 - 2</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>MCS-317</td>
<td>Special Topics in Computational Intelligence</td>
<td>3- 0 - 2</td>
<td>4</td>
<td>100</td>
</tr>
</tbody>
</table>

* L – T – P: Lectures - Tutorials – Practical
*** As per the elective offered by the concerned Department.

Part-II Semester IV
MCS – 401 Major Project: 20 credits

4. SCHEME OF EXAMINATIONS

(i) English shall be the medium of instruction and examinations.
(ii) Examinations shall be conducted at the end of each semester as per the academic calendar notified by the University of Delhi.
(iii) The scheme of evaluation shall be as follows:
Performance of the students will be evaluated based on a comprehensive system of continuous evaluation. For each course, there shall be two minor tests, assignments/practical & laboratory work and an end-semester examination: (Minor Test I, Minor Test II, Assignments/practical & laboratory work - 50% weightage; End-semester examination - 50% weightage). The implementation of the evaluation process would be monitored by a Committee to be constituted by the Department at the beginning of each academic year. For each course, the duration of written end semester examination shall be two hours.

Each student shall carry out a minor project in the third semester and a major project in the fourth semester. The projects will be carried out under the supervision of a teacher(s) (not more than two) to be approved by the Department. In case there are joint supervisors, at least one of them must be from the Department. Normally both the minor and the major projects will be carried out by the students under the same supervisor(s). The projects will be evaluated by a three (four)-member committee including the supervisor(s) and two members (other than the supervisor(s)) to be appointed by the Department in consultation with the internal supervisor. The committee will monitor the progress of the projects and will hold mid-semester and end-semester evaluation.

The minor and the major projects shall carry 200 and 500 marks respectively distributed as follows:

(a) Mid-semester evaluation
(b) End-semester evaluation  
   (i) Dissertation
   (ii) Viva-voce

Examination for courses shall be conducted only in the respective odd and even Semesters as per the Scheme of Examinations. Regular as well as Ex-Students shall be permitted to appear/re-appear/improve in courses of odd semesters only at the end of odd semesters and courses of even semesters only at the end of even semesters.

5. **PASS PERCENTAGE**

In order to pass a course, a student must secure at least 40% marks in the end semester examinations and 40% marks in the internal assessment. Minimum marks for passing the examination in each semester shall be 45% in aggregate of a semester.

6. **PROMOTION CRITERIA**

**SEMESTER TO SEMESTER:** Students shall be required to fulfill the Part to Part Promotion Criteria. Within the same Part, students shall be allowed to be promoted from a Semester to the next Semester, provided she/he has passed at least half of the courses of the current semester.

**PART TO PART:**
I to II: Admission to Part-II of the Programme shall be open to only those students who have successfully passed at least 75% papers out of papers offered for the Part-I courses comprising of Semester-I and Semester-II taken together. However, he/she will have to clear the remaining papers while studying in Part-II of the Programme.

7. **DIVISION CRITERIA**

Successful candidates will be classified on the basis of the combined results of Part-I and Part-II examinations as follows:

(i) I Division       60% or more marks in the aggregate.
(ii) II Division     50% or more marks but less than 60% marks in the aggregate.
(iii) Pass           All others

8 **QUALIFYING PAPERS** N.A.

9 **SPAN PERIOD**

No student shall be admitted as a candidate for the examination for any of the Parts/Semesters after the lapse of four years from the date of admission to the Part-I/Semester-I of the programme.

10 **ATTENDANCE REQUIREMENTS**

No student shall be considered to have pursued a regular course of study unless he/she is certified by the Head of the Department of Computer Science, University of Delhi, to have attended 75% of the total number of lectures, tutorials and seminars conducted in each semester, during his/her course of study. Provided that he/she fulfils other conditions, the Head, Department of Computer Science may permit a student to the next semester who falls short of the required percentage of attendance by not more than 10 per cent of the lectures, tutorials and seminars conducted during the semester.

11 **COURSE CONTENT FOR EACH PAPER**

**Part I Semester I**

**MCS 101: DESIGN AND ANALYSIS OF ALGORITHMS**

Review of algorithm design techniques like Iterative Techniques and Divide & Conquer through Sorting, Searching and Selection problems.

Review of Lower Bounding techniques: decision trees, adversary.

String Processing: KMP, Boyre-Moore, Rabin Karp algorithms.

Introduction to randomized algorithms: random numbers, randomized quick sort, randomly built binary search tree.
Number Theoretic Algorithms: GCD, addition and multiplication of two large numbers, polynomial arithmetic, Fast-Fourier transforms.

Advanced Techniques to analyze algorithms: Use and study advanced data structures union-find (Disjoint Set Structure), Fibonacci heaps.

Graph algorithms: Matching and Flows.

Parallel algorithms: Basic techniques for sorting, searching and merging in parallel.

Geometric algorithms: Point location, Convex hulls and Voronoi diagrams.

Complexity Theory: Classes P, NP, NP-Hard, NP Complete.

Approximation Algorithms: Introduction through examples.

Readings:


MCS 102: ARTIFICIAL INTELLIGENCE

Introduction: Introduction to AI applications and AI techniques, Production systems, control strategies, reasoning - forward and backward chaining.

Intelligent Agents: Definitions of a rational agent, reflex, model-based, goal-based, and utility-based agents, the environment in which a particular agent operates.


Knowledge Representation: First order predicate calculus, resolution, unification, natural deduction system, refutation, logic programming, PROLOG, semantic networks, frame system, value inheritance, conceptual dependency, Ontologies.
Planning: basic representation for planning, symbolic-centralized vs. reactive-distributed, partial order planning algorithm.

Uncertainty: different types of uncertainty - degree of belief and degree of truth, various probability constructs - prior probability, conditional probability, probability axioms, probability distributions, and joint probability distributions, Bayes' rule, other approaches to modeling uncertainty such as Dempster-Shafer theory and fuzzy sets/logic.

Natural language processing: component steps of communication, contrast between formal and natural languages in the context of grammar, parsing, and semantics

Readings:

4. R. Akerkar, Introduction to Artificial Intelligence, Prentice-Hall of India, 2005

MCS 103: INFORMATION SECURITY

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

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

Cryptography: Substitution, transposition ciphers, symmetric-key algorithms-Data Encryption Standard, advanced encryption standards, public key encryption - RSA; Diffie-Hellman key exchange, ECC cryptography, Message Authentication- MAC, hash functions.

Digital signatures: Symmetric key signatures, public key signatures, message digests, public key infrastructures.

Security Mechanisms: Intrusion detection, auditing and logging, tripwire, system-call monitoring;

Readings:


**MCS 104: 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, benchmarking and performance; practical implementation of a database system.

**Readings:**


**MCS 105: COMPUTATIONAL INTELLIGENCE**

**Introduction** to Computational Intelligence, Computational Intelligence vs Artificial Intelligence.

**Rough Sets:** Introduction, Set Approximation, Decision Tables.

**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.

**Artificial Neural Networks:** The neuron as a simple computing element, the Perceptron, Multilayer Neural Networks, Supervised Learning Neural Networks, Unsupervised Learning Neural Networks, Radial Basis Function Networks, Reinforcement Learning

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

**Readings:**

**Part I Semester II**

**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.

**Readings**:

MCS 202: ADVANCED OPERATING SYSTEMS

Detailed study of contemporary popular operating systems for the chosen operating system (s), detached design of the following modules will be discussed.

**Process and Processor Management:** Scheduling schemes, Interprocess communication, threads.

**File Management:** Interface between file systems and IOCS, directory structures, allocation of disk space, file protection, file system reliability.

**I/O Management:** I/O system, I/O strategies, buffering.

**Memory Management:** Swapping, demand paging, segmentation

**Readings:**


MCS 203: 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.

**Readings:**

2. Jiawei Han and Micheline Kamber, *Data Mining: Concepts and Techniques (2nd Ed.)*, Morgan Kaufmann, 2006.

MCS 204: ADVANCED COMPUTER NETWORKS
Wireless Communication Principles: Wireless propagation characteristics, transmission error, multipath fading, intrusion.


Multiple access and Duplexing techniques: Frequency Division Multiple Access, Time Division Multiple Access, Code Division Multiple Access, Space Division Multiple Access, Wavelength Division Multiple Access, duplexing techniques - Time Division Duplexing, Frequency Division Duplexing.

Mobile cellular networks: Global Systems for Mobile combinations (GSM), General Packet Radio Service (GPRS), Enhanced Data rates for GSM Evolution (EDGE), Wireless Local loops, Mobility and Hands-off in mobile cellular networks.

Wireless Local Area Networks: Carrier Sense Multiple Access (CSMA/CA) protocol, Distributed Coordination Function, Point Coordination Function, Infrastructure based WLAN, ADHOC WLAN, IEEE 802.11 WLAN standards.

Readings:

MCS 205: ELECTRONIC COMMERCE

Building Blocks of Electronic Commerce: Introduction, 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, BizTalk framework Compliant Server

Security of E-commerce transactions: Review of cryptographic tools, authentication, signatures, observers, anonymity, privacy, traceability, key certification, management and escrow


Global eCommerce and Law: Cyber law in India, comparative evaluation of Cyber laws of certain countries.

Readings:

**MCS 206: 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.

**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.

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

**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 Integration**: 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.

**Readings**:


**MCS 207 : 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.

**Integer Linear Programming**: Cutting plane algorithms, branch and bound technique and approximation algorithms for traveling salesman problem.


**Readings:**


**MCS 208 : 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, multilingual on-line natural language processing.

**Readings:**


Part II Semester III

MCS 301 Minor Project

MCS 302: DIGITAL IMAGE PROCESSING & MULTI-MEDIA

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, Wavelets, 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.

Readings:

**MCS 303: NEURAL NETWORKS**

**Introduction:** Neuron as basic unit of Neurobiology, McCulloch-Pitts model, Hebbian Hypothesis; limitations of single-layered neural networks.


**Kernel methods and support vector machines:** binary classification, multiclass classification, allowing for training errors: soft margin techniques; neural networks and temporal sequences: sequence recognition, sequence generation; applications.

**Readings:**


**MCS 304: SOFTWARE QUALITY ASSURANCE & TESTING**

**Introduction:** Concept of Software quality, product and process quality, software quality metrics, quality control and total quality management, quality tools and techniques, quality standards.

**Designing software quality assurance system:** Statistical methods in quality assurance, fundamentals of statistical process control, process capability, Six-sigma quality.

**Testing:** Test strategies, test planning, functional testing, stability testing and debugging techniques.

**Reliability:** Basic concepts, reliability measurements, predictions and management.

**Readings:**

**MCS 305: MACHINE LEARNING**

**Overview and Introduction to Bayes Decision Theory:** Machine intelligence and applications, pattern recognition concepts classification, regression, feature selection, supervised learning class conditional probability distributions, examples of classifiers bayes optimal classifier and error, learning classification approaches.

**Linear machines:** General and linear discriminants, decision regions, single layer neural network, linear separability, general gradient descent, perceptron learning algorithm, mean square criterion and widrow-Hoff learning algorithm; multi-Layer perceptrons: two-layers universal approximators, backpropagation learning, on-line, off-line error surface, important parameters.

**Learning decision trees:** Inference model, general domains, symbolic decision trees, consistency, learning trees from training examples entropy, mutual information, ID3 algorithm criterion, C4.5 algorithm continuous test nodes, confidence, pruning, learning with incomplete data.

**Instance-based Learning:** Nearest neighbor classification, k-nearest neighbor, nearest neighbor error probability.

**Machine learning concepts and limitations:** Learning theory, formal model of the learnable, sample complexity, learning in zero-bayes and realizable case, VC-dimension, fundamental algorithm independent concepts, hypothesis class, target class, inductive bias, occam's razor, empirical risk, limitations of inference machines, approximation and estimation errors, Tradeoff.

**Machine learning assessment and Improvement:** Statistical model selection, structural risk minimization, bootstrapping, bagging, boosting.

**Support Vector Machines:** Margin of a classifier, dual perceptron algorithm, learning non-linear hypotheses with perceptron kernel functions, implicit non-linear feature space, theory, zero-Bayes, realizable infinite hypothesis class, finite covering, margin-based bounds on risk, maximal margin classifier.

**Readings:**

**MCS 306: EMBEDDED SYSTEMS**

*Introduction to Embedded Systems*: Overview of embedded systems, features, requirements and applications of embedded systems, recent trends in the embedded system design, common architectures for the ES design, embedded software design issues, interfacing and communication Links, introduction to development and testing tools.

*Embedded System Architecture*: Basics of 8 – bit RISC microcontroller (PIC), block diagram, addressing modes, instruction set, timers, counters, stack operation, programming using PIC controller, basics of 32 – bit microprocessor (ARM), processor and memory organization, data operations, flow of control, pipelining in ARM, ARM bus (AMBA).

*Embedded Software*: Programming in embedded environment, Programming for microcontrollers such as Intel 8051 and PIC, overview of Java 2 micro edition (J2ME), concept of a MIDLET, applications of J2ME in mobile communication.

*Applications of Embedded Systems*: Industrial and control applications, networking and telecom applications, DSP and multimedia applications, applications in the area of consumer appliances, concept of smart home.

**Readings:**


**MCS 307: CRYPTOGRAPHY**

*Elementary number theory*: Prime numbers, Fermat’s and Euler’s theorems, Testing for primality, Chinese remainder theorem, discrete logarithms.
**Finite fields:** Review of groups, rings and fields; Modular Arithmetic, Euclidean Algorithms, Finite fields of the form GF(p), Polynomial Arithmetic, Finite fields of the form GF(2^n).

**Data Encryption Techniques:** Algorithms for block and stream ciphers, private key encryption – DES, AES, RC4; Algorithms for public key encryption – RSA, DH Key exchange, KERBEROS, elliptic curve cryptosystems.

Message authentication and hash functions, Digital Signatures and authentication protocols, Public key infrastructure, Cryptanalysis of block and stream ciphers.

**Readings:**


**MCS 308: DISTRIBUTED COMPUTING**

**Introduction to distributed computing systems:** Evolution of distributed computing systems, Distributed computing systems models, issues in the design of distributed operating systems.

**Interprocess communication in distributed systems:** Message passing, synchronization, buffering, failure handling, group communication.

**Remote Procedure Calls:** Remote Procedure Call (RPC) models, transparency of RPC, RPC messages, marshaling arguments and results, exception handling, lightweight RPC.

**Distributed shared memory:** General architecture of Distributed Shared Memory (DSM), granularity, replacement strategies, thrashing.

**Distributed process management:** Synchronization – clock synchronization, event ordering, mutual exclusion; election algorithm, process migration, threads.

**Distributed file system:** File accessing models, file-sharing semantics, file-caching semantic, case study – Network file systems.

**Readings:**


**MCS 309: MODELING AND SIMULATION**

**Systems and environment:** Concept of model and model building, model classification and representation, Use of simulation as a tool, steps in simulation study.
**Continuous-time and Discrete-time systems:** Laplace transform, transfer functions, state-space models, order of systems, z-transform, feedback systems, stability, observability, and controllability. Statistical Models in Simulation: Common discrete and continuous distributions, Poisson process, and empirical distributions.

**Random Numbers:** Properties of random numbers, generation of pseudo random numbers, techniques of random number generation, tests for randomness, random variate generation using inverse transformation, direct transformation, convolution method, acceptance-rejection.

**Design and Analysis of simulation experiments:** Data collection, identifying distributions with data, parameter estimation, goodness of fit tests, selecting input models without data, multivariate an time series input models, verification and validation of models, static and dynamic simulation output analysis, steady-state simulation, terminating simulation, confidence interval estimation, Output analysis for steady state simulation, variance reduction techniques.

**Queuing Models:** Characteristics of queuing systems, notation, transient and steady-state behavior, performance, network of queues.

**Large Scale systems:** Model reduction, hierarchical control, decentralized control, structural properties of large scale systems.

**Readings:**


**MCS 310 : SPECIAL TOPICS IN COMPUTER NETWORKS**

**Real-time and non-real-time applications:** Quality Of Service (QOS) requirements of real-time applications – bandwidth, delay and delay variation parameters, Quality of service metrics, guaranteed and best-effort services.

**IEE E Wireless LAN (WLAN) standard:** 802.11 and 802.11e standards, WLAN services - association, disassociation, re-association, distribution, integration, authentication, de-authentication and data delivery services.

**WLAN centralized protocol functions:** Point Coordination Functions (PCF), Hybrid Coordination Function (HCF), HCF Controlled Channel Access (HCCA); HCCA admission control mechanisms, HCCA parameterized QOS.
**WLAN distributed protocol functions:** Distributed Coordination Functions (DCF), Enhanced Distributed Channel Access (EDCA), EDCA priority based QOS.

**Performance analysis of WLAN distributed protocol functions:** Random variables and random process, Markov chain model of DCF and EDCA protocols, Throughput and delay analysis.

**Readings:**


**MCS 311: SPECIAL TOPICS IN DATA MINING**

Classification Techniques: Models and Patterns, Performance Measures, Forms of Knowledge, Decision Trees, Linear Regression, Neural Networks, k-Nearest Neighbors, Naïve Bayesian Classifiers, Support Vectors Machines, Ensemble Methods

Clustering Techniques: Clustering Concepts, Clustering Vs Classification, Clustering Techniques, Partitioning Methods, Comparing k-Means and k-Medoids, Expectation-Maximization, Hierarchical Methods, Density-Based Methods, Grid-Based Methods, Dealing with Large Data

Use of the techniques for web usage mining, user tracking and profiling, web content and structure mining, web personalization, text mining, spatial mining, bioinformatics and other scientific applications.

**Readings:**

MCS 312: SPECIAL TOPICS IN THEORETICAL COMPUTER SCIENCE
(NP – Completeness and Approximation)

Introduction to NP_completeness and Approximation.

Problems from first principle: Satisfiability SAT, 3SAT.

Graphs: Clique, Covering, Graph Partitioning, Subgraph problem, Graph Isomorphism, Graph Coloring, Hamiltonian Cycle Problem, TSP.


Sets and Partitions: Set partition and Covering, Subset sum.

NP-hard problems: Clustering Problems like k-means clustering, co-clustering, connected k-means clustering. More new problems as they are added to the class of NPC or NPH.

Approximation algorithms for the above problems.

Readings:

6. Part of the course will be covered by research papers.

MCS 313: SPECIAL TOPICS IN INFORMATION SECURITY
**Information hiding:** Introduction, Background, and Applications of Information hiding: Data hiding, applications of data hiding.

**Steganography:** Frameworks of secret communication, Security of steganography systems, Information hiding in noisy data, Adaptive & non-adaptive algorithms, Active and malicious attackers, Information hiding in written text, Invisible communication.

**Data hiding in still images:** LSB encoding, BPCS steganography, Lossless data hiding, Data hiding by quantization, Patchwork, Transform domain methods, Robust data hiding in JPEG images, frequency domain watermarking Detecting malicious tempering, Robust wavelet-based watermarking, Kundur-Hatzinakos watermarking, Data hiding in binary images, Zhao-koch method, Wu-Lee method, CPT method, TP method, Data hiding in fax images.


**Readings:**


**MCS 314: SPECIAL TOPICS IN SOFT COMPUTING**

**Rough Sets:** Information Systems, decision tables, indiscernibly relation, set approximation, approximation of family of sets, analysis of decision tables.

**Type-2 Fuzzy Sets:** Notion of uncertainty of membership in a fuzzy set, footprint of uncertainty, embedded fuzzy sets, operations on type-2 fuzzy sets, type-2 fuzzy relations, type reduction, type-2 fuzzy inference system.

**Fuzzy Clustering:** Limitations of hard partitioning and need for fuzzy clustering, FCM, PCM, GK, and FMLE algorithms, cluster validity measures.

**Projected Clustering:** The problem of high dimensionality in clustering, use of projected clustering methods to address the problem of high dimensionality – grid based, density based, centroid based, and hierarchical approaches.

**Rough Set Based Methods:** Information granulation using rough sets, decision rules in rough set models, classification, and clustering methods based on rough sets.

**Neuro Fuzzy Systems:** Neuro fuzzy systems of Mamdani, logical, and Takagi-Sugeno type, flexible neuro fuzzy systems.

**Readings:**

**MCS 315: SPECIAL TOPICS IN DATABASE SYSTEMS**

Introduction to Web Data Management and XML.

**A Survey of Web Data Management Systems:** Web Query Systems; Web Information Integration Systems; Web Data Restructuring.

**XML Basics:** Semi-structured Data, XML Schemas, XML indexing, XSLT, XHTML, DOM and SAX parsers.

**XML Query Languages:** Xquery, Xpath, XsLT, XSQL.

**Node and Link Objects:** Representing Metadata of Web Documents and Hyperlinks, Metadata Associated with HTML and XML Documents, Representing Structure and Content of Web Documents, Representing Structure and Content of Hyperlinks, Node and Link Objects, Node and Link Structure Trees.

**Databases Modeling:** Recent Approaches in Modeling Web Data, Storage of XML data in databases, publishing data from databases in XML.

Use of Tools for storing and retrieving data from XML Databases.

**Readings:**


**MCS 316: SPECIAL TOPICS IN ARTIFICIAL INTELLIGENCE (MULTIAGENT SYSTEMS)**


**Reactive and Hybrid Agents:** Brooks and the Subsumption Architecture, The Limitations of Reactive Agents, Hybrid Agents.
**Multiagent Interactions**: Utilities and Preferences, Multiagent Encounters, Dominant Strategies and Nash Equilibria, Competitive and Zero-Sum Interactions, The Prisoner's Dilemma.

**Reaching Agreements**: Mechanism Design, Auctions, Negotiation, Task-Oriented Domains, Worth-Oriented Domains, Argumentation.

**Communication**: Speech Acts, Agent Communication Languages, KIF, KQML, The FIPA Agent Communication Languages, Ontologies for Agent Communication, Coordination Languages.

**Working Together**: Cooperative Distributed Problem Solving, Coherence and Coordination, Task Sharing and Result Sharing, Task Sharing in the Contract Net, Result Sharing, Handling Inconsistency, Coordination, Multiagent Planning and Synchronisation.

**Readings**:


**MCS 317: SPECIAL TOPICS IN COMPUTATIONAL INTELLIGENCE (Rough Granular Computing)**

**Rough Sets in Approximation**: Parameterized approximation space, uncertainty function, rough inclusion function, lower and upper approximations, properties of approximations such as accuracy and quality of approximation, learning approximation space from data-discretization and approximation spaces, distances and approximation spaces; concept approximation.

**Data Reduction**: Reducts in the context of information systems and decision tables, significance of attributes and stability of reducts, representatives in information systems and decision tables.

**Classification and Clustering Methods**: Information granulation, decision rules in rough set models, evaluation of decision rules, nearest neighbour algorithms; self organizing system for information granulation, rough clustering and its evaluation.

**Readings**:

2. P. Doherty, W. Lukaszewicz, A. Skowron, A. Szalas: *Knowledge Engineering: A