SRI SATHYA SAI INSTITUTE OF HIGHER LEARNING

(Deemed to be University)

Syllabus for

M.Tech.(Computer Science)

Prasanthi Nilayam – 515 134

Anantapur District, Andhra Pradesh, Ph: (08555) 287239, Fax: 286919

Website: www.sssihl.edu.in ; Email: registrar@sssihl.edu.in

SRI SATHYA SAI INSTITUTE OF HIGHER LEARNING
(Deemed to be University)

Syllabus for M.Tech. (Computer Science)
(Applicable from the batch 2017–18 onwards)

Basic Structure

M.Tech. (Computer Science) is a four-semester program for 72 Credits. Students with either Bachelor's degree in Engineering or Master's degree in Science are admitted. The students are expected to have undergone formal educational training with appropriate credits in first level courses in Computer organization and architecture, Computer networks, Data base systems, Systems programming. Students are also expected to have undergone formal training in Programming with C, C++ and Java language. These courses constitute the prerequisites for the M.Tech.(Computer Science) program. In addition to this, fair knowledge of Operating systems, Compiler Design, Formal Languages and Automata Theory, hands on experience with UNIX environment and familiarity in programming with PYTHON, MATLAB etc. will be advantageous to the students seeking admission to this course. A student takes in all 10 courses of which 6 are core courses which pertain to fundamentals of computer science. The remaining 4 are elective courses which give the scope for specialization in the individual's interest or thrust areas of the department.

Course Design

Semester Duration: A maximum of 14 weeks are typically used in the semester to deliver any subject.

Credit Distribution:

1. Total 70 credits for the course is distributed as given below :
    a. 6 Core Theory subjects — 3 credits each
    b. 5 Core Practical subjects — 2 credits each
    c. 4 Elective subjects — 4 credits each

d. 4 Seminar presentations — 1 credit each

e. 2 Viva voce at the end of semester — 1 credit each

f. Comprehensive Viva voce in the fourth semester — 2 credits

g. Project during the third and fourth semester — 18 credits.

2. An elective subject may be designed to have two different components/mode of delivery namely, Theory and Practical with clear division of credits among the components. For example a 4 credit course could be specified as 2L+2P to indicate 2 credits for lectures and 2 credits for practical or as 3L+P meaning 3 credits for lecture and one credit for practical or L+3P to indicate 1 credit for lectures and 3 credits for practical.

3. Typically one lecture credit (T) is given one period per week, one practical credit (P) is given minimum of two and maximum of three periods per week.

4. In the first two semesters students have four seminar presentations that demand independent study of research papers, latest technology trends in the areas of interest and presentation skills. Seminar-I & III will be on study of Research Papers published in journals. Seminar-II & IV will be based on happenings and latest technology trends in the area of Computer Science.

5. The Comprehensive Viva voce is conducted in the final semester.

6. The students have to do a two-semester project starting from third semester.

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DEPARTMENT OF MATHEMATICS & COMPUTER SCIENCE

SCHEME OF INSTRUCTION AND EVALUATION
M.Tech.(Computer Science)

(Effective from the batch 2017-18 onwards)

Paper Code	Title of the Paper	Credits	Hours	Types of Papers	Modes of Evaluation	Maximum Marks
FIRST SEMESTER						
MTCS-101	Design and Analysis of Algorithms	3	3	T	IE2	100
MTCS-101(P)	Practicals: Design and Analysis of Algorithms	2	4	P	I	50
MTCS-102	Advanced Computer Architecture	3	3	T	IE2	100
MTCS-102(P)	Practicals: Advanced Computer Architecture	2	4	P	I	50
MTCS-103	Parallel Processing	3	3	T	IE2	100
MTCS-103(P)	Practicals: Parallel Processing	2	4	P	I	50
MTCS-104	Elective-I	4*	4*	T	IE2	100*
MTCS-105	Seminar-I	1	-	-	I	50
MTCS-106	Seminar-II	1	-	-	I	50
MTCS-107	Semester End Viva voce	1	-	SEV	E1	50
SAWR-100N	Awareness Course-I: Education for Life – Individual Transformation	**Non-Credit**	**1**	I	-	--
		---- 22	**26**			**------ 700**
SECOND SEMESTER						
MTCS-201	Theory of Computation	3	3	T	IE2	100
MTCS-202	Distributed Systems	3	3	T	IE2	100
MTCS-202(P)	Practicals: Distributed Systems	2	4	P	I	50
MTCS-203	Topics in Database Management Systems	3	3	T	IE2	100
MTCS-203(P)	Practicals: Topics in Database Management Systems	2	4	P	I	50
MTCS-204	Elective-II	4*	4*	T	IE2	100*
MTCS-205	Elective-III	4*	4*	T	IE2	100*
MTCS-206	Seminar-III	1	-	-	I	50
MTCS-207	Seminar-IV	1	-	-	I	50
MTCS-208	Semester End Viva voce	1	-	SEV	E1	50
SAWR-200N	Awareness Course-II: God, Society and Man	**Non-Credit**	**1**	I	-	--
		---- 24*	26*			**------ 750**
THIRD SEMESTER						
MTCS-301	Elective-IV	4*	4*	T	IE2	100*
MTCS-401	Project Work – Review	-	22	PW	-	50**
		---- 4	26*			**------ 100**
FOURTH SEMESTER						
MTCS-401	Project Work	18	24	PW	E2	150***
MTCS-402	Comprehensive Viva voce	2	-	COV	E1	50
		---- 20	24			**----- 250**
	TOTAL:	**70**	**102***			**1800***

PS: Please refer to guidelines for 'Modes of Evaluation for various types of papers', and 'Viva voce nomenclature & scope and constitution of the Viva voce Boards'.

* Credits split between Lectures and Practical, total marks for the subject, and the grand total marks for the paper, may change based on the credits allocated for the Lecture and Practicals of the elective(s) the students opt for. i.e., the elective paper A may be designed to have two different components/mode of delivery namely, Theory and Practical with clear division of credits among the components. For example a 4 credit course could be specified as 2L+2P to indicate 2 credits for lectures and 2 credits for practical or as 3L+P meaning 3 credits for lecture and one credit for practical or L+3P to indicate 1 credit for lectures and 3 credits for practical, .

** The Project Work topic would be finalized by the end of the second semester, and the Project Work starts in the third semester and gets completed in the fourth semester. Then interim review would consist of an oral examination to assess the progress made by the student in the project work. Student will be asked to make a presentation along with a submission of report of work done so far.

*** Total marks for the Project Work would be for **200 marks**, which would include

- **50 marks** for the review of the project work by the student at the end of the third semester (please see **)
- **100 marks** for the Project Report Examination
- **50 marks** for Project Viva voce conducted at the end of the 4th semester.

Continuous Internal Evaluation (CIE) & End Semester Examination (ESE)

Indicator	Legend
IE1	CIE and ESE ; ESE single evaluation
IE2	CIE and ESE ; ESE double evaluation
I	Continuous Internal Evaluation **(CIE)** only Note: 'I' does not connote 'Internal Examiner'
E	End Semester Examination **(ESE)** only Note: 'E' does not connote 'External Examiner'
E1	ESE single evaluation
E2	ESE double evaluation

STREAMS of Elective Courses

STREAM I: INTELLIGENT SYSTEMS AND KNOWLEDGE ENGINEERING

Paper Code	Elective Title	Theory/ Practical	Credits	Prerequisite
ISKE 1	Artificial Intelligence	T	3	--
ISKE 1(P)	Practicals: Artificial Intelligence	P	1	
ISKE 2	Genetic Algorithms	T	3	--
ISKE 2(P)	Genetic Algorithms	P	1	
ISKE 3	Natural Language Processing	T	3	First level Course in A.I
ISKE 3(P)	Practicals: Natural Language Processing	P	1	First level Course in A.I

ISKE 4	Neural Networks	T	3	--
ISKE 4(P)	Practicals: Neural Networks	P	1	--
ISKE 5	Data Mining and Data Warehousing	T	3	First level course in Databases
ISKE 5(P)	Practicals: Data Mining and Data Warehousing	P	1	First level course in Databases
ISKE 6	Pattern Recognition	T	3	Foundations in Probability and Statistics.
ISKE 6(P)	Practicals: Pattern Recognition	P	1	Foundations in Probability and Statistics.
ISKE 7	Machine Learning	T	3	Foundations in Probability and Statistics.
ISKE 7(P)	Practicals: Machine Learning	P	1	Foundations in Probability and Statistics.
ISKE 8	Mining of Big Data Sets	T	2	--
ISKE 8(P)	Practicals: Mining of Big Data Sets	P	2	--

STREAM II: ADVANCED COMPUTER NETWORKS

Paper Code	Elective Title	Theory/ Practical	Credits	Prerequisite
ACN 1	Telecom Networking	T	3	First level Course in Computer Networks
ACN 1(P)	Practicals: Telecom Networking	P	1	First level Course in Computer Networks
ACN 2	Network Security	T	3	First level Course in Computer Networks
ACN 2(P)	Practicals: Network Security	P	1	
ACN 3	Wireless and Mobile Networks	T	3	First level Course in Computer Networks
ACN 3(P)	Practicals: Wireless and Mobile Networks	P	1	First level Course in Computer Networks
ACN 4	Advanced Computer Networks	T	3	First level Course in Computer Networks
ACN 4(P)	Practicals: Advanced Computer Networks	P	1	First level Course in Computer Networks

STREAM III: HUMAN COMPUTER INTERACTION

Paper Code	Elective Title	Theory/ Practical	Credits	Prerequisite
HCI 1	Digital Image Processing	T	3	--
HCI 1(P)	Practicals: Digital Image Processing	P	1	
HCI 2	Medical Image Processing	T	3	First level Course in Image Processing
HCI 2(P)	Practicals: Medical Image Processing	P	1	First level Course in Image Processing
HCI 3	Computer vision	T	3	First level Course in Image Processing
HCI 3(P)	Practicals: Computer vision	P	1	First level Course in Image Processing
HCI 4	Advanced Topics in Image Processing	T	3	First level Course in Image Processing
HCI 4(P)	Practicals: Advanced Topics in Image Processing	P	1	First level Course in Image Processing
HCI 5	Video Processing	T	3	First level Course in Image Processing
HCI 5(P)	Practicals: Video Processing	P	1	First level Course in Image Processing

STREAM IV: THEORETICAL COMPUTER SCIENCE

Paper Code	*Elective Title*	Theory/ Practical	Credits	*Prerequisite*
TCS 1	Advanced Algorithms	T	3	First level Course in Algorithms, Probability.
TCS 1(P)	Practicals: Advanced Algorithms	P	1	First level Course in Algorithms, Probability.
TCS 2	Cryptography	T	3	--
TCS 2(P)	Practicals: Cryptography	P	1	--

STREAM V: COMPUTER SYSTEMS

Paper Code	Elective Title	Theory/ Practical	Credits	Prerequisite
CS 1	Compiler Design	T	3	
CS 1(P)	Practicals: Compiler Design	P	1	

CS 2	Embedded Computing	T	3	First course in Architecture, OS
CS 2(P)	Practicals: Embedded Computing	P	1	First course in Architecture, OS
CS 3	Advanced Programming in Unix Environment	T	2	
CS 3(P)	Practicals: Advanced Programming in Unix Environment	P	2	
CS 4	Programming for performance	T	2	First course in Architecture
CS 4(P)	Practicals: Programming for Performance	P	2	First course in Architecture
CS 5	Operating Systems	T	3	
CS 5(P)	Practicals: Operating Systems	P	1	

STREAM VI: MULTI-CORE AND PARALLEL COMPUTING

Paper Code	Elective Title	Theory/ Practical	Credits	Prerequisite
MPC 1	Parallel Numerical Linear Algebra	T	3	First level Course in Architecture, Algorithms, Numerical Linear Algebra
MPC 1(P)	Practicals: Parallel Numerical Linear Algebra	P	1	First level Course in Architecture, Algorithms, Numerical Linear Algebra
MPC 2	Multi core Computing	T	3	First level Course in Architecture, Algorithms
MPC 2(P)	Practicals: Multi core Computing	P	1	First level Course in Architecture, Algorithms
MPC 3	High Performance Embedded Computing	T	3	First level Course in Architecture, Algorithms, Operating Systems
MPC 3(P)	Practicals: High Performance Embedded Computing	P	1	First level Course in Architecture, Algorithms, Operating Systems

MPC 4	High Performance Computing with Accelerators	T	2	First Level course in Architecture, Systems Programming
MPC 4(P)	Practicals: High Performance Computing with Accelerators	P	2	First Level course in Architecture, Systems Programming
MPC 5	Cloud Computing	T	2	First Level course in Architecture, Systems Programming
MPC 5(P)	Practicals: Cloud Computing	P	2	First Level course in Architecture, Systems Programming
MPC 6	Multi Processor Programming	T	2	First Level course in Architecture, Systems Programming
MPC 6(P)	Practicals: Multi Processor Programming	P	2	First Level course in Architecture, Systems Programming

STREAM VII: SOFTWARE ENGINEERING

Paper Code	***Elective Title***	**Theory/ Practical**	**Credits**	***Prerequisite***
SE 1	Object Oriented System Design	T	3	--
SE 1(P)	Practicals: Object Oriented System Design	P	1	--
SE 2	Web Technology	T	3	--
SE 2(P)	Practicals: Web Technology	P	1	--

STREAM VIII: MATHEMATICAL METHODS IN COMPUTER SCIENCE

Paper Code	***Elective Title***	***Theory/ Practical***	***Credits***	***Prerequisite***
MMCS 1	Mathematical Methods in Image Processing	T	3	First level course in PDE and Calculus of Variations

MMCS 1(P)	Practicals: Mathematical Methods in Image Processing	P	1	First level course in PDE and Calculus of Variations
MMCS 2	Numerical Methods in Image Processing	T	3	First level course in Calculus of Variations
MMCS 2(P)	Practicals: Numerical Methods in Image Processing	P	1	First level course in Calculus of Variations
MMCS 3	Mathematical Methods for Data Mining	T	3	First level courses in Probability and Linear Algebra
MMCS 3(P)	Practicals: Mathematical Methods for Data Mining	P	1	First level courses in Probability and Linear Algebra

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M.TECH. (COMPUTER SCIENCE)
CORE COURSES (4 CREDITS)

MTCS-101 DESIGN AND ANALYSIS OF ALGORITHMS

(3 Credits) (42 Periods)

Unit 1 : Design & Analysis Techniques (10 periods)
Growth of functions, Loop invariant, Divide and Conquer, Master method for solving recurrences, Dynamic programming, Greedy Algorithms (excluding starred sections), Amortized analysis, Probabilistic Analysis and Randomized Algorithms (excluding starred sections).

Unit 2: Sorting & Order statistics (6 periods)
Sorting in linear time, Heapsort, Quicksort, Medians and Order statistics

Unit 3 : Data Structures
Elementary data structures, Hash tables, Binary search trees, Red Black trees, Augmenting Data Structure, Data structure for disjoint sets (12 periods)

Unit 4: Graph algorithms (10 periods)
Graph searching techniques, Minimum spanning trees, single source shortest paths, all pairs shortest paths

Unit 5: Specialized topics (4 periods)
String Matching, Computational geometry.

Total Periods: 42 periods

Text book: Introduction to algorithms, 3rd edition, Thomas H Cormen, Charles E Leiserson, Ronald Rivest, Cliffor Stein. Chapters: 1 to 17, 21 to 25, 32, 33

Reference Book: Introduction to design & analysis of algorithms, 2nd edition, Anany Levitin.

MTCS-101(P) Practicals: DESIGN AND ANALYSIS OF ALGORITHMS

(1 Credit)

Algorithms / Exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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MTCS-102 Advanced Computer Architecture

(3 Credits) (42 Periods)

Unit 1:
Instruction Set Architectures, Microcode (H&P5 Chapter 1, H&P5 Appendix A) Pipelining Review (H&P5 Appendix C) Cache Review (H&P5 Appendix B-1 - B-40)
(7 periods)

Unit 2:
Instruction level parallelism – hardware and software techniques (e.g., dynamic scheduling, superscalar, static and dynamic branch prediction, VLIW, loop unrolling). (H&P5 Chapter 3) Exceptions (H&P5 Appendix C)
(12 periods)

Unit 3:
Branch Prediction (H&P5 Appendix C, Chapter 2)
Memory hierarchy – advanced concepts in caches (e.g., prefetching, lockup-free caches, and multi-level caches),
main memory, and virtual memory. (H&P5 Chapter 2 (P.71 – P.105))
Memory Protection (H&P5 Appendix B(B41 -B67), Chapter 2 (P.105 – P.112))
(14 periods)

Unit 4:
Vector Processors and GPUs (H&P5 Chapter 4)
Multiprocessors/multicore – overview of different models, cache coherence with shared-memory systems/multicore (snoopy and directory solutions), synchronization. (H&P5 Chapter 5) (9 periods)

Total 42 Periods

TEXTBOOK:
1. [H&P5] "Computer Architecture: A Quantitative Approach (5th Edition)", 2012, John L. Hennessy and David A. Patterson, ISBN: 978-0123838728

REFERENCE BOOKS
1. "Digital Design and Computer Architecture, 2nd edition" by D. M. Harris and S. L. Harris (Morgan Kaufmann, 2012).

2. "Modern Processor Design: Fundamentals of Superscalar Processors (1st Edition)", 2004. John P. Shen and Mikko H. Lipasti, ISBN: 0070570647, Princeton University Library Owns.

MTCS-102(P) Practicals: Advanced Computer Architecture (2 Credits)

Algorithms/Exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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MTCS-103 PARALLEL PROCESSING

(3 Credits) (42 Periods)

Unit 0: Introduction - Modern Parallel Computers - Types of Concurrency – Programming. 3 Periods

Unit 1: Parallel Architecture – Interconnection Network – Processor arrays – Multiprocessors – Multi Computers – Flynn's taxonomy. 5 Periods.

Unit 2: Parallel Algorithm Design – Foster's Design Methodology – Example Problems. 4 Periods

Unit 3: Message Passing programming Model – MPI – Point to Point & Collective Calls. 4 Periods.

Unit 4: Algorithms for Illustrations – Sieve of Eratosthenes – Floyd's Algorithm.(To discuss all the concepts introduced so far). 4 Periods

Unit 5: Performance analysis – Speed up and Efficiency – Amdahl's Law – Gustafson's Barsis Law – Karp Flatt Metric – Isoefficiency Metric. 4 Periods

Unit 6: Matrix Vector Multiplication – Monte Carlo Methods – Matrix Multiplication – Solving linear System - finite Difference Methods - sorting algorithm - combinatorial Search. 14 Periods

Unit 7: Shared Memory Programming – Open MP. 4 Periods.

Total: 42 Periods.

Text Book:
Parallel Programming in C with MPI and OpenMP by Michale J Quinn, Tata McGraw Hill 2004.

Reference Book:
Introduction to Parallel Computing by Anantha Grama, Anshul Gupta, George Karypis, Vipin Kumar, Pearson education LPE, Second edition, 2004.

MTCS-103(P) Practicals: PARALLEL PROCESSING (2 Credits)

1. Message Passing programming Model – MPI – Point to Point & Collective Calls.
2. Document classification Problem
3. Matrix Vector & Matrix Matrix Multiplication
4. Parallel Quick Sort
5. Shared Memory Programming – Open MP

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MTCS-201 Theory of Computation

(3 Credits) (42 Periods)

Unit 1 Introduction to Basic Models of Computation and the finite representation of Infinite Objects 4 periods

Unit 2 Finite Automata and Regular Languages 6 periods

Unit 3 Pushdown Automata and Context - Free Language 6 periods

Unit 4 Turing Machines and their Variants - Recursive Functions - Church's Thesis 14 periods

Unit 5 Undecidability - Reducibility and Completeness – Time Complexity and NP-Completeness 12 periods

Total 42 periods

Key Text Elements of theory of computation by Harry Lewis R, Christos H. Papadimitriou, 2nd edition, PHI Publications, 1998.

Coverage of Key Text Chapters: 1 (only 1.7 and 1.8), 2, 3, 4 (except 4.4 and 4.6), 5, 6, 7.

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MTCS-202 DISTRIBUTED SYSTEMS

(3 Credits) (42 Periods)

Unit 1: Basics – Remote method invocation, indirect communication, distributed objects (Ch. 5-8) 5 Periods

Unit 2: Services – P2P Systems, Distributed file Systems, Name Services (Ch. 9-10, 12-13) 8 Periods

Unit 3: Infrastructure -- Time and Global States, Coordination and agreement, Distributed Transactions, Replication, and Security (Ch. 11, 14-18) 12 Periods

Unit 4: Applications -- Mobile and Ubiquitous Computing, Distributed Multimedia Systems, Google (Ch. 19-21) 8 Periods

Unit 5: Cloud Computing -- Introduction to cloud paradigm, Structure of cloud data centers, Computing in the cloud and challenges, MapReduce paradigm (Reference book/papers) 9 Periods

Total: 42 Periods

TEXT BOOK:

1. Distributed Systems – Concepts & Design, by Coulouris, Dollimore, Kindbeg, and Blair. 5th Edition, Addison-Wesley, 2012 [Chapters 5 –21]

REFERENCE BOOKS

1. Guide to Reliable Distributed Systems: Building High-Assurance Applications and Cloud-Hosted Services, Springer-Verlag, 2012 [Chapters 1-3, 5, for Cloud Computing]

MTCS-202(P) Practicals: DISTRIBUTED SYSTEMS (2 Credits)

Algorithms/Exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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MTCS-203 TOPICS IN DATABASE MANAGEMENT SYSTEMS

(3 Credits) (42 Periods)

Unit 1 : DATA STORAGE AND QUERYING 10 periods
Indexing and Hashing, Algorithms for Query Processing and Query Optimization

Unit 2 : TRANSACTION MANAGEMENT 12 periods
Concurrency Control Techniques, Database Recovery Techniques,

Unit 3 : SYSTEM ARCHITECTURE 12 periods
Database-System Architectures, Parallel Databases, Distributed Databases.

Unit 4 : ADVANCED TOPICS 8 periods
Advanced Application Development, Temporal and Spatial Data, Advanced Transaction Processing.

Total 42 periods

Key Text: Silberschatz, A., Korth, H. F., and Sudarsham, S. (2010) *Database System Concepts*, 6th Edition, McGraw-Hill.
Chapters 11, 12, 13 (upto 13.4), 15 to 19, 24 to 26

References:

1. Fundamentals of Database Systems by Elmasri, R., and Navathe, S. B., 4th edition(2007), Pearson Education.
2. Ramakrishnan, R., and Gherke, J. (2000) *Database Management Systems*, Second Edition, McGraw-Hill.
3. Sunderraman, R. (2008) *Oracle 10g Programming: A Primer*, Addison-Wesley

MTCS-203(P)

Practicals: TOPICS IN DATABASE MANAGEMENT SYSTEMS

(2 Credit)

Algorithms/Exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

M.TECH. (COMPUTER SCIENCE)
LIST OF ELECTIVE COURSES (3CREDITS)

STREAM I: INTELLIGENT SYSTEMS AND KNOWLEDGE ENGINEERING

ISKE 1 ARTIFICIAL INTELLIGENCE

(3 Credits) (42 Periods)

Unit 1:

Introduction – what is AI? – Intelligent agents, environments – Solving problems by searching: problem solving agents –Example problems – Uninformed search strategies – Informed search and exploration: Informed search strategies –Heuristic functions– Local search algorithms – Optimization problems. (10 periods)

Unit 2:

Logical Agents :Knowledge Based Agents – Logic – Propositional logic – Reasoning patterns – Propositional Inference – Agents based on propositional logic – First Order Logic :Representation – Using FOL – Knowledge Engineering – Inference in FOL: Unification And Lifting – Forward Chaining – Backward Chaining – Resolution – Examples. (14 periods)

Unit 3:

Knowledge Representation: Ontological Engineering – Categories and objects – Actions situations and events – Mental events and mental objects – Reasoning Systems – Truth maintenance systems (9 periods)

Unit 4:

Learning from Observations: Forms of learning – Inductive learning – Learning Decision trees - Knowledge in Learning – Knowledge in Learning – Explanation based learning – Learning using relevance information (9 periods)

Total (42 Periods)

TEXT BOOK

1.Artificial Intelligence – A Modern Approach , by Stuart J. Russel and Peter Norvig, Prentice Hall, Pearson Education, 2003.
[Chapters & Sections : 1: 1.1 ; 2: 2.1 to 2.4 ; 3:3.1 to 3.6; 4: 4.1 to 4.3 ; 7: 7.1 to 7.7; 8 : 8.1 to 8.4; 9: 9.1 to 9.5 ; 10: 10.1 to 10.8; 18: 18.1 to 18.3 ; 19: 19.1 to 19.4]

REFERENCES

1. Artificial Intelligence, Structures and Strategies for Complex Problem Solving, by George F. Luger and William A. Stubblefield, The Benjamin / Cummings Publishing Co, 1993.
2. Artificial Intelligence and Soft Computing, by Amit Konar, CRC Press, 2000.

ISKE 1(P) Practicals: ARTIFICIAL INTELLIGENCE

(1 Credit)

Algorithms/Exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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ISKE 2 GENETIC ALGORITHMS (3 Credits) (42 Periods)

Mathematical Foundations for Genetic Algorithms - Concepts in Genetic Algorithm and their Implementation - Operators and Techniques in Genetic Search - Genetic Based Machine Learning - Applications.

TEXT BOOK

1. Genetic Algorithms In Search, Optimization, And Machine Learning, by David E. Goldberg,Addison - Wesley Pub. Co., INC. 1989.

ISKE 2(P) Practicals: GENETIC ALGORITHMS (1 Credit) (42 Periods)

Algorithms/Exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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ISKE 3 NATURAL LANGUAGE PROCESSING (3 Credits) (42 Periods)

Introduction To Languages And Grammars - Transformational Grammars Of Natural Language - Two-Level Representation - Transition Networks - From Grammar To Acceptor- Two Level Processing Systems RTN's And ATN's- Issues And Applications.

TEXT BOOK

1. Computer Processing Of Natural Language, by Gilbert K. Krulee,Prentice Hall 1991.

ISKE 3(P) Practicals: NATURAL LANUAGE PROCESSING (1 Credit)

Algorithms/Exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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ISKE 4 NEURAL NETWORKS

(3 Credits) (42 Periods)

Unit 1: Introduction:

What is Neural Networks? Human Brain, Models of a Neuron, Neural Networks viewed as Directed Graphs, Network Architectures, Learning Processes**:** Learning With a Teacher, Learning Without a Teacher: Reinforcement Learning and Unsupervised Learning, Learning Tasks 5 periods

Unit 2: Rosenblatt's Perceptrons:

Introduction, Perceptron, Perceptron Convergence Theorem, The Batch Perceptron Algorithm 3 periods

Unit 3: Multi-Layer Perceptrons:
Preliminaries, Batch Versus On-line Learning, Back-Propagation Algorithm, Summary of BP Algorithm, Heuristics for making BP Algorithm Perform better, Virtues and Limitations of BP Learning, Supervised Learning viewed as an Optimization Problem
4 periods

Unit 4: Radial-Basis Function Networks:
Introduction, Cover's Theorem, Interpolation Problem, Radial Basis Function Networks, K-Means Clustering, Recursive Least-Squares Estimation of the weight vector, Hybrid learning procedure for RBF Networks, Interpretations of Gaussian Hidden Units, Kernel regression and its relation to RBF Networks. 6 periods

Unit 5: Support Vector Machines:
Introduction, Optimal Hyper-plane for Linearly Separable Patterns and Non-separable Patterns, SVM viewed as a Kernel Machine, Design of SVMs, XOR problem
8 periods

Unit 6: Regularization Networks:
Introduction, Hadamard's conditions for well-posedness, Tikhonov's Regularization Theory, Regularization Networks, Generalized Radial-Basis-Function networks
8 periods

Unit 7: Self-Organizing Maps:
Introduction, Two Basic Feature mapping Models, Self-Organizing Maps, Summary of Self-organizing Algorithm, Properties of Feature Map, Contextual Maps Hierarchical Vector Quantization, Kernel Self-Organizing Map. Relationship between Kernel SOM and Kullback-Leibler Divergence 8 periods

Total 42 periods

TEXT BOOK:
Neural Networks and Learning Machines: by Simon Haykin, Eastern Economy Edition, Third Edition, 2009.
[Chapters: Introduction (1-6, 8, 9), Chapter 1(1.1-1.4, 1.6, 1.8), Chapter 4(4.1-4.4, 4.6, 4.15, 4.16), Chapter 5(5.1-5.11), Chapter 6(6.1-6.6), Chapter 7(7.1-7.5), Chapter 9(9.1-9.4, 9.6-9.8, 9.10)

ISKE 4(P) Practicals: NEURAL NETWORKS (1 Credit)

Algorithms/Exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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ISKE 5 DATA MINING AND DATA WAREHOUSING

(3 Credits) (42 Periods)

INTRODUCTION

Relation to statistics, databases, machine learning - Taxonomy of data mining tasks - Steps in data mining process - Overview of data mining techniques.

VISUALIZATION AND STATISTICAL PERSPECTIVES

Visualization – Dimension reduction techniques - Data summarization methods - Statistical Perspective - Probabilistic - Deterministic models - Clustering - Regression

analysis - Time series analysis - Bayesian learning.

PREDICTIVE MODELING

Predictive Modeling - Classification - Decision trees - Patterns - Association rules - Algorithms.

DATA WAREHOUSING

Design - Dimensional Modeling - Meta data - Performance issues and indexing - VLDB issues – Development life cycle - Merits.

APPLICATIONS

Tools - Applications - Case Studies.

TEXT BOOKS

1. Advances in Knowledge Discovery and Data Mining, by Usama M. Fayyad, Geogory Piatetsky Shapiro, Padhrai Smyth and Ramasamy Uthurusamy ,The M.I.T Press, 1996.
2. Data Mining Concepts and Techniques, by Jiawei Han, Micheline Kamber, Morgan Kauffmann Publishers, 2000.
3. The Data Warehouse Life Cycle Toolkit, by Ralph Kimball, John Wiley & Sons Inc, 1998.
4. Data Warehousing in Action, by Sean Kelly, John Wiley & Sons Inc., 1997.
5. Data mining techniques, A.K.Pujari, University press, India, 2001

ISKE 5(P) Practicals: DATA MINING AND DATA WAREHOUSING

(1 Credit)

Algorithms/Exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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ISKE 6 PATTERN RECOGNITION **(3 Credits) (42 Periods)**

Unit 1: Introduction: (2 periods)
Introduction, Features, Feature Vectors, Classifiers, Supervised, Unsupervised and Semi-Supervised Learning.

Unit 2: Classifiers based on Bayes Theory: (6 periods)
Introduction, Bayes Decision Theory, Discriminant Functions, Bayes Classification for Normal Distributions, Estimation of Unknown Probability Distributions**:** *ML Parameter Estimation, MAP Estimation, Bayesian Inference, Maximum Entropy Estimation, Mixture Models, Non-Parametric Estimation*, the Naïve-Bayes Classifier, the Nearest Neighbor Rule, Bayesian Networks.

Unit 3: Linear Classifiers: (8 periods)
Introduction, Linear Discriminant Functions and Decisions, Hyper-planes, The Perceptron algorithm, Least Square Methods, Mean Square Estimation Revisited,

Logistic Discrimination, Support Vector Machines for Separable Classes, SVM for Non-Separable Classes, SVM for Multiclass Case, ϑ-SVM

Unit 4: Nonlinear Classifiers: (8 periods)
XOR Problem, Two Layer Perceptron, Three-Layer Perceptrons, Algorithms based on Exact Classification of Training Set, The Back-Propagation Algorithm, Variation of BP Theme, Choice of Cost Function, Choice of Network Size, Generalized Linear Classifiers, Capacity of d-dimensional space in linear Dichotomies, Polynomial Classifiers, Radial Basis Function Networks, Universal Approximators, Probabilistic Neural Networks, SVM-Nonlinear Case, Beyond SVM Paradigm, Decision Trees, Combining Classifiers, Boosting, Class Imbalance Problem

Unit 5: Clustering: (18 periods)
Introduction, Proximity Measures, Number of Possible Clusterings, Categories of Clustering Algorithms, Sequential Clustering Algorithms, Agglomerative Algorithms, Divisive Algorithms, Hierarchical Algorithms for Large Datasets., Choice of the Best Number of Clusters, Hard Clustering Algorithms, Vector Quantization. Algorithms based on Graph Theory, Competitive Learning algorithms

Total (42 periods)

TEXT BOOK

1. Pattern Recognition by Sergios Theodoridis and Knostantinos Koutroumbas, Fourth Edition, Elsevier Publications, 2009.
   Chapters: 1, 2, 3, 4, 11, 12.1-12.3, 13, 14.5, 15.1-15.3

ISKE 6(P) Practicals: PATTERN RECOGNITION (1 Credit)

Algorithms/Exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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ISKE 7 MACHINE LEARNING

(3 Credits) (42 Periods)

Prerequisite: Introductory Probability and Statistics

Unit 1: Introduction - Examples of Machine Learning Applications, Classification, Regression, Unsupervised Learning, Reinforcement Learning, Supervised Learning, Vapnik-Chervonenkis (VC) Dimension, Probably Approximately Correct (PAC) Learning, Learning Multiple Classes, Regression, Model Selection and Generalization (4 Periods)

Unit 2: Bayesian Decision Theory – Classification, Losses and Risks, Discriminant Functions, Utility Theory, Association Rules (3 Periods)

Unit 3: Parametric Methods - Maximum Likelihood Estimation, Bernoulli Density, Multinomial Density, Gaussian Density, Bias and Variance, Bayes' Estimator, Parametric Classification, Regression, Model Selection Procedures (3 Periods)

Unit 4: Multivariate Methods - Multivariate Data, Parameter Estimation, Estimation of Missing Values, Multivariate Normal Distribution, Multivariate Classification, Multivariate Regression (5 Periods)

Unit 5: Clustering - Mixture Densities, k-Means Clustering, Expectation-Maximization, Mixtures of Latent Variable Models, Supervised Learning after Clustering, Hierarchical Clustering (5 Periods)

Unit 6: Decision Trees – Univariate Trees, Classification Tree, Regression Trees, Pruning, Rule Extraction from Trees, Learning Rules from Data, Multivariate Trees (3 Periods)

Unit 7: Linear Discrimination - Generalizing the Linear Model, Geometry of the Linear Discriminant, Two Classes Multiple Classes, Gradient Descent, Logistic Discrimination, Discrimination by Regression (4 Periods)

Unit 8: Bayesian Estimation - Estimating the Parameter of a Distribution, Bayesian Estimation of the Parameters of a Function, Use of Basis/Kernel Functions, Bayesian Classification, Gaussian Processes (4 Periods)

Unit 9: Graphical Models - Canonical Cases for Conditional Independence, Example Graphical Models, Naive Bayes' Classifier, Linear Regression, Belief Propagation, Chains, Trees, Poly trees, Junction Trees, Markov Random Fields, Learning the Structure of a Graphical Model, Influence Diagrams (5 Periods)

Unit 10: Design and Analysis of Machine Learning Experiments - Factors, Response, and Strategy of Experimentation, Response Surface Design, Randomization, Replication, and Blocking, Cross-Validation and Resampling Methods, K-Fold Cross-Validation, Bootstrapping, Measuring Classifier Performance, Interval Estimation, Hypothesis Testing, Assessing a Classification Algorithm's Performance, Binomial Test, Approximate Normal Test, t Test, Comparing Two Classification Algorithms, McNemar's Test K-Fold Cross-Validated Paired t Test, Comparing Multiple Algorithms by analysis of variance, Comparison over Multiple Datasets (6 Periods)

Total: 42 Periods

Text Book:
Introduction to Machine Learning, Ethem ALPAYDIN, The MIT Press, February 2010, ISBN-10: 0-262-01243-X, ISBN-13: 978-0-262-01243-0

Prescribed Chapters: 1, 2, 3, 4, 5, 7, 9, 10, 14, 16, 19

Reference books:

1. Machine Learning, by Tom Mitchell, McGraw Hill (Oct 1997).

2. Pattern Recognition and Machine Learning by Christopher M. Bishop, Pub Springer (Aug 2006)

3. Machine Learning: An Algorithmic Perspective by Stephen Marsland, Pub Chapman & Hall/crc (Apr 2009)

ISKE 7(P) Practicals: MACHINE LEARNING (1 Credit)

Algorithms/Exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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ISKE 8 Mining of Big Data Sets (2 Credits) (28 Periods)

UNIT-I (4 Periods)

Data Mining: Bonferroni's Principle - Hash Functions - Power Laws. MapReduce and the New Software Stack - Distributed File Systems - Physical Organization of Compute Nodes - Large-Scale File-System Organization – MapReduce - Extensions to MapReduce -Workflow Systems - Recursive Extensions to MapReduce - Pregel

The Communication Cost Model- Communication-Cost for Task Networks - Complexity Theory for MapReduce - Reducer Size and Replication Rate - A Graph Model for MapReduce Problems - Case Study: Matrix Multiplication

UNIT-II (6 Periods)

Finding Similar Items - Applications of Near-Neighbor Search - Jaccard Similarity of Sets- Collaborative Filtering as a Similar-Sets Problem - Shingling of Documents - k-Shingles - Choosing the Shingle - Hashing Shingles - Shingles Built from Words - Similarity-Preserving Summaries of Sets - Matrix Representation of Sets - Minhashing - Locality-Sensitive Hashing for Documents - LSH for Minhash Signatures - Analysis of the Banding Technique - Combining the Techniques - Distance Measures - The Theory of Locality-Sensitive Functions - Applications of Locality-Sensitive Hashing - Methods for High Degrees of Similarity - Finding Identical Items

UNIT-III (6 Periods)

Mining Data Streams - The Stream Data - Sampling Data in a Stream - A Motivating Example - Filtering Streams - The Bloom Filter - Counting Distinct Elements in a Stream - Estimating Moments - Counting Ones in a Window - Query Answering in the DGIM Algorithm – Decaying Windows

Link Analysis - PageRank - Early Search Engines and Term Spam - Efficient Computation of PageRank - PageRank Iteration Using MapReduce - Other Efficient Approaches to PageRank Iteration - Topic-Sensitive PageRank - Link Spam - Architecture of a Spam Farm - Analysis of a Spam Farm - Combating Link Spam – Trust Rank - Spam Mass

UNIT-IV (6 Periods)

Frequent Itemsets - Association Rules - Finding Association Rules with High Confidence - Use of Main Memory for Itemset Counting - Monotonicity of Itemsets - Handling Larger Datasets in Main Memory - The Multistage Algorithm - The Multihash - The SON Algorithm and MapReduce - Counting Frequent Items in a Stream

UNIT- V (6 Periods)

Clustering - Introduction to Clustering Techniques - Clustering Strategies - The Curse of Dimensionality - Hierarchical Clustering - Hierarchical Clustering in Non-Euclidean Spaces - K-means Algorithms - The Algorithm of Bradley, Fayyad, and Reina - The CURE Algorithm - Clustering for Streams and Parallelism

Text Book: Mining of Massive Datasets by Jure Leskovec, Anand Rajaraman, Jeffrey D. Ullman Cambridge University Press, 2nd Edition

The text book will be supplemented with research papers and assignments & Projects designed for the course by the instructor.

ISKE 8(P) Practicals: Mining of Big Data Sets (2 Credits)

Map Reduce, Finding Similar Items, Mining Data Streams, Link Analysis, Frequent Item-sets, Clustering, Recommendation System related Algorithms/Exercises from the syllabus will be implemented in Lab. This will be evaluated internally.

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STREAM II: ADVANCED COMPUTER NETWORKS

ACN 1 TELECOM NETWORKING

(3 Credits) (42 Periods)

Unit 1: (8 Periods)
Introductory Concepts of Telecommunications; Transmission and Switching; (Chapters 1 to 4 from key text)

Unit 2: (10 Periods)
Digital Networks; Signaling; Local and long-distance networks.
(Chapters 6 to 10 from key text)

Unit 3: (15 Periods)
Enterprise Networks: Wide Area Networks; CCIITT Signaling System No. 7.
(Chapters 11 to 14 from key text)

Unit 4: (9 Periods)
Cellular and PCS Radio Systems, Advanced Broadband Digital Transport Formats: SONET/SDH; Asynchronous Transfer Mode (ATM).
(Chapters 18 to 20 from key text)

Total 42 Periods

KEY TEXT BOOKS

1. Fundamentals of Telecommunications, 2nd Edition, Roger L. Freeman, Wiley-IEEE Press; 2 Edn., 2005, ISBN-10: 0471710458 ISBN-13: 978-0471710455.

REFERENCES

2. Telecommunication System Engineering, Roger L. Freeman, Wiley-Interscience; 4th edition, 2004, ISBN-10: 0471451339 ISBN-13: 978-0471451334.

3. Next Generation Telecommunications Networks, Services, and Management, Thomas Plevyak, Veli Sahin, Wiley-IEEE Press, 2010.

ACN 1(P) Practicals: TELECOM NETWORKING

(1 Credits)

Algorithms/Exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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ACN 2 NETWORK SECURITY (3 Credits) (42 Periods)

Unit 1: (3 Periods)
Introduction-Motivating examples, Basic concepts-confidentiality, integrity, availability, security policies, security mechanisms, assurance, Basic Cryptography-Historical background, Transposition /Substitution, Caesar Cipher, Introduction to Symmetric crypto primitives, Asymmetric crypto-primitives, and Hash functions.

Unit 2: (3 Periods)
Secret Key Cryptography-Data Encryption Standard (DES), Encrypting large messages (ECB, CBC, OFB, CFB, CTR), Multiple Encryption DES (EDE).

Unit 3: (3 Periods)
Message Digests, Strong and weak collision resistance, The Birthday Paradox MD5, SHA-1.

Unit 4: (6 Periods)
Public Key Cryptography-Applications, Theory: Euclidean algorithm, Euler Theorem, Fermat Theorem, Totent functions, multiplicative and additive inverse RSA, Selection of public and private keys.

Unit 5: (6 Periods)
Authentication-Security Handshake pitfalls, Online vs. offline password guessing, Reflection attacks, Per-session keys and authentication tickets, Key distribution centers and certificate authorities

Unit 6: (6 Periods)
Trusted Intermediaries-Public Key infrastructures, Certification authorities and key distribution centers, Kerberos

Unit 7: (5 Periods)
Real-time Communication Security Introduction to TCP/IP protocol stack, Implementation layers for security protocols and implications, IPsec: AH and ESP, IPsec: IKE, SSL/TLS

Unit 8: (5 Periods)
Electronic Mail Security, Distribution lists, Establishing keys, Privacy, source authentication, message integrity, non-repudiation, proof of submission, proof of delivery, message flow confidentiality, anonymity, Pretty Good Privacy (PGP)

Unit 9: (5 Periods)
Firewalls and Web Security, Packet filters, Application level gateways, Encrypted tunnels, Cookies, Web security problem.

Total 42 Periods

TEXT BOOKS

1. Network Security: Private Communication in a public world, by Charlie Kaufman, Radia Perlman and Mike Speciner, IInd Edn, ISBN 0-13-046019-PrenticeHall PTR, 2002.

REFERENCE BOOKS

1. Cryptography and Network Security: Principles and Practice, BY, William Stallings, Prentice Hall, 4th Edn, 2009.

2. Firewalls and Internet Security: Repelling the Wily Hacker, by William Cheswick, Steven M. Bellovin and Aviel D. Rubin, 2nd edition, Addison- Wesley Profession, 2000.

ACN 2(P) Practicals: NETWORK SECURITY **(1 Credit)**

Algorithms/Exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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ACN 3 WIRELESS AND MOBILE NETWORKS

(3 Credits) (42 Periods)

Unit 1: (6 periods)
Wireless Local Area Networks - IEEE 802.11 family and related protocols; (Chapters 1,2 from key text)

Unit 2: (12 periods)
Wireless Wide Area Networks - 3G/LTE/WiMAX;
(Chapters 3 from key text, Chapters 1 and 2 from Ref Book 4by Martin Sauter)

Unit 3: (15 periods)
Mobile Ad Hoc Networks - Medium access control and Routing protocols;
(Chapters 5 to 7 from key text)

Unit 4: (9 periods)
Quality of service in Mobile Ad Hoc Networks, Wireless Sensor Networks - IEEE 802.15.4. (Chapters 10.1-10.5, 12 from key text)

Total 42 Periods

TEXTBOOK:

1. C. Siva Ram Murthy and B. S. Manoj, Ad Hoc wireless networks: architectures and protocols, Prentice Hall PTR, 2004.

REFERENCE BOOKS:

2. Mobile Communications, Jochen H. Schiller, 2nd edition, Addison-Wesley, 2003, ISBN 0-321-12381-6.

3. Wireless Communications & Networks (2nd Edition), William Stallings, 2004.

4. Beyond 3G - Bringing Networks, Terminals and the Web Together: LTE, WiMAX, IMS, 4G Devices and the Mobile Web 2.0 by Martin Sauter, Wiley; 1 edition (February 17, 2009) ISBN-10: 0470751886.

5. Principles of Wireless Networks: A Unified Approach by Kaveh Pahlavan, 2nd Edition, 2012 (Expected), ISBN-13: 978-0470697085, Wiley.

6. 4G: LTE/LTE-Advanced for Mobile Broadband, Erik Dahlman, Stefan Parkvall, Johan Skold, ISBN-10: 012385489X, ISBN-13: 978-0123854896, Academic Press, 2011.

7. Mobile Ad Hoc Networks: Current Status and Future Trends, Jonathan Loo, Jaime Lloret Mauri, Jesus Hamilton Ortiz, CRC Press, 2011, Edited Book.

8. Wireless Ad Hoc Networking: Personal-Area, Local-Area, and the Sensory-Area Networks, Shih-Lin Wu, Yu-Chee Tseng, Auerbach Publications, 2007, Edited Book.

9. Mobile, Wireless, and Sensor Networks: Technology, Applications, and Future Directions, Rajeev Shorey, A. Ananda, Mun Choon Chan, Wei Tsang Ooi, Wiley-IEEE Press, 2006, ISBN-13: 978-0471718161, Edited Book

ACN 3(P) Practicals: WIRELESS AND MOBILE NETWORKS

(1 Credit)

Algorithms/Exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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ACN 4 ADVANCED COMPUTER NETWORKS

(3 Credits) (42 Periods)

Unit 1: Overview of pre-requisites (8 periods)
Introduction to Networking and Network Routing.
(Chapters 1 to 5, 7 from key text)

Unit 2: Router Architectures (10 periods)
Router Architectures IP Address Lookup Algorithms, IP Packet Filtering and Classification. (Chapters 14 to 16 from key text)

Unit 3: Quality of Service Routing (12 periods)
Quality of Service Routing, MPLS and GMPLS, Routing and Traffic Engineering with MPLS, VoIP Routing. (Chapters 17 to 20 from key text)

Unit 4: Packet queuing and scheduling (12 periods)
Switching Packets, Packet Queuing and Scheduling, Traffic Conditioning.
(Chapters 21 to 23)

Total: 42 periods

Key Textbook(s):

1. Network Routing: Algorithms, Protocols and Architectures, Medhi and Ramaswami, Morgan-Kaufmann, 2007, ISBN 13: 978-0-12-088588-6, ISBN 10:0-12-088588-3.

Reference books:

2. Network Algorithmic: An Interdisciplinary Approach to Designing Fast Networked Devices, George Varghese, Morgan-Kaufmann, 2005.

3. Routing, Flow, and Capacity Design in Communication and Computer Networks, Michal Pioỉ ro and Deepankar Medih, Morgan-Kaufmann, 2004.

4. Network Architecture, Analysis, and Design, James D. McCabe, Morgan-Kaufmann, 2007.

ACN 4(P) PRACTICALS: ADVANCED COMPUTER NETWORKS

(1 Credit)

Algorithms/Exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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STREAM III: HUMAN COMPUTER INTERACTION

HCI 1 DIGITAL IMAGE PROCESSING (3 Credits) (42 Periods)

Unit 1: Introduction to Digital Image Processing- Fundamental Steps in Digital Image Processing - Components of an Image Processing System (4 periods)

Unit 2: Digital Image Fundamentals – Elements of visual perception – Light and electromagnetic spectrum – image sensing and acquisition - Image Sampling and Quantization- Basic Relationships between Pixels – An introduction to mathematical tools used in digital image processing (4 Periods)

Unit 3:Intensity Transformations and Spatial Filtering – Some basic intensity transformation functions - Histogram Processing – Fundamentals of spatial filtering- Smoothing and sharpening spatial filters - combining spatial enhancement methods (8 Periods)

Unit 4:Filtering in the frequency domain – Sampling and the Fourier transform of sampled functions – basics of filtering in the frequency domain – image smoothing and sharpening using frequency domain filters – selective filtering (8 Periods)

Unit 5: Image Restoration and Reconstruction – Model for image degradation and restoration process – noise models – restoration in the presence of noise only spatial filtering – periodic noise reduction by frequency domain filtering – linear position invariant degradations – estimating the degradation function – inverse filtering (10 periods)

Unit 6: Image Segmentation- Point, line and edge detection – thresholding – region based segmentation (8 Periods)

Total: 42 Periods

TEXTBOOK

1. Digital Image Processing –by Rafael. C. Gonzalez & Richard E. Woods. 3rd Edition, Pearson Education, 2002. [Chapters 1, 2, 3.1 to 3.7, 4.1 to 4.10, 5.1 to 5.7, 10.1 to 10.4]
2. Relevant research papers selected for the course by the instructor

REFERENCE BOOKS

1. Image Processing – The Fundamentals by Maria Petrou and Costas Petrou, Second Edition, John Wiley and Sons, 2010

2. Fundamentals of Digital Image Processing, by Anil. K. Jain , Eastern Economy Edition, Prentice Hall of India 1997

HCI 1(P) Practicals: DIGITAL IMAGE PROCESSING (1 Credit)

Algorithms/Exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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HCI 2 MEDICAL IMAGE PROCESSSING (3 Credits) (42 Periods)

Historical perspective -Generic Principles – modality – contrast – SNR – resolution – toxicity - Measurements and Modeling : Review of Linear Systems and Models – Basic Model For Tomography - Sampling - Fourier and Hankel transforms - k-space.

XRay projection radiography – Reconstruction in X-Ray Tomography - Computerized Tomography - acquisition and reconstruction methods - relaxation and contrast mechanisms – applications - Nuclear medicine - radio nuclides, PET, SPECT imaging – Applications of Probability : PET.

Ultrasound Imaging - echo equation - beam forming - Medical Image Processing - physics of Magnetic resonance imaging - MRI reconstruction, functional MRI.
Fuzzy and Neuro Fuzzy Systems: Medical Image Analysis and Processing – Wavelets and Fuzzy gated SPECT Images of Ventricles.

Visualization of medical imaging data-segmentation applications.

TEXT BOOKS

1. Medical Imaging Systems by Albert Macovski, Prentice Hall, 1983.

2. The Basics of MRI, by Joseph Hornak Online at http://www.cis.rit.edu/htbooks/mri

3. Introduction to Mathematics of Medical Imaging, by Charles L.Epstein, Pearson Education, Prentice Hall, NJ, 2003.

4. Fuzzy and Neuro Fuzzy Systems in Medicine, by H.N.Teodorescu, L.C.Jain, Abraham Kandel, Computational Intelligence, CRC Press, 1999.

REFERENCE BOOKS

1. Biosignal and Biomedical Image Processing: MATLAB Based Applications, by John L Semmlow, CRC Press.

2. Biomedical Signal and Image Processing, by Kavyan Najarian, CRC Press.

3. Handbook of Medical Imaging: Processing and Analysis, by Isaac Bankmem, Academic Press , 2000.

4. Fundamentals of Digital Image Processing, by Anil. K. Jain, Eastern economy ed., Prentice Hall of India, 1997.

HCI 2(P) Practicals: MEDICAL IMAGE PROCESSSING

(1 Credit)

Algorithms/Exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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HCI 3 COMPUTER VISION

(3 Credits) (42 Periods)

Prerequisite: Basic course on Image processing.

Unit 1: Review of pre-requisites-I (2 periods)
Motivation, Image Representation and Image Analysis Tasks, Image Representations, a Few Concepts - Image Digitization, Sampling, Quantization, Digital Image Properties, Metric and Topological Properties of Digital Images, Histograms, Entropy, Image Quality, Noise in Images, Color Images ,Color Spaces, Cameras: An Overview

Unit 2: Review of pre-requisites-II
The Image, its Mathematical and Physical Background (3 periods)

Overview / Linearity / The Dirac Distribution and Convolution / Linear Integral Transforms / Images as Linear Systems / Introduction to Linear Integral Transforms / 1D Fourier Transform / 2D Fourier Transform / Sampling and the Shannon Constraint / Discrete Cosine Transform / Wavelet Transform / Eigen-Analysis / Singular Value Decomposition / Principle Component Analysis / Other Orthogonal Image Transforms / Images as Stochastic Processes / Images as Radiometric Measurements / Image Capture and Geometric Optics / Lens Aberrations and Radial Distortion / Image Capture from a Radiometric Point of View / Surface Reflectance /

Unit 3: Data Structures for Image Analysis (2 periods)
Levels of Image Data Representation / Traditional Image Data Structures / Matrices / Chains / Topological Data Structures / Relational Structures / Hierarchical Data Structures / Pyramids / Quadtrees / Other Pyramidal Structures

Unit 4: Segmentation (7 periods)
Watershed Segmentation / Region Growing Post-Processing / Matching / Matching Criteria / Control Strategies of Matching / Evaluation Issues in Segmentation / Supervised Evaluation / Unsupervised Evaluation/Mean Shift Segmentation / Active Contour Models - Snakes / Traditional Snakes and Balloons / Extensions / Gradient Vector Flow Snakes / Geometric Deformable Models - Level Sets and Geodesic Active Contours / Towards 3D Graph-Based Image Segmentation / Simultaneous Detection of Border Pairs / Sub-optimal Surface Detection / Graph Cut Segmentation / Optimal Single and Multiple Surface Segmentation

Unit 5: Shape Representation and Description (8 periods)
Region Identification / Contour-Based Shape Representation and Description / Chain Codes / Simple Geometric Border Representation / Fourier Transforms of Boundaries / Boundary Description using Segment Sequences / B-Spline Representation / Other Contour-Based Shape Description Approaches / Shape Invariants / Region-Based Shape Representation and Description / Simple Scalar Region Descriptors / Moments / Convex Hull / Graph Representation Based on Region Skeleton / Region Decomposition / Region Neighborhood Graphs / Shape Classes

Unit 6: Object Recognition (10 periods)
Knowledge Representation / Statistical Pattern Recognition / Classification Principles / Classifier Setting / Classifier Learning / Support Vector Machines / Cluster Analysis / Neural Nets / Feed-Forward Networks / Unsupervised Learning / Hopefield Neural Nets / Syntactic Pattern Recognition / Grammars and Languages / Syntactic Analysis, Syntactic Classifier / Syntactic Classifier Learning, Grammar Inference / Recognition as Graph Matching / Isomorphism of Graphs and Sub-Graphs / Similarity of Graphs / Optimization Techniques in Recognition.

Unit 7: Image Understanding (10 Periods)
Image Understanding Control Strategies / Parallel and Serial Processing Control / Hierarchical Control / Bottom-Up Control / Model-Based Control / Combined Control / Non-Hierarchical Control / RANSAC: Fitting via Random Sample Consensus / Point Distribution Models / Active Appearance Models / Pattern Recognition Methods in Image Understanding / Classification-Based Segmentation / Contextual Image Classification / Boosted Cascade of Classifiers for Rapid Object Detection / Scene Labeling and Constraint Propagation / Discrete Relaxation / Probabilistic Relaxation / Searching Interpretation Trees / Semantic Image Segmentation and Understanding / Semantic Region Growing

Total: 42 Periods

Key Text

1. Image Processing, Analysis, and Machine Vision by Milan Sonka, Vaclav Hlavac, Roger Boyle. 3rd Ed, March 19, 20
2. 07, Thomson Brooks/Cole Pub.

Coverage of KeyTexts:
Relevant sections from Chapters 1 to 10 from Key Text.

References: Latest editions of

1) **"**Computer Vision: A Modern Approach" by David A. Forsyth and Jean Ponce, Prentice Hall of India, 2006Emanuele Trucco, Alessandro Verri, "Introductory Techniques for 3-D Computer Vision", Prentice Hall, 1998.
2) Robert M. Haralick and Linda G. Shapiro, "Computer and Robot Vision", Addison-Wesley.
3) Mubarak Shah, "Fundamentals of Computer Vision", Free E-Book available at Authors site: http://vision.eecs.ucf.edu/faculty/shah.html

HCI 3(P) PRACTICALS: COMPUTER VISION **(1 Credit)**

Algorithms/Exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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HCI 4 ADVANCED TOPICS IN IMAGE PROCESSING

(3 Credits) (42 Periods)

Unit 1 : Mathematical Preliminaries (4 Periods)

Direct methods in the Calculus of Variations, The Space of Bounded Variation, Viscosity Solutions in PDEs, Curvature, Dominated Convergence Theorem.

Unit 2 : Image Restoration (8 Periods)

Image Degrading, The Energy Method, PDE-Based Methods, Enhancing PDEs, Neighborhood filters, Non-local Means algorithm.

Unit 3 : The Segmentation Problem (10 Periods)

The Mumford and Shah functional, Geodesic Active Contour and the Level set Method

Unit 4 : Image Classification (10 Periods)

Level-Set Approach for image classification, A variation model for image classification and restoration.

Unit 5 : Vector-Valued Images (10 Periods)

An extending notion of gradient, The Energy Method, PDE-Based Methods.

Total 42 Periods

Key Text: "Mathematical Problems in Image Processing" by Gilles Aubert, Pierre Kornprobst, 2nd Ed, Springer Chapters 2, 3, 4, 5.4 and 5.5 from Key Text.

HCI 4(P) Practicals: ADVANCED TOPICS IN IMAGE PROCESSING

(1 Credit)

Algorithms/Exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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HCI 5 VIDEO PROCESSING

(3 Credits) (42 Periods)

Unit 1: Introduction (5 Periods)

Video Formation and Representation, Analog and Digital Video

Unit 2: Video Sampling (8 Periods)

Basics of Lattice theory and Sampling over Lattices, Sampling video signals, Rate Conversion

Unit 3: Video Modeling (9 Periods)

Camera Model, Illumination Model, Object Model, Scene Model, 2-D Motion Models

Unit 4: 2D-Motion Estimation (10 Periods)

Optical Flow, Pixel Based Motion Estimation, Mesh Based Motion Estimation, Global Motion Estimation, Region-based Motion Estimation

Unit 5: 3D-Motion Estimation (10 Periods)

Feature Based Motion Estimation, Direct Motion Estimation, Iterative Motion Estimation

Total 42 Periods

Key Text: "Video Processing and Communications" by Yao Wang, Jorn Ostermann and Ya-Qin Zhang, 2002, Prentice Hall, Chapters 1- 7 from Key Text

Reference:

1. Advances in Image And Video Segmentation by Yu-Jin Zhang, IRM Press (May 2, 2006)
2. Multidimensional Signal, Image, and Video Processing and Coding by John W. Woods, Academic Press (March 13, 2006)

HCI 5(P) Practicals: VIDEO PROCESSING

(1 Credit)

Algorithms/Exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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STREAM IV: THEORETICAL COMPUTER SCIENCE

TCS 1 ADVANCED ALGORITHMS

(3 Credits) (42 Periods)

Unit 1: Preliminaries 7 (Periods)

Complexity classes-Lower bounding OPT – Well Characterized problems – MinMax relations - Chernoff bounds – The Minmax principle – Randomness and Non-Uniformity – Occupancy problems – Two point sampling – Stable marriage problem – Coupon Collector's problem

Unit 2: Approximate Algorithms 12 (Periods)

Matroid and greedy methods - Min cut algorithm – Las Vegas – Monte Carlo – Set Cover – Greedy algorithm – LP duality – Dual fitting – Rounding – Primal Dual Schema, Knapsack – pseudo-polynomial time algorithm – FPTAS

Unit 3: Randomized Algorithms 15 (Periods)

Probabilistic Recurrence - Randomized selection - Delaunay Triangulation- Minimum Spanning Trees - Counting Problems

Unit 4: Advanced data structures 8 (Periods)

Fundamental data structuring problem – Random Treaps - Skip lists – Hash tables with O(1) search time

Total 42 Periods

Key Text Books:

1. Randomized Algorithms; Rajeev Motwani and Prabhakar Raghavan, Cambridge University Press

[Chapters : 1, 2, 3, 4 (only 4.1), 8, 9(only 9.6), 10(only 10.3)]

2. Approximate Algorithm; Vijay V. Vazirani, Springer

[Chapters: 1, 2, 8, 12, 13, 14, 15, 28]

3. Introduction to Algorithms, 2nd edition, Thomas H. Cormen, Ronald L.Rivest and Clifford, MIT Press and McGraw-Hill, 2001.

[Chapter: 16]

TCS 1(P) Practicals: ADVANCED ALGORITHMS

(1 Credit)

Algorithms/Exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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TCS 2 CRYPTOGRAPHY (3 Credits) (42 Periods)

Unit 1 : Introduction
OSI Security Architecture – Security Attacks - Security services – Security Mechanisms – A Model for Network Security

Unit 2 : Classical Cryptography Techniques
Symmetric Cipher Model-Substitution Techniques – Transposition Techniques – Rotor Machines – Steganography

Unit 3 : Block Cipher and the Data Encryption Standards
Block Cipher Principles – The Data Encryption Standards – The Strength of DES – Differential and Linear Cryptanalysis – Block Cipher Design Principles

Unit 4 : Finite Fields
Groups, Rings and Fields - Modular Arithmetic – The Euclidean Algorithm – Finite Fields of the Form GF(p) – Polynomial Arithmetic – Finite Fields of the Form GF(2^n)

Unit 5: Advanced Encryption Standard
Evaluation Criteria for AES – The AEs Cipher

Unit 6 : More on Symmetric Ciphers
Multiple Encryption and Triple DES – Block Cipher Modes of Operation – Stream Ciphers and RC4

Unit 7 : Confidentiality Using Symmetric Encryption
Placement of encryption functions – Traffic Confidentiality – Key Distribution – random number Generation

Unit 8 : Introduction to Number Theory
Prime Number – Fermat's and Euler's Theorems – Testing for Primality – The Chinese Reminder Theorem – Discrete Logarithm Problem

Unit 9 : Public-Key Cryptographic and RSA
Principles of Public-Key Cryptosystems – The RSA algorithms - Key Management-Diffie-Hellman key Exchange - Elliptic Curve Architecture and Cryptography

Unit 10: Message Authentication and Hash Functions
Authentication requirements – Authentication functions – Message Authentication Codes – Hash functions – Security of Hash functions and MACs

Unit 11: Hash and MAC Algorithms
Secure Hash algorithm – Whirlpool – HMAC – CMAC

Unit 12: Digital Signatures and Authentication Protocols
Digital Signature – Authentication Protocols – Digital Signature Standards

TEXT BOOK

1. Cryptography and Network Security - Principles and Practices, by William Stallings Prentice Hall of India, 4th Edn, 2003.

[Chapters : 1 to 13 (except Recommended readings and Appendices from all chapters)]

REFERENCES:

1. Cryptography and Network Security**,** by Atul Kahate, Tata McGraw -Hill, 2003.
2. Applied Cryptography, by Bruce Schneier, John Wiley & Sons Inc, 2001

TCS 2(P) Practicals: CRYPTOGRAPHY **(1 Credit)**

Algorithms/Exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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STREAM V: COMPUTER SYSTEMS

CS 1 COMPILER DESIGN (3 Credits) (42 Periods)

Unit 1: Introduction - Why compilers? - Programs related to compiler - The Translation Process - Major Data structures in a compiler - Boot strapping and porting 2 periods

Unit 2: Scanning - The scanning process - Regular expressions - Finite automata - Regular expressions to DFA 5 periods

Unit 3: Context free grammars and Parsing - The Parsing process - CFG - Parse trees and Abstract Syntax Trees - Ambiguity 2 periods

Unit 4: Top-Down Parsing - Recursive descent parsing - LL(1) Parsing - First and Follow sets- Error recovery 6 periods

Unit 5: Bottom-Up Parsing - Overview - LR(0) parsing - SLR(1) parsing - LR(1) and LALR(1) parsing - Error recovery 6 periods

Unit 6: Semantic analysis - Attribute Grammar - Algorithms for attribute computation - Symbol table - Data types and type checking 10 periods

Unit 7: Runtime environments - Fully static environment- stack-based environment - Fully dynamic environment - Parameter passing mechanisms 5 periods

Unit 8: Code Generation - Intermediate code and data structures - Basic techniques - Code generation for data structure references - Code generation for control statements and logical expressions - Code generation for functions and procedure calls 6 periods

Total 42 periods

TEXT BOOK

Compiler Construction: principles and Practice by Kenneth C. Louden, Cengage Learning Publishers, Indian Edition, 1997
[Chapters: 1.1-1.6, 2.1-2.4, 3.1 – 3.4, 4.1 – 4.3, 4.5, 5.1, 5.1 – 5.4, 5.7, 6.1-6.4, 7.1 – 7.5, 8.1 – 8.5]

REFERENCE BOOKS:

1. Compilers: Principles, Techniques And Tools, V. Aho, Ravi Sethi And J.D. Ullman, Addison Wesley Publishing Company, 2nd edition, 1986.
2. Crafting A Compiler, Charles N. Fischer, Ronald K. Cytron,Richard J. LeBlanc, Jr.,Addison-Wesley, 2010.
3. Compiler Design in C, by Allen. I. Holub, Prentice Hall Of India, Eastern Economy Edition, Second Indian Reprint, 1993.

CS 1 (P) Practicals: COMPILER DESIGN (1 Credit)

Algorithms/Exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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CS 2 Embedded Computing (3 Credits) (42 Periods)

Unit 1: An Overview of Embedded Computing
Introduction to embedded systems; characteristics, challenges; design process.

Unit 2: Embedded Hardware Fundamentals.
Introduction to Microcontrollers, Microprocessors, DSPs; ARM & SHARC processors; I/O programming; execution modes; ARM & SHARC buses; CPU performance & power consumption; data compression example; I/O devices, component interfacing, design, development debugging and testing. Types of memory.

Unit 3: Embedded Software and Platforms.
Interrupts & ISRs, Embedded OSs, Development tools and programming languages. Real time systems: Memory management, Scheduling, Utilization. Real time OS's: Desktop OS Vs RTOS, BSPs, Task management, Race conditions, Priority inversion, ISRs & Scheduling, Inter-Task Communication, Timers and other RTOS services.

Unit 4: Programming Exercises: Overview of: ARM processor based development boards, WinCE, RT-Linux. Simple programming exercises using C and assembly programming. Hint: use the examples discussed in Book1 & Reference 1.

Text Books:

1. Computer as Components. Wayne Wolf, Morgan Kaufmann Pub. Indian Edition 2008.
   [Chap. 1.1-1.4, 2.3,2.4,3.2, 3.6-3.8, 4.1-4.8]

2. Embedded Real time Systems Programming, Sriram V. Iyer, Pankaj Gupta, Tata McGraw-Hill Pub. Co. Ltd, 2004. [Chaps 2, 3.2, Ch 4 to Ch 7]

Reference Books:

1. Embedded Systems, Raj Kamal, -Hill Pub. Co. Ltd, 11th print 2007. [Chaps 1-5, Appendix G]

2. An Embedded Software Primer, David E. Simon, Pearson Education, 2007. [Chps 5-10]

3. Programming for Embedded Systems, Dream Software Team, WILEY dreamtech India Ltd. 2005. [has lots of excellent case studies].

CS 2(P) Practicals: Embedded Computing (1 Credit)

Algorithms/Exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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CS 3 Advanced Programming in the UNIX Environment

(2 Credits) (28 Periods)

Unit 1 : Introduction (4 Periods)
UNIX System Overview, UNIX Architecture Files and Directories, Input and Output, Error Handling, Signals, Time Values, System Calls and Library Functions

Unit 2 : File I/O (6 Periods)
File Descriptors, open and open at Functions, creat Function, close Function, lseek Function, read Function, write Function, I/O Efficiency, File Sharing, dup and dup2 Functions sync, fsync, and fdatasync Functions, fcntl Function

Unit 3: Files and Directories (6 Periods)
stat, fstat, fstatat, and lstat Functions, File Types, File Access Per missions, Ownership of New Files and Directories, chmod, fchmod, and fchmodat Functions, chown, fchown, fchownat, and lchown Functions, link, linkat, unlink, unlinkat, and remove Functions, Creating and Reading Symbolic Links, Reading Directories, chdir, fchdir, and getcwd Functions, Device Special Files

Unit 4: Process Control (6 Periods)
fork Function, vfork Function, exit Functions, wait and waitpid Functions, waitid Function, wait3 and wait4 Functions, Race Conditions, exec Functions, Interpreter Files, system Function

Unit 5: Signals (6 Periods)
signal Function, Unreliable Signals, Interrupted System Calls, Reentrant Functions, SIGCLD Semantics, kill and raise Functions, alarm and pause Functions, sigprocmask Function, sigpending Function, sigaction Function, sigsetjmp and siglongjmp Functions, sigsuspend Function, sleep, nanosleep, and clock_nanosleep, sigqueue Function

Total (28 Periods)

Text Book: Advanced Programming in the UNIX Environment Third Edition by W. Richard Stevens Stephen A. Rago

CS 3(P) Practicals: Advanced Programming in the UNIX Environment

(2 Credits)

Relevant exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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CS 4 Programming for performance

(2 Credits) (28 Periods)

Unit 1: Introduction (4 Periods)

basic concepts, cost/performance analysis, Valgrind and gdb, Parallel debuggers.

Unit 2: Architecture/Microarchitecture (6 Periods)
Operational intensity, Core 2/Core i7, Compute Core Optimizations
In-core optimizations (ILP - pipelining, superscalar etc. branch predictions etc.)
Assembly level optimizations, Profiling tools: perfexpert, perf, How to write branchless code,

Unit 3: Benchmarking (6 Periods)
Benchmarking (Issues with accurately timing a code)
Nano level benchmarking: Discuss X-ray paper
Timer granularity. Compare c-time, get time of day and rdtsc etc

Unit 4: Vectorization (6 Periods)
SIMD vectorization, SIMD programming (scalar dot product),
How to write code so as to make compiler generate effective SIMD code

Unit 5: Memory Locality Optimizations (6 Periods)
Locality (Memory specific optimizations)
Prefetching, caching, cache blocking, register blocking etc.
Loop specific optimizations., membench (and memory mountain),
versions of MMM using perfexpert, perf and papi, Optimize Matrix Transpose

Total (28 Periods)

CS 4(P) Practicals: Programming for performance

(2 Credits)

Relevant exercises from different units in the syllabus will be implemented in Lab.
This will be evaluated internally.

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CS 5 Operating Systems (3 Credits) (42 periods)

Unit 0: Introduction: Operating system (OS) concepts – System Calls – OS structure
6 Periods

Unit 1: Process Management: Processes – Threads – Inter process communication – Scheduling – Processes in MINIX
10 Periods

Unit 2: I/O: I/O hardware – I/O software – Deadlocks – I/O in MINIX
10 Periods

Unit 3: Memory Management: Swapping – Virtual Memory – Paging – Segmentation – Process Manager in MINIX
10 Periods

Unit 4: File System: Files – Directories – File System Implementation - MINIX File System
6 Periods

Total 42 Periods

TEXT BOOK

1. The MINIX book - Operating Systems – Design and Implementation, Andrew S. Tanenbaum, Third Edition, Pearson Education, 2006.
[Chapters: 1, 2(2.1 – 2.5), 3(3.1-3.4), 4(4.1-4.7), 5(5.1 – 5.3**,** 5.6)]

REFERENCE BOOKS:

1. Modern Operating Systems, by Andrew S. Tanenbaum, III Edn, Pearson Education, 2001.

2. Operating System Concepts by Silberchatz A & Gallvin. VII Edn, Addison Wesley, 1997.

3. Operating Systems, by William Stallings, III Edn, Pearson Education, 2001.

CS 5(P) Practicals: Operating Systems (1 Credit)

Relevant exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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STREAM VI: MULTI-CORE AND PARALLEL COMPUTING

MPC 1 PARALLEL NUMERICAL LINEAR ALGEBRA

(3 Credits) (42 Periods)

Unit 1: Overview - Implementation–Performance analysis- Modeling – Measurements.

Unit 2: Building blocks in Linear Algebra–Direct solution of sparse linear system

Unit 3: Krylov subspaces - projection

Unit 4: Iterative methods for linear systems

Unit 5: Preconditioning and parallel preconditioning –Linear eigen value problem – Generalized eigenvalue problem.

Unit 6: Implementation of selected methods in a specific parallel programming platform.

TEXTBOOK

1. Numerical Linear Algebra for High Performance Computers, by Jack J Dongarra, Lain S Duff, Danny C Sorrenson, H. A .Vander Verst, ACM Portal, 1998 (ISBN: 0898714281)

REFERENCE BOOKS

1. Linear Algebra and Differential Equations using MATLAB , by Martin Gloubitsky, Michael Dellsitz, Brooks / Cole Publishing Co,ACM Portal ,1999.

MPC 1(P) Practicals: PARALLEL NUMERICAL LINEAR ALGEBRA

(1 Credit)

Relevant exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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MPC 2 MULTI CORE COMPUTING

(3 Credits) (42 Periods)

Introduction to Multi-Core Architecture:

Motivation for Concurrency in Software - Parallel Computing Platforms - Parallel Computing in Microprocessors - Differentiating Multi - Core Architectures from Hyper-Threading Technology - Multi-threading on Single-Core versus Multi -Core Platforms - Understanding Performance

Principles of Parallel Algorithm Design:

Preliminaries - Decomposition Techniques – Characteristics of Tasks and Interactions – Mapping Techniques for Load Balancing-Methods for containing Interaction overheads – Parallel Algorithm Models

Basic Communication Operations:

One – to - All Broadcast and All – to - All Reduction – All – to - All Broadcast and Reduction – All Reduce and Prefix Operations - Scatter and Gather – Circular Shift

Analytic modeling of Parallel Programs:

Source of Overhead in Parallel Program – Performance Metrics –for Parallel System – Scalability of Parallel System – Asymptatic Analysis of Parallel Program.

System Overview of threading:

Defining Threads – System view of Threads – Threading above OS – Threading inside OS – Threading inside Hardware – Application of Programming Models and Threading – Virtual Environment – Runtime Virtualization – System Virtualization.

Programming using the Message – Passing Paradigm:

Principles of Message Passing Program – Basic Building Blocks – Topologies and Embedding – Collectiv Communications and Computation Operations

Programming shared address space platforms:

Thread basics – Synchronization Primitives in PThreads-Controlling Thread and Synchronization Attributes – Thread Cancellation – OpenMP: Standard for Directive Based Parallel Programming

Algorithms:

Dense Matrix - Algorithms - Sorting Algorithms - Graph Algorithms - Search Algorithms for Discrete Optimization Problems

TEXT BOOKS

1. Multi-core Programming (increasing performance through software multi-threading) by Shameem Akhter and Jason Roberts, Intel Press(2006)
2. Introduction to Parallel Computing , by Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, Second Edition , Addison-Wesley , 2003

MPC 2(P) Practicals: MULTI CORE COMPUTING

(1 Credit)

Relevant exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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MPC 3 HIGH PERFORMANCE EMBEDDED COMPUTING

(3 Credits) (42 Periods)

Embedded Computing: The Landscape of High - Performance Embedded Computing Design Methodologies - Models of Computation, Reliability, Safety, and Security

CPUs: Comparing Processors - RISC Processors and Digital Signal Processors

Parallel Execution Mechanisms - Variable-Performance CPU Architectures

Programs: Code Generation and Back - End Compilation - Memory - Oriented Optimizations - Program Performance Analysis - Models of Computation and Programming

Processes and Operating Systems: Real -Time Process Scheduling-Languages - and Scheduling Operating System Design and Verification

Multiprocessor Architectures: Embedded Multiprocessors - Multiprocessor Design Techniques - Interconnection Networks - Physically Distributed Systems and Networks - Multiprocessor Design Methodologies and Algorithms

Multiprocessor Software: Embedded Multiprocessor Software - Real - Time Multiprocessor Operating Systems - Services and Middleware for Embedded Multiprocessors - Design Verification

Hardware / Software Co-Design: Design Platforms– Performance Analysis Hardware. Software Co-Synthesis Algorithms -Hardware/Software Co-Simulation

TEXT BOOKS

1. HIGH - PERFORMANCE EMBEDDED COMPUTING - Architectures, Applications, and Methodologies By, Wayne Wolf,1 st Ed, Elsevier Pub 2006.

MPC 3(P): Practicals: HIGH PERFORMANCE EMBEDDED COMPUTING

(1 Credit)

Relevant exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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MPC 4 HIGH PERFORMANCE COMPUTING WITH ACCELERATORS

(2 Credits) (28 Periods)

Unit 1: (6 periods)
Course Overview, CPU architecture review and GPU architecture overview.
Thread Synchronization, Kernel-Based Data Parallel Programming and Memory Model for Locality.

Unit 2: (8 periods)
Measuring effective performance of an application, Define Occupancy.
GPU specific performance optimization techniques: Memory Coalescing, efficient Shared memory usage, Branch Divergence.
Memory Hierarchy Optimization: Locality and Data Placement
Memory Hierarchy Optimizations: Reuse and Tiling

Unit 3: (6 periods)
Parallel Algorithm Patterns – Reduction/Scan, stencil computation and Sparse computation,

GPU computing tools and libraries, Application specific optimization techniques.
MPI in a Heterogeneous Computing Cluster: domain partitioning, data distribution, data exchange, and using heterogeneous computing nodes.

Unit 4: (8 periods)
Some relevant research papers that are focused on generic GPU optimization techniques are covered.

Total: 28 Periods

Note: Depending on the circumstances, OpenCL could be used in place of CUDA (OpenCL is another language similar to CUDA which is gaining importance recently).

TEXT BOOKS

1. Programming Massively Parallel processors, A hands on Approach, by David B Kirk and Wen-mei W.Hwu, Elsevier Morgan Kauffman, 2012.

REFERENCES:

1. CUDA by Example: An Introduction to General-Purpose GPU Programming, by Jason Sanders and Edward Kandrot, Addison Wesley Professional, 1st edition, 2010.
2. GPU Computing Gems by Wen-mei W. Hwu, Emerald Edition, Morgan Kauffman Publishers, 2011.
3. Heterogeneous Computing with OpenCL by Benedict R. Gaster, et al., Morgan Kaufmann, 2012.

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MPC 4(P) Practicals: HIGH PERFORMANCE COMPUTING WITH ACCELERATORS (2 Credits)

Unit 1:

GPU programming Model: introduction to CUDA, CUDA Execution Model.
Lab 0: Work through simple CUDA example, Synchronization, CUDA debugging and profiling tools.
Lab 1: Debug and profile a simple kernel before optimizing it.

Unit 2:

Lab 2: programming assignment of simple and tiled matrix multiplication in.
Test 1: Quiz based on descriptive questions.

Unit 3:
Lab 3: programming assignment of optimizing reduction tree. (memory specific optimizations)
Lab 4 (optionaT) : Optimal binding of CPU cores and GPUs to a process.
Lab 5 (optionaT) : Optimal mapping of CPU cores to GPUs in MPI-CUDA based applications.

Unit 4:
Course Project: This is a project intensive course, where in the student groups will apply the performance optimization techniques learned here to a chosen application.

Note: Depending on the circumstances, OpenCL could be used in place of CUDA.
(OpenCL is another language similar to CUDA which is gaining importance recently).

TEXT BOOK

1. Programming Massively Parallel processors, A hands on Approach, by David B Kirk and Wen-mei W.Hwu, Elsevier Morgan Kauffman, 2012.
2. Annual nVIDIA GTC Conference Presentations on Performance Optimizations and toolset.

REFERENCES:

1. CUDA by Example: An Introduction to General-Purpose GPU Programming, by Jason Sanders and Edward Kandrot, Addison Wesley Professional, 1st edition, 2010.
2. GPU Computing Gems by Wen-mei W. Hwu, Emerald Edition, Morgan Kauffman Publishers, 2011.
3. Heterogeneous Computing with OpenCL by Benedict R. Gaster, et al., Morgan Kaufmann, 2012.

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MPC 5 CLOUD COMPUTING (2 Credits) (28 Periods)

UNIT- 1 (8 Periods)

Distributed System Models and Enabling Technologies:: Scalable Computing over the internet - Technologies for Network-Based Systems -- System Models for Distributed and Cloud Computing -- Software Environments for Distributed Systems and Clouds -- Performance, Security, and Energy Efficiency.

Computer Clusters for Scalable Parallel Computing:: Clustering for Massive Parallelism -- Computer Clusters and MPP Architectures --Design Principles of Computer Clusters -- Cluster Job and Resource Management –

Case Studies of Top Supercomputer Systems --Tianhe-1A: The World Fastest Supercomputer in 2010 --XT5 Jaguar: The Top Supercomputer in 2009 -- IBM Roadrunner: The Top Supercomputer in 2008. (Cases may be changed with the availability of information from time to time regarding TOP supercomputers)

UNIT-2 (15 Periods)

Virtual Machines and Virtualization of Clusters and Data Centers:: Implementation Levels of Virtualization--Virtualization Structures/Tools and Mechanisms -- Virtualization of CPU, Memory, and I/O Devices -- Virtual Clusters and Resource Management -- Virtualization for Data-Center Automation.

Cloud Platform Architecture over Virtualized Data Centers -- Cloud Computing and Service Models -- Data-Center Design and Interconnection Networks -- Architectural Design of Compute and Storage Clouds -- Public Cloud Platforms: GAE, AWS, and Azure -- Inter-cloud Resource Management -- Cloud Security and Trust Management –

Service-Oriented Architectures for Distributed Computing -- Services and Service-Oriented Architecture -- Message-Oriented Middleware -- Portals and Science Gateways -- Discovery, Registries, Metadata, and Databases -- Workflow in Service-Oriented Architectures

Cloud Programming and Software Environments -- Features of Cloud and Grid Platforms -- Parallel and Distributed Programming Paradigms -- Programming Support of Google App Engine -- Programming on Amazon AWS and Microsoft Azure -- Emerging Cloud Software Environments

UNIT-3 (5 Periods)

Ubiquitous Clouds and the Internet of Things: Cloud Trends in Supporting Ubiquitous Computing -- Performance of Distributed Systems and the Cloud -- Enabling Technologies for the Internet of Things -- Innovative Applications of the Internet of Things --Online Social and Professional Networking

Total 28 periods

Text Book:
Distributed and Cloud Computing: From Parallel Processing to the Internet of Things
Kai Hwang, Geoffrey C. Fox, Jack J. Dongarra

MPC 5(P) Practicals: CLOUD COMPUTING (2 Credits)

Virtual Machines and Virtualization of Clusters and Data Centers:

Cloud Platform Architecture over Virtualized Data Centers -- Public Cloud Platforms: GAE, AWS, and Azure -- Inter-cloud Resource Management -- Cloud Security and Trust Management.

Service-Oriented Architectures for Distributed Computing -- Services and Service-Oriented Architecture -- Message-Oriented Middleware -- Portals and Science Gateways -- Discovery, Registries, Metadata, and Databases -- Workflow in Service-Oriented Architectures

Cloud Programming and Software Environments -- Programming Support of Google App Engine -- Programming on Amazon AWS and Microsoft Azure

Text Book:

Distributed and Cloud Computing: From Parallel Processing to the Internet of Things
Kai Hwang, Geoffrey C. Fox, Jack J. Dongarra.

The text book will be supplemented with research papers and assignments & Projects designed for the course by the instructor.

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MPC 6 Multi Processor Programming

(2 Credits) (28 Periods)

UNIT-I: Mutual Exclusion: Critical Section - 2Thread solution- Filter Lock - Lamport Bakery Algorithm - Bounded Time stamp - Concurrent objects – Shared Memory - Primitive Synchronization operators (4 Periods)

UNIT-II: Universality Consensus: Lock Free Universal Construction- Wait Free Universal Construction - Spin Locks and Contention: Queue Locks – Composite Locks- Hierarchical Locks - Monitor Locks and conditions -Readers-writers Locks (6 Periods)

UNIT-III: Linked Lists and role of Locking - Fine & Coarse grained synchronization, Optimistic Synchronization, Lazy Synchronization, Non-Blocking Synchronization. (6 Periods)

UNIT-IV: *Concurrent Queues – Concurrent stacks - Concurrent Hashing* - Skip Lists and Balanced Search (4 Periods)

UNIT-V: *Barriers* (4 Periods)

UNIT-VI: Transactional Memory (4 Periods)

Total (28 Periods)

Key Text: The Art of Multiprocessor Programming

Authors: Maurice Herlihy, Nir Shavit

Elsevier 2008.
Morgan Kaufmann Publishers is an imprint of Elsevier.
30 Corporate Drive, Suite 400, Burlington, MA 01803, USA
ISBN: 978-0-12-370591-4

MPC 6(P) Practicals: Multi Processor Programming

(2 Credits)

Relevant exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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STREAM VII: SOFTWARE ENGINEERING

SE 1 OBJECT ORIENTED SYSTEM DESIGN

(3 Credits) (42 Periods)

INTRODUCTION

Overview of Object Oriented Systems Development - Object Basics: The object Model - Classes and Objects - Complexity - Notation - Process - Object types - Object state – Object - Oriented Systems Development Life Cycle.

OBJECT ORIENTED METHODOLOGIES

Rumbaugh methodology - Booch methodology – Jacobson methodology – Patterns – Frameworks – Unified approach – Unified Modeling Language - Use case – Class diagram – Interactive diagram – Package diagram – Colloboration diagram – State diagram– Activity Diagram.

OBJECT ORIENTED ANALYSIS:

Identifying use cases – Object analysis – Classification – Identifying object relationships – Attributes and methods.

OBJECT ORIENTED DESIGN

Design axioms – Designing classes – Access layer– Object storage – Object interoperability.

SOFTWARE QUALITY AND USABILITY

Designing interface objects–Software quality assurance– System usability–Metrics.

TEXT BOOKS

1. Object Oriented Systems Development, Ali Bahrami, Irwin McGraw – Hill,1999.
2. UML Distilled, by Martin Fowler, IInd Edn, PHI / Pearson Education, 2002.

REFERENCE BOOKS

1. Object Oriented Analysis and Design with Applications, by Grady Booch, IInd Edn, Benjamine Cummings, USA, 1994.
2. Object Oriented Modeling and Design, by James R.Rumbaugh, Michael R. Blaha et al Pearson Education Asia, 1991.
3. Object Oriented Software Construction, by Betrand Meyor, IInd Edn, Prentice Hall PTR, New Jersey, 1997
4. Introduction to Object Oriented Analysis and Design, by Stephen R Schach, Tata McGraw-Hill, 2003.
5. UML 2 Bible, Tom Pender, Wiley Publishing, Inc, 2005

SE 1(P) Practicals: OBJECT ORIENTED SYSTEM DESIGN

(1 Credit)

Relevant exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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SE 2 WEB TECHNOLOGY (3Credits) (45 Periods)

Unit-1 Introduction (2 Periods)

The importance of web technology, Evolution of the Web, Basic concepts -TCP/IP, Ipv4 Vs Ipv6, Important Web components, App/Web servers, Internet who's who

Unit-2 Client Side components: (14 Periods)

Client Side Programming, Markup languages – HTML, Validators, HTML5 elements;

Cascading Style Sheets (CSS), CSS Box Model, Manipulating behaviour – Java Script Language, Functions, Objects, Closures, Browsers and DOM, Event handling, Client side Ajax, Cookies (Client), Javascript security, Introduction to unobtrusive frameworks like jQuery. Lab Hands-on

Unit-3 Server Side Programming : (10 Periods)

Client side Vs Server side, Why Server?, Java Servlet Architecture, Servlet Lifecycle, Web Application architecture, Session management, Server Cookies, Event handling on the server side, **JSP,** JSP Lifecycle, Expression language concepts, , Database connections / JDBC, Server side Ajax, Lab hands-on with Servlets / JSP

Unit-4 Server Side Business Layer (3 Periods)

Enterprise Java Beans (EJB-3), EJB versions, Session Beans, Entity Beans, Message driven beans, Java persistence API (JPA) concepts. Hands-on Lab

Unit-5 – Server Side Foundations of Interoperability & Standardization (16 Periods)

Application to application messages, XML, Fundamental building blocks of XML, XML Parsing, DTD/Schema, XSL concepts, introduction to JSON

Web Services Introduction, Evolution of Web Services Technologies, Architecture – Basic Technology: SOAP (Simple Object Access ProtocoT) , WSDL, REST, Path to Service Oriented Architecture. Hands-on Lab

Total 45 Periods

TEXT BOOKS

1. Web Technologies – Theory and Practice: by M Srinivasan, Pearson, 2012. All Chapters

REFERENCE BOOKS

1. An Introduction to XML and Web Technologies, by Anders Miller, Michael Schwartzbach, Addison Wesley, 2006.

2. Web Services:Principles and Technology, by Michael P Papzoglou, Pearson - Prentice hall , 2007.

3. Web Services: Concepts, Architecture and Applications, by Gustavo Alonso, Fabio Casati , Harumi Kuno ,Vijay Machiraju , Springer – Verlag , 2004.

SE 2(P) Practicals: WEB TECHNOLOGY (1Credit)

Relevant exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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STREAM VIII: MATHEMATICAL METHODS IN COMPUTER SCIENCE

MMCS 1 Mathematical Methods in Image Processing

(3 Credits) (42 Periods)

Unit 1: Introduction: (6 Periods)

What is a Digital Image? Partial Differential Equations and Image Processing

Unit 2: Mathematical Preliminaries: (18 Periods)

Direct methods in the Calculus of Variations
Space of Bounded Variation functions
Viscosity solutions in PDEs
Curvature
Other classical results

Units 3: **Image restoration:** (18 Periods)

Image Degradation
The Energy Method
Regularization problem
PDE-Based methods: Nonlinear Diffusion,
Smoothing-Enhancing PDEs
Scale space theory

Total of Periods: **(42 Periods)**

Text Book: Mathematical Problems in Image Processing, Gilles Aubert, Pierre Kornprobst, Springer; 1 edition (November 9, 2001)
[Chapters: 1, 2, 3.]

MMCS 1(P) Practicals: Mathematical Methods in Image Processing

(1 Credit)

Relevant exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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MMCS 2 Numerical methods in Image Processing

(3 Credits) (42 Periods)

Unit 1: Short introduction to calculus of variations, Short introduction to differential geometry (8 Periods)
Unit 2: Curve evolution theory and invariant signatures (8 Periods)
Unit 3: The Osher-Sethian level-set method (7 Periods)
Unit 4: The level-set method: numerical considerations (7 Periods)
Unit 5: Mathematical morphology, Distance maps and skeletons (7 Periods)
Unit 6: Problem Solving (5 Periods)
Total : (42 Periods)

Text Book: Numerical Geometry of Images, Ron Kimmel, M. Bronstein, A. Bronstein, Springer, 2003.[Chapters: 1 to 6]

MMCS 2(P) Practicals: Numerical methods in Image Processing

(1 Credit)

Relevant exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.

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MMCS 3 Mathematical Methods for Data Mining

(3Credits) (42 Periods)

Unit 1: Introduction: Motivating Challenges, The Origins of Data Mining, Data Mining Tasks, Data Attributes and Measurement, Types of Data Sets, Measurement and Data Collection Issues, Data Preprocessing: Aggregation, Sampling, Dimensionality Reduction (5 Periods)

Unit 2: Basic techniques for Classification Decision Trees, Model Over fitting, Evaluating the Performance of a Classifier, Holdout Method, Random Subsampling, Cross-Validation, Bootstrap, Methods for Comparing Classifiers. (8 Periods)

Unit 3: Advanced Techniques for Classification Rule-Based Classifier, Nearest-Neighbor classifiers, Bayesian Classifiers, Artificial Neural Network(ANN), Support Vector Machine (SVM), Ensemble Methods: Bias-Variance Decomposition, Bagging, Boosting, The Receiver Operating Characteristic Curve (7 Periods)

Unit 4: Association Analysis: Basic Concepts and Algorithms Frequent Item set Generation-The apriori Principle, Rule Generation in Apriori Algorithm, Alternative Methods for Generating Frequent Item sets: FP-Growth Algorithm, Evaluation of Association Patterns, Objective Measures of Interestingness, Simpson's Paradox. (7 Periods)

Unit 5: Cluster Analysis: Basic Concepts and Algorithms The Basic K-means Algorithm, Agglomerative Hierarchical Clustering, The DBSCAN Algorithm,Strengths and Weaknesses of DBSCAN, Cluster Evaluation techniques. (7 Periods)

Unit 6: Cluster Analysis: Additional Issues and Algorithms Prototype-Based Clustering: Fuzzy Clustering, Clustering Using Mixture Models, Self-Organizing Maps (SOM), Density-Based Clustering: Grid-Based Clustering, Subspace Clustering, Graph-Based Clustering: Minimum Spanning Tree (MST) Clustering, Hierarchical Clustering with Dynamic Modeling, Scalable Clustering Algorithms
(8 Periods)

Total: (42 Periods)

Text Books:

1. Introduction to Data Mining by Pang-Ning Tan, Michael Steinbach, Vipin Kumar. Pearson Publishers, 2007, [Chap. 1,2, 4, 5.1-5.6, 6.1-6.6, 8, 9.1-9.4]

Reference Books:

2. Data Mining: Concepts and Techniques by Jiawei Han, Micheline Kamber, Morgan Kaufmann pub, 2001

3. Data Mining: Practical Machine Learning Tools and Techniques by Ian H. Witten, Eibe Frank, Mark A. Hall, Morgan Kaufmann pub, 2011, 3rd Ed.

MMCS 3(P): Practicals: Mathematical Methods for Data Mining

(1 Credit)

Relevant exercises from different units in the syllabus will be implemented in Lab. This will be evaluated internally.