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

UNIVERSITY OF DELHI
EXAMINATION BRANCH

Date 20th July 2009

COURSE: M. Sc. (COMPUTER SCIENCE)

Check List of New Course Evaluation for AC Consideration

S.No.	Parameters	Status
1	Affiliation	
2	Programme Structure	
3	Codification of Papers	
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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-1 and Semester-2.

		Semester-1	Semester-2
Part-I	First Year	Semester-I	Semester-II
Part-II	Second Year	Semester-III	Semester-IV

3. CODIFICATION OF PAPERS

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

Part-I Semester I

Paper No.	Title	L - T - P*	Credits	Total Marks
MCS - 101	Design & Analysis of Algorithms	3- 1 - 0	4	100
MCS - 102	Artificial Intelligence	3- 0 - 2	4	100
MCS - 103	Information Security	3- 0 - 2	4	100
MCS - 104	Database Systems & Implementation	3- 0 - 2	4	100
MCS - 105	Computational Intelligence	3- 0 - 2	4	100

Part-I Semester II

Paper No.	Title	L - T - P*	Credits	Total Marks
MCS - 201	Compiler Design	3- 0 - 2	4	100
MCS - 202	Advanced Operating Systems	3- 0 - 2	4	100
MCS - 203	Data Mining	3- 0 - 2	4	100
MCS - 204	Advanced Computer Networks	3- 0 -2	4	100
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

Paper No.	Title	L - T - P*	Credits	Total Marks
MCS-205	Electronic Commerce	3– 0 - 2	4	100
MCS-206	Numerical Computing	3– 0 - 2	4	100
MCS-207	Combinatorial Optimization	3– 1 - 0	4	100
MCS-208	Computational Linguistics	3– 0 - 2	4	100

Part-II Semester III

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

List of Elective Courses for Part-II Semester III

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

* **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		30% weightage
(b)	End-semester evaluation		
	(i)	Dissertation	30% weightage
	(ii)	Viva-voce	40% weightage

(iv) 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:

1. T.H. Cormen, C.E.Leiserson, R.L. Rivest, and C. Stein, **Introduction to Algorithms**, McGraw-Hill, 2002.
2. Sara Baase, **Computer Algorithms: Introduction to Design and Analysis**, Addison Wesley, 1999
3. R. Motwani and P. Raghavan, **Randomized Algorithms**, Cambridge University Press, 1995.
4. Teofilo F.Gonzalez, **Handbook of NP-Completeness: Theory and Applications** Chapman & Hall, 2009.
5. Vijay V. Vazirani, **Approximation Algorithms**, Springer-Verlag, France, 2006.
6. S. Rajasekharan and John Reif, **Handbook of Parallel Computing: Models, algorithms and applications**, Chapman and Hall/CRC, 2007.
7. Gareth A. Jones and Josephine M. Jones, **Elementary Number Theory,** Springer, 1998.
8. F P Preparata and M I Shamos, **Computational Geometry: An Introduction** Springer, 1993.

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.

Searching Techniques and Game Playing: Breadth first search, depth first search, iterative deepening, uniform cost search, hill climbing, simulated annealing, genetic algorithm search, heuristic search, Best first search, A* algorithm, AO* algorithm, Minmax and game trees, refining minmax, Alpha – Beta pruning, constraint satisfaction.

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:

1. S. Russell and P. Norvig, **Artificial Intelligence: A Modern Approach** (2nd ed.), Pearson Education, 2006.
2. Elaine Rich and Kelvin Knight, **Artificial Intelligence**, Tata McGraw Hill, 2002.
3. Nils J Nilson, **Artificial Intelligence: A New Synthesis**, Morgan Kaufmann Publishers , Inc., San Francisco, California, 2000.
4. R. Akerkar, **Introduction to Artificial Intelligence**, Prentice-Hall of India, 2005
5. Dan W. Patterson, **Introduction to Artificial Intelligence and Expert Systems**, Prentice Hall of India, 2006.
6. Nils J. Nilson, **Principles of Artificial Intelligence**, Narosa Publishing House, 2001
7. W.F. Clocksin and C.S. Mellish, **Programming in PROLOG**, Narosa Publishing House, 2002.
8. Saroj Kaushik, **Logic and Prolog Programming**, New Age International Publisher, 2006.

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:

1. W. Stalling, **Cryptography and Network Security Principles and Practices** (4th ed.), Prentice-Hall of India, 2006.
2. C. Pfleeger and SL Pfleeger, **Security in Computing** (3rd ed.), Prentice-Hall of India, 2007.
3. D. Gollmann, **Computer Security**, John Wiley and Sons, NY, 2002.

4. J. Piwprzyk, T. Hardjono and J. Seberry, **Fundamentals of Computer Security**, Springer-Verlag Berlin, 2003.
5. J.M. Kizza, **Computer Network Security**, Springer, 2007.
6. M. Merkow and J. Breithaupt, **Information Security: Principles and Practices**, Pearson Education, 2006.

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, bench marking and performance; practical implementation of a database system.

Readings:

1. A.Silberschatz, H.Korth and S.Sudarshan, **Database System Concepts (5th Ed.)**, McGraw Hill, 2006.
2. R.Elmasri and S.B.Navathe, **Fundamentals of Database Systems (4th Ed.)**, Addison Wesley 2006.
3. R.Ramakrishnan and J.Gehrke, **Database Management Systems (3rd Ed.),** McGraw Hill, 2005.
4. Philip Lewis, Arthur Berstein and Michel Kifer, **Databases and Transaction Processing-an application oriented approach,** Addison Wesley, 2002.
5. Michael Stonebraker and Joe Hellerstein, **Reading in Database Systems, (4th Ed.),** Morgan Kaufmann Publisher.
6. J. Gray, and A. Reuter, **Transaction Processing: Concepts and Techniques**, Morgan Kaufmann, 1993.
7. Jim Gray, **The Benchmark Handbook for Database and Transaction Processing Systems, (2nd Ed.)**, Morgan Kaufmann Publisher, 1993.

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:

1. Leszek Rutkowski, **Computational Intelligence: Methods and Techniques,** Springer 2008.
2. Amit Konar, **Computational Intelligence: Principles, Techniques and Applications,** Springer, 2005.
3. Andries P. Engelbrecht, **Computational Intelligence: An Introduction,** John Wiley and Sons, 2007.
4. K.H. Lee, **First Course on Fuzzy Theory and Applications**, Springer, 2005
5. D. E.Goldberg, **Genetic Algorithms in Search, Optimization, and Machine Learning**, Addison-Wesley, Reading, 1989
6. E. Alpaydin, **Introduction to Machine Learning**, Prentice-Hall of India, 2004

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:

1. A..V. Aho, R. Sethi and J. D. Ullman, **Compilers: Principles, Techniques, and Tools** (US edition), Addison Wesley, 1986.
2. A. Holub, **Compiler Design in C**, Prentice-Hall of India, 2006.
3. R. Mak, **Writing Compilers and Interpreters** (2^{nd} ed.), John Wiley & Sons, 1996.
4. D. Galles, **Modern Compiler Design**, Pearson Education, 2007.
5. S. Chattopadhyay, **Compiler Design**, Prentice-Hall of India, 2005.

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:

1. Maurice J. Bach, **Design of the UNIX Operating System**, Prentice Hall, 1986.
2. Gary Nutt, **Kernel Projects for Linux**, Addison Wesley, 2001.
3. William Stallings, **Operating Systems: Internals and Design Principles** (5^{th} ed.), Prentice-Hall of India, 2006.
4. D.M. Dhamdhere, **Operating Systems: A Concept Based Approach** (2^{nd} ed.), Tata McGraw-Hill, 2007.

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:

1. Margaret H. Dunham, **Data Mining: Introductory and Advanced Topics**, 2002.
2. Jiawei Han and Micheline Kamber, **Data Mining: Concepts and Techniques (2^{nd} Ed.),** Morgan Kaufmann, 2006.
3. Arun Pujari, **Data Mining Techniques**, University Press, 2001.
4. G.K. Gupta, **Introduction to Data Mining with Case Studies**, Prentice-Hall of India, 2006
5. Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Introduction **to Data Mining**, Addison Wesley, ISBN: 0-321-32136-7, 2005.

MCS 204: ADVANCED COMPUTER NETWORKS

Wireless Communication Principles: Wireless propagation characteristics, transmission error, multipath fading, intrusion.

Modulation techniques and bandwidth estimations: Amplitude Shift Keying, Phase Shift Keying , Frequency Shift Keying, Quardrature Amplitude Modulations, Direct Sequence and Frequency Hopping Spread Spectrum technologies.

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 Cordination Function, Point Cordination Function, Infrastructure based WLAN, ADHOC WLAN, IEEE 802.11 WLAN standards.

Readings:

1. A. S. Tanenbaum, **Computer Networks (4th Ed.),** PHI Learning Private Limited.
2. B. A. Forouzan, **Data Communications and Networking (4th Ed.),** Tata McGraw-Hill Publishing Company Limited.
3. K. Pahlavan and P. Krishnamurthy, **Principles of Wireless Networks, A unified Approach,** Pearson Education Asia, 2002.
4. P. Nicopolitidis, M. S. Obaidat, G. I. Papadimitriou and A. S. Pomportis, **Wireless Networks,** John Wiley and Sons, Ltd. 2003.

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

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.

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

Readings:

1. E.M. Awad, **Electronic Commerce From Vision to Fulfillment** (3rd ed.), Prentice-Hall of India, 2006.
2. P.T. Joseph, **E-Commerce An Indian Perspective**, Prentice-Hall of India, 2007.
3. Scott Bonneau, Tammy Kohl, Jeni Tennison, Jon Duckett and Kevin Williams, **XML Design Handbook**, Wrox Press Ltd., 2003.
4. Michael Cheshar, Ricky Kaura, and Peter Linton, **Electronic Business and Commerce**, Springer, 2003.
5. W.J. Pardi, **XML in Action: Learn to quickly create dynamic, data-driven sites with the Web's hottest new technology**, Prentice Hall of India, 1999.
6. P. Weill and M.R. Vitale, **Place to Space: Migrating to eBusiness Models**, Harvard Business School Press, 2001.
7. D. Whiteley, **eCommerce: Strategy, Technologies and Applicaitons**, Tata McGraw-Hill Edition, 2001.
8. M. Fitzgerald, **Building B2B Applications with XML: A Resource Guide**, John Wiley and Sons, Inc., 2001.

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:

1. K.E. Atkinson, W. Han, **Elementary Numerical Analysis**, 3rd Edition, Wiley, 2003.
2. C. Xavier, S. S. Iyengar, **Introduction to Parallel Algorithms** (Wiley Series on Parallel and Distributed Computing, Wiley-Interscience, 1998.
3. A. Kharab, R.B.Guenther, **An Introduction to Numerical Methods: A MATLAB Approach** (1st ed.), Chapman & Hall/CRC, 2001.

4. B. Bradie, **A Friendly Introduction to Numerical Analysis**, Pearson Education, 2007.
5. S.R. Otto and J.P. Denier, **An Introduction to Programming and Numerical Methods in MATLAB**, Springer, 2005.
6. M.K. Jain, S.R.K. Iyengar and R.K. Jain, **Numerical Methods for Scientific and Engineering Computation** (7^{th} ed.), New Age International Publishers, 2007.

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.

Graph Algorithms: Primal-Dual algorithm and its application to shortest path, Math-flow problems (Ford and Fulkerson labeling algorithms, Dijkstra's algorithm, Ford-Warshall algorithms), 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 for matroid intersection problem.

Readings:

1. C.H. Papadimitriou and K. Steiglitz, **Combinatorial Optimization: Algorithms and Complexity**, Prentice-Hall of India, 2006.
2. K. Lange, **Optimization**, Springer, 2004.
3. Mokhtar S.Bazaraa, John J. Jarvis and Hanif D. Sherali, **Linear Programming and Network Flows**, John Wiley & Sons, 2004.
4. H.A. Taha, **Operations Research: An Introduction** (8^{th} ed.), Prentice Hall, 2006.

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:

1. A.M. Andrew, **Artificial Intelligence**. Kent: Abacus Press, 1983.

2. R., Grishman, **Computational Linguistics**, Cambridge: Cambridge University Press, 1986.
3. G. Keith, and M. Glover, **Primary Language Learning with Microcomputers.** London: Croom Helm, 1987.
4. S. Nirenburg, (ed) **Machine Translation: I Theoretical and Methodological Issues**. Cambridge, Cambridge University Press, 1987.
5. W.A. Sedlow, and S.Y. Sedlow, (eds.) **Computer in Language Research,** Hillsdale: N.S. Lawrence Erlbawn, 1979.

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:

1. Rafael C. Gonzalez and Richard E.Woods, **Digital Image Processing**, Prentice–Hall of India, 2002.
2. William K. Pratt, **Digital Image Processing: PIKS Inside** (3rd ed.), John Wiley & Sons, Inc., 2001.

3. Bernd Jahne, **Digital Image Processing**, (5th revised and extended edition), Springer, 2002.
4. S. Annadurai and R. Shanmugalakshmi, **Fundamentals of Digital Image Processing**, Pearson Education, 2007.
5. M.A. Joshi, **Digital Image Processing: An Algorithmic Approach**, Prentice-Hall of India, 2006.
6. B. Chandra and D.D. Majumder, **Digital Image Processing and Analysis**, Prentice-Hall of India, 2007.

MCS 303: NEURAL NETWORKS

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

Supervised Learning: Single-layered neural networks, Hopfield-Little model, perceptron rules, Gradient-descent algorithms; Multi-layered neural networks: first order methods, back propagation algorithm, second order methods, RBF networks; Constructive algorithms: single-hidden layer algorithms, upstart algorithm, cascade correlation algorithm; Unsupervised Learning: competitive learning, competition through lateral inhibition.

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:

1. S. Haykin, **Neural Networks: A Comprehensive Foundation** (2nd ed.), Prentice Hall, 1999
2. R.Rojas and J. Feldman, **Neural Networks: A Systematic Introduction** (1st ed.), Springer, 1996.
3. C.M. Bishop, **Neural Networks for Pattern Recognition**, Oxford University Press, 1995.
4. S.N. Sivanandam, S. Sumathi and S.N. Deepa, **Introduction to Neural Networks using MATLAB 6.0**, Tata McGraw-Hill, 2006.
5. B. Yegnanarayana, **Artificial Neural Networks**, Prentice-Hall of India, 2006.

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:

1. N.S. Godbole, **Software Quality Assurance: Principles and Practice,** Narosa Publishing House, 2006.
2. G.G. Schulmeyer and J. McManus (eds.), **Handbook of Software Quality Assurance** (3rd ed.), Prentice Hall, 1999.
3. G. O'Regan, **A Practical Approach to Software Quality**, Springer Verlag, 2002.
4. Daniel Galin, **Quality Assurance: From theory to implementation**, Pearson Education Ltd., 2004.
5. S.H. Kan, **Metrics and Models in Software Quality Engineering** (2nd ed.), Pearson Education Inc., 2003.
6. J.D. McGregor and D.A. Sykes, **A Practical Guide to Testing**, Addison-Wesley, 2001.
7. Glenford J. Myers, **The Art of Software Testing** (2nd ed.), John Wiley, 2004.
8. D. Graham, E.V. Veenendaal, I. Evans and R. Black, **Foundations of Software Testing**, Thomson Learning, 2007.

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:

1. E. Alpaydin**, Introduction to Machine Learning**, Prentice Hall of India, 2006.
2. T. M. Mitchell, **Machine Learning**, McGraw-Hill, 1997.
3. C. M. Bishop, **Pattern Recognition and Machine Learning**, Springer, 2006.
4. R. O. Duda, P. E. Hart, and D.G. Stork, **Pattern Classification**, John Wiley and Sons, 2001.
5. Vladimir N. Vapnik, **Statistical Learning Theory**, John Wiley and Sons, 1998.
6. J. Shawe-Taylor and N. Cristianini, Cambridge, **Introduction to Support Vector Machines**, University Press, 2000.

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:

1. Daniel W. Lewis, **Fundamentals of Embedded Software, where C and assembly meet,** Pearson Education 2001.
2. John B. Peatman, **Design with PIC Microcontrollers,** Pearson Education, 1997.
3. Robert B. Reese, **Microprocessors: From assembly language to C using PIC18Fxx2**, Shroff Publishers and Distributors Pvt Ltd. 2005.
4. Wayne Wolf, **Computers as Components: Principles of Embedded Computing System Design**, Elsevier Publication 2000.
5. Michael Juntao Yuan, **Enterprise, J2ME – Developing Mobile Java Applications,** Pearson Education, 2003.
6. Andrew N. Sloss, Dominic Symes, Chris Wright, **ARM System Developer's Guide – Designing and Optimizing System Software,** Elsevier Publications, 2007.
7. A. Silberschatz, P.B.Galvin and G. Gagne, **Operating System Concepts** (6^{th} ed.), John Wiley & Sons, Inc., 2001
8. K.V.K.K.Prasad**, Embedded/Real Time Systems: Concepts, Design and Programming**, Dreamtech Press, New Delhi, India, 2003.

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").

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:

1. W. Stallings, **Cryptography and Network Security Principles and Practices** (4^{th} ed.), Prentice-Hall of India, 2006
2. C. Pfleeger and S.L. Pfleeger, **Security in Computing** (3^{rd} ed.), Prentice-Hall of India, 2007
3. MY Rhee, **Network Security**, John Wiley and Sons, NY, 2002.

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:

1. P.K. Sinha, **Distributed Operating Systems, Concept and Design,** Prentice Hall of India, 1997.
2. A.S Tannenbaum, M.V. Steen, **Distributed Systems, Principles and Paradigms**, Prentice Hall of India, 2002.
3. Vijay K. Garg, **Elements of Distributed Computing** Wiley – IEEE 2002.

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:

1. Narsingh Deo, **System Simulation with Digital Computer**, Prentice Hall of India, 1999.
2. Averill Law, **Simulation Modeling and Analysis (3rd Ed.)**, Tata McGraw-Hill, 2007.
3. G. Gordan, **System Simulation (2nd Ed.),** Pearson Education, 2007.
4. A.F. Seila, V. Ceric and P. Tadikamalla, **Applied Simulation Modeling** (International Student Edition), Thomson Learning, 2004.
5. Jerry Banks, **Handbook of Simulation: Principles, Methodology, Advances, Applications, and Practice**, Wiley Inter Science, 1998.
6. J. Banks, J.S. Carson, B.L. Nelson, **Discrete Event System Simulation (4th Ed.),** Prentice-Hall of India, 2004.
7. N.A. Kheir, **Systems Modeling and Computer Simulation**, Marcel Dekker, 1988.

B.P. Zeigler, T.G. Kim, and H. Praehofer, **Theory of Modeling and Simulation (2nd Ed.),** Academic Press, 2000.

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:

1. Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications IEEE Std. 802.11™-2007.
2. G., Bianchi, **IEEE 802.11-saturation throughput analysis,** IEEE Communication. Letters, vol. 2, pp. 318–320, Dec. 1998.
3. G., Bianchi, **Performance analysis of the IEEE 802.11 distributed coordination function,** IEEE J. Selected Areas in Communication, vol. 18, 535-547, Mar. 2000.
4. S., Choi, J.D., Prado, S., Shankar, and S., Mangold, **IEEE 802.11e contention-based channel access (EDCF) performance evaluation,** in *Proc. IEEE ICC'03*, vol. 2, May 2003, pp. 1151–1156.
5. S., Mangold, S., Choi, G.R., Hiertz, O., Klein, and B., Walke, **Analysis of IEEE 802.11e for QoS support in wireless LANs,** IEEE Wireless Communications , December 2003, pp.40-50.
6. Y., Xiao, **A Simple and Effective Priority Scheme for IEEE 802.11,** IEEE Communications Letters, vol. 7, no. 2, February 2003.
7. X., Chen, H., Zhai, X., Tian, and Y,Fang, **Supporting QoS in IEEE 802.11e Wireless LANS,** IEEE Transactions on Wireless Communications, Vol.5, No. 8, August 2006 pp-2217-2227.

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:

1. D.J.Hand, Heikki Mannila, Padhraic Smyth, **Principles of Data Mining,** MIT Press 2001,

2. Trevor Hastie, Robert Tibshirani, Jerome H. Friedman, **The Elements of Statistical Learning,** Springer, 2001.
3. Soumen Chakrabarti, **Mining the Web,** Morgan Kaufmann, 2002.
4. Sushmita Mitra, Tinku Acharya, **Data Mining: Multimedia, Soft Computing, and Bioinformatics,** Wiley, 2003, ISBN: 978-0-471-46054-1**.**
5. Ronen Feldman, James Sanger, **The Text Mining Handbook**, Cambridge University Press, 2006.
6. John Wang, **Encyclopedia of Data Mining**, IGI Global, 2008.

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.

Network Design Problems: Steiner tree, Spanning Trees, Cuts and Connectivity, Routing and Flow Problems.

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:

1. M. R. Garey and D. S. Johnson, **Computers and Intractability: A Guide to the Theory of NP-Completeness (Series of Books in the Mathematical Sciences)**, 1979.
2. Teofilo F. Gonzalez, **Handbook of NP-Completeness: Theory and Applications** 2009.
3. Vijay V. Vazirani, Springer-Verlag, **Approximation Algorithms**, France, 2006.
4. Teofilo F. Gonzalez, **Handbook of Approximation Algorithms and Metaheuristics (Chapman & Hall/Crc Computer and Information Science Series)** 2007.
5. Mokhtar S. Bazaraa, John J. Jarvis, and Hanif D. Sherali, **Linear Programming and Network Flows** by 2004.
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 steganogarphy, Lossless data hiding, Data hiding by quantication, Patchwork, Transform domain methods, Robust data hiding in JPEG images, frequency domain watermarking Detecting malicious tempering, Robust waveletbased watermarking, Kundur-Hatzinakos watermarking, Data hiding in binary images, Zhao-koch method, Wu-Lee method, CPT method, TP method, Data hiding in fax images.

Watermarking: Introduction, Watermarking principals, Applications, Requirements and algorithmic design issues, Evaluation and standards of watermarking.
Fingerprinting: Introduction, Terminology and requirements, Classifications, Research history, fingerprinting schemes, Statistical fingerprinting, and Collusion-secure fingerprinting.

Readings:

1. I.J.Cox, M.L.Miller, J.A.Bloom, J.Fridrich, T.Kalker, **Digital Watermarking and Stegonagraphy,** Morgan Kaufman 2008.
2. F.Y.Shih, **Digital Watermarking and Stegonagraphy Fundamentals and Techniques,** CRC press 2008.
3. Stefon Katzeubeisser, F.A.Petitolos, **Information Hiding Techniques for Stegonagraphy and digital watermarking**, Aatech House London 2008.

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, foot print 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:

1. L. Rutkowski, **Computational Intelligence,** Methods and Techniques, Springer, 2008
2. J. Valente de Oliveira, W. Pedrycz, **Advances in Fuzzy Clustering and its Applications,** John Wiley & Sons, 2007.
3. J. Stepaniuk, **Rough-Granular Computing in Knowledge Discovery and Data Mining**, Springer, 2008.
4. F. Hopner, F. Hoppner, F. Klawonn, **Fuzzy Cluster Analysis: Methods for Classification, Data Analysis and Image Recognition**, John Wiley & Sons, 1999.

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:

1. Sourav Bhowmick, Sanjay Madria, and Wee Keong Ng, **Web Data Management A Warehouse Approach,** Springer.
2. Kevin William, **Professional XML Databases,** Wrox publications.

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

Intelligent Agents: Environments, Intelligent Agents, Agents and Objects, Agents and Expert Systems, Agents as Intentional Systems, Abstract Architectures for Intelligent Agents, Purely Reactive Agents, Perception, Agents with State, How to Tell an Agent What to Do, Utility Functions.

Practical Reasoning Agents: Practical Reasoning, Means-Ends Reasoning, The Blocks World, Implementing a Practical Reasoning Agent, Commitment to Ends and Means, The Procedural Reasoning System.

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:

1. Michael Wooldridge, **An Introduction to MultiAgent Systems**, Wiley Series in Agent Technology, 2002.
2. G. Weiss**. Multiagent Systems--A Modern Approach to Distributed Artificial Intelligence.** MIT Press, Cambridge, MA, 3rd edition, 2001.
3. S. Russell and P. Norvig, **Artificial Intelligence: A Modern Approach** (2^{nd} ed.), Pearson Education, 2006.
4. Rafael H. Bordini, Jomi Fred Hübner, Michael Wooldridge, **Programming Multi-Agent Systems in AgentSpeak using Jason,** Wiley Series in Agent Technology, 2007.
5. Lin Padgham, Michael Winikoff, **Developing Intelligent Agent Systems: A Practical Guide**, Wiley Series in Agent Technology, 2004.
6. Fabio Luigi Bellifemine, Giovanni Caire, Dominic Greenwood, **Developing Multi-Agent Systems with JADE**, Wiley Series in Agent Technology, 2007.

MCS 317: SPECIAL TOPICS IN COMPUTAIONAL 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 if 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:

1. J. Stepaniuk, **Rough- Granular Computing in Knowledge Discovery and Data Mining,** Springer, 2008.
2. P. Doherty, W. Lukaszewicz, A. Skowron, A. Szalas: **Knowledge Engineering: A**

Rough Sets Approach, Springer, 2006.

3. I. Duntsch, G. Gediga, **Rough Set Data Analysis: A Road to Non-invasive Knowledge Discovery, Methodos** Publishers, Bangor, 2000.
4. T. Y. Lin, N. Cercone, **Rough Sets and Data Mining - Analysis of Imperfect Data,** Kluwer Academic Publishers, Boston, 1997.
5. L. Polkowski, A. Skowron (eds.), **Rough Sets in Knowledge Discovery 1: Methodology and Applications, Studies in Fuzziness and Soft Computing,** vol. 18, Physica Verlag, Heidelberg, 1998.
6. L. Polkowski, A. Skowron (eds.), **Rough Sets in Knowledge Discovery 2: Methodology and Applications, Studies in Fuzziness and Soft Computing,** vol. 19, Physica Verlag, Heidelberg, 1998.
7. S. K. Pal, P. Mitra, **Pattern Recognition Algorithms for Data Mining – Scalability, Knowledge Discovery, and Soft Granular Computing**, Chapman & Hall/CRC, 2004.