UNIVERSITY OF HYDERABAD

MCA, MTech and Int. MTech
COURSE CURRICULUM

School of Computer and Information Sciences

I. Master in Computer Applications (MCA)

I-Semester			II-Semester		
Code	**Course Title**	**Credits**	**Code**	**Course Title**	**Credits**
CA500	Mathematical Foundations of Computer Science	3	CA522	Data and File Structures	3
CA520	Computer Organization and Architecture	4	CA523	Operating Systems	4
CA505	Accounting and Financial Management	3	CA524	Object Oriented Programming	3
CA521	Programming Methodology	3	CA502	Computer Based Optimization Techniques	3
CA501	Computer Based Numerical and Statistical Techniques	3	CA525	Software Engineering	3
CA510	Software Lab -I (Intro to UNIX & C, H/W Installation)	2	CA511	Software Lab - II (ALP, C++& Java)	2
		18			**18**

III-Semester			IV-Semester		
Code	**Course Title**	**Credits**	**Code**	**Course Title**	**Credits**
CA526	Data Base Management Systems	3	CA546	Data Warehousing	3
CA545	Internet Technologies	3	CA529	Algorithms	4
CA527	Computer Networks	3	CA547	Computer Graphics and Visualization	4
CA528	Theory of Computation	4	CA548	Introduction to AI	3
	Elective – I (Interdisciplinary subject)	3/4		Elective – II	3/4
CA512	DBMS Lab	2	CA513	Communication Skills (Lab)	2
		18/19			**19/20**

V-Semester			VI-Semester		
Code	**Course Title**	**Credits**	**Code**	**Course Title**	**Credits**
CA506	Information Systems Management	3	CA519	Project	12
	Elective – III	3/4			
	Elective – IV	3/4			
	Elective – V	3/4			
	Elective – VI	3/4			
		15/19			**12**

Grand Total 100 (min)

CA500 MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE

Prerequisite: Nil

Aim: To provide basic mathematical foundation required for various computer science courses.

Course Content: Discrete Maths: Theory of Sets; Mathematical Induction; Relations and Functions; Recurrence Relation; Calculus: Functions; Limits and Continuity; Differentiation and Integration; Differential Equations. Logic: Logic operators such as AND, OR etc., Truth tables; Theory of inference and Deductions; Mathematical Introduction; Predicate calculus Predicates and Quantifiers.
Linear equation & Matrices: Row/Column operations; Gaussian Elimination; Decomposition; Inverse; Determinants; Properties of determinants; Cramer's Rule; Decomposition; Inverse. Vector spaces Linear Independence, Bases, subspace and dimensionality, Length, angle, direction cosines; orthogonalizations. Theory of Graphs: Graphs, subgraphs, isomorphism; Classes of graphs; paths and cycles; Trees; Connectivity; Planar Graphs; Hamiltonian and Eulerian Graphs.

Books:
1. Korthage, R.R.: Discrete Computational Structures, Academic Press, 1974.
2. Preparata, F.P.: Introduction to Discrete structures, Addison-Wesley, 1973.
3. Trembley, J.P. and Manohar R.P.: Introduction to Discrete Mathematical structures with Applications to Computer Science, McGraw Hill, 1975.
4. Lew: Computer Science: Mathematical Introduction, Prentice Hall International.

CA501 COMPUTER BASED NUMERICAL AND STATISTICAL TECHNIQUES

Prerequisite: Nil

Aim: To familiarise students with statistical and numerical techniques needed in problem-solving and industrial applications.

Course content: CA503 and Numerical Techniques for finding roots, Bisection method, Newton-Raphson method, numerical integration using Simpson's rules, Gaussian quadrature method, solving differential equations, interpolation and extrapolation.

Books:
1. Numerical Recipes in C
2. The books suggested for CA503

CA502 COMPUTER BASED OPTIMIZATION TECHNIQUES

Prerequisite: None

Aim: To introduce various optimization techniques and their computer implementation.

Course Content: Optimization Problems; The Simplex Algorithm; Duality; Computational Considerations for the Simplex Algorithm Max-Flow and Shortest Path; Transportation Problem, Assignment Problem; Integer Linear Programming; Cutting-Plane Algorithm for Integer Linear Programs; Branch-And-Bound and Dynamic Programming;

Book: Christos H. Papadimitriou and Kenneth Steiglitz: Combinatorial Optimization (Algorithms and Complexity).

CA503 COMPUTER ORIENTED STATISTICAL METHODS

Prerequisite: Nil

Aim: To familiarise students with basic statistical concepts and their application in different areas of computer science. Also to introduce students to efficient algorithms for computing different statistical measures.

Course Content: Basic statistical measures – mean, median, standard deviation, skew, kurtosis; rank, percentile, frequency distributions, standard distributions, regression analysis, least squares fit, polynomial and curve fitting, multiple regression; Introduction to time-series analysis, forecasting, moving averages, exponential smoothing, autoregressive models; Goodness of fit methods, ANOVA, F-test, applications to computer Science.

Books: Any book on statistics with additional books given below:

1. W.H. Press, et.al: Numerical recipes in C, Cambridge University Press.
2. Statsoft : Statsoft online Textbook, http://www.statsoft.com.
3. C. Chatfield: An Introduction to Time-Series Analysis, Oxford University Press.

Course Format: Class lectures and lab assignments. Typical break-up: Classroom lectures: 20 Classes, Lab sessions: 6 classes.

CA505 ACCOUNTING & FINANCIAL MANAGEMENT

Prerequisite: None

Aim: To introduce basic concepts of accounting and financial management to entry-level computer science students and work toward basics of computerized accounting & financial management systems.

Course Content: Accounting: Principles, Concepts and Conventions, Double entry system of Accounting, Introduction of basic books of Accounts of sole proprietary concern, Control Accounts for Debtors and Creditors, Closing of books of Accounts and preparation of Trial balance. Final Accounts: Trading, Profit and Loss accounts and Balance sheet of sole proprietary concern with normal closing entries. Introduction to Manufacturing account, finally accounts of partnership firms, limited Co.. Financial Management: Meaning and role. Ratio Analysis: Meaning, Advantages, Limitation, Types of ratios and their usefulness. Fund flow statement: Meaning of the terms - fund, flow and fund, working capital cycle, preparation and interpretation of the fund flow statement. Costing : Nature, importance and basic principles. Budget and budgetary control: Nature, scope and importance. Break-even analysis, it's uses and limitations, construction of break even chart, practical applications of marginal costing. Standard costing: Nature and scope, Computation and analysis of variances with reference to material cost, labour cost and overhead cost, interpretation of the variances. Introduction to computerized accounting system: Coding logic and codes required, master files, transaction files, Introduction to documents used for data collection, Processing of different files and output obtained.

Books:

1. Kellock, J.: Elements of Accounting, Heinemann, 1978.
2. Rockley, L.E.: Finance for the Non-Accountant, 2nd Edn. Basic Books, 1976.
1. Levy and Sarnet: Principles of Financial Management Prentice-Hall International.
3. Arnold. : Financial Accounting, Prentice-Hall International.
4. Horngren, and Sundem,: Introduction to Financial Accounting, Prentice-Hall International.
5. Murthy , U.S. : Management Finance, 2nd Edn., Vakils Fefers & Simons Ltd., 1978.
6. Van Home, James, C.: Financial Management & Policy, Prentice Inc.
7. Pandey, I.M.: Financial Management, Vikas Publications 1978.

CA506 INFORMATION SYSTEM MANAGEMENT

Prerequisite: Nil

Aim: To introduce the concepts and practices of Management Information Systems

Course Content: Introduction to data processing concepts, MIS, data collection, preparation, verification, editing and checking, storage, retrieval, records, files. Business files - Master and Transaction file, file generations, back-ups and file recovery procedures, Disk and Tape based files; Storage Organizations and accessing methods. COBOL programming - language constructs and structured programming features, examples for files accessing. File sorting, searching, merging, matching, Table handling, Report Writer, DBMS Concepts.

Books:

1. R J Verzello, John Reutter III: Data Processing: Systems and Concepts, Mc Graw Hill Book Co.- 1982.
2. Roy, M.K. and Dastidar Ghosh, D: COBOL Programming, Tata McGraw Hill Pub. Comp. Ltd. 1982.
3. Philippakis and Kazmier: Information system Through COBOL 2nd Ed. McGraw Hill Int. Ed.
4. Philippakis and Kazmier: Advanced COBOL Programming - McGraw Hill.
5. Popkin, G.S.: Advanced structured COBOL 2nd Edn. Kent Publ. Comp. 1987.
6. Pierson & Horn: Structured COBOL Programming, Scott Freshman and Co. 1986.
7. Rajaraman, V. & Sahasrabuddhe, H.V.: Computer Programming in COBOL, Prentice-Hall India.
8. Grover, P.S: Programming with Structured COBOL, Macmillan, 1989.
9. A Stern & Stern: Structured COBOL Programming - Addison Wesley.

CA520 COMPUTER ORGANIZATION AND ARCHITECTURE

Pre-requisite: Basic knowledge of Computer Programming in a high level language

Aims and Objectives: This is a first level course, suitable for both hardware and software oriented students. It not only describes computer structures solely from the programming viewpoint, but also for those who will eventually work with systems that involve a variety of equipment, interfacing, and communication facilities.

Course Content: Overview of Computer Hardware, History and technological milestones. Data representation: Codes, number systems, integer representation, sign magnitude, 1's complement, 2's complement. Boolean Algebra, Boolean expressions and their simplification. SOP and POS. Karnaugh Maps, Basic logic gates, logic diagrams. Combinational circuits: Half adder, Full adder, Subtractor, multiplexer, de-multiplexer, decoder, encoder. Sequential circuits: Latches, Flip-flops, RS, JK, D, T types. Counter, shift registers etc. Basic Computer organization, Instruction set, Register transfer language, CPU: Control unit construction, Instruction cycle. Memory organization: Memory hierarchy, Cache, Main memory, auxiliary memory. IO organization, interfacing, Polling, interrupt, Vectored and daisy interrupt structures. DMA, microinstructions, control memory. Computer Arithmetic, Floating point numbers underflow, overflow, precision consideration.

Recommended Books:

1. V. Carl Hamacher, Zvonko G. Vranesic, Safwat G. Zaky, Computer Organization, McGraw-Hill International Edition, 1996.
2. Computer System Architecture, Morris M. Mano, Computer System Architecture, Prentice Hall

CA521 PROGRAMMING METHODOLOGY

Prerequisite: Nil

Aim: To inculcate problem-solving skills and to introduce basics of programming through C language to entry-level computer science students.

Course Content: Problem Analysis, flow Charts, decision tables. Pseudo codes and Algorithms, High level language and Programmer's Model of Computer System. Algorithmic Programming Language: Representation of integers, real's, characters, constants and variables, arithmetic expressions and their evaluation using rules of hierarchy. Assignment statements, Logical constants variables and expression Control structures - sequencing alteration, iteration. Arrays, Manipulating vectors and matrices. Subroutines overhead cost, interpretation of the variances. Compiling, debugging and testing in integrated development environment.

Books:

1. Kerninghan, BW. and Richie, DM.: The C programming language, PHI, 2nd edition, 1999.
2. Michael Schneider; Introduction to problem solving and programming through pascal.
3. Drmey R.G.: How to solve it by Computer.
4. Gries D.: Science of programming.
5. Niklaus Wirth.: Data Structures + Algorithms = Programs.

CA522 DATA AND FILE STRUCTURES

Prerequisite: CA521, a basic course in programming, or approval from instructor.

Aim: This is a first level course that describes various structuring methods of data, their practical use and introduces the concepts of external data storage schemes.

Course Content:

Module I: Fundamental Notations: Primitive and Composite Data types, Time and Space Complexity of Algorithms, Sorting Algorithms. Data Structures: Stacks, Queues, Arrays, Linked Lists, Trees and Graphs.

Module II: Fundamental File Structure Concepts; Organizing Files for Performance; Keysorting; Indexing; Consequential Processing and the Sorting of Large Files; B-Trees and Other Tree-structured File Organizations; The B+ Tree Family and Indexed Sequential File Access; Hashing; Extendible Hashing.

Course format: Lectures, Tutorials and Programming assignments.

Books:

1. Wirth, Nicolaus: Algorithms + Data structures = Programs. Prentice-Hall International, 1975.
2. Horowitz, E., and Sahni.S: Fundamentals of Data structures. Computer Science Press, 1978.
3. Knuth, D.: The Art of Computer Programming, Vols. 1-2. Addison-Wesley, 1970-80.
4. Aho, A. V., Hopcroft, and Ullman, J.E.: Data Structures with Pascal, Prentice-Hall International, 1985.
5. Tanenbaum, A.M., and Augenstein, M.J.: Data Structures with Pascal, Prentice-Hall International, 1985.
6. Stubbas, D.: Data Structures with Abstract Data Types and Modula2, Brooks & Cole Pub. Co. 1987.
7. Trembley & Sorenson: An Introduction to Data Structures with Applications; Tata McGraw Hill.
8. Kruse, R. L., Leung, B. P., and Tondo, C. L.: Data Structures and Program Design in C; Prentice-Hall of India, 1999.
9. Weiss, M. A.: Data Structures and Algorithm Analysis in C++; Addison-Wesley, 1994.
10. Michael J. Folk and Bill Zoellick, "File Structures" (Second Edition).

CA523 OPERATING SYSTEMS

Prerequisite: Computer Organization and Programming Methodology.

Syllabus:

- History, Evolution and Philosophy Hardware evolution Economic Forces and constraints Structuring methods : Layered model, object - server model Application needs and significant case histories
- Tasking and Processes Tasks, processes Structures; ready list, process control block etc. Despatching, content switches Role of interrupts
- Process co-ordination and synchronization Concurrent execution Sharing access, race conditions Deadlock: Causes, conditions, prevention Models and mechanisms (eg. Busy waiting, spin locks, Dekker's algorithm, semaphores, mutex locks, region, monitors)
- Scheduling and Dispatch Pre-emptive and non-preemptive scheduling schedules and policies
- Physical and Virtual Memory Organization Physical memory and registers Overlays, swapping, partitions Pages and segments Placement and replacement policies Thrashing, working sets
- Device Management Free lists, layout Servers, interrupts Recovery from failures
- File Systems and Naming File layout (eg. Indexed, contiguous) Directories, contents and structure Naming, searching, access, backups Fundamental file concepts; basic file Organizations, basic file manipulations, blocking and buffering Sequential files Non sequential files (eg. hashed files, tree-structured files, B-trees, multiple key files)
- Security and Protection Overview of System security with examples Security methods and devices, protection access, authentication Memory protection Recovery Management
- Communications and Networking Protocol suites Streams and datagrams Internetworking and routing Servers, services
- Distributed and Real time systems Synchronization and timing Failures, risks and recovery Special concerns in real-time systems

Text Books:

1. Silberschatz and Galvin, "Operating System Concepts" Addison Wesley fifth edition 1997
2. Tanenbaum "Modern Operating Systems" Prentice Hall India. 1992
3. Stallings "Operating System" PH I Second edition. 1994
4. Crowley "Operating Systems A design Oriented Approach" Tata MacGraw Hill 1998.

References:

1. Beck et al. "Linux Kernel Internals", Addison Wesley Longman, Second Edition 1998
2. U. Vahalia, " Unix Internals", Prentice Hall International 1997.

CA524 OBJECT ORIENTED PROGRAMMING

Prerequisite: CA521 or special approval from instructor

Aim: To introduce students to objects and object oriented concepts

Syllabus: Abstract data types, abstraction, encapsulation, objects and object hierarchies, inheritance, polymorphism, virtual functions. Differences between other programming paradigms and oop. Examples and programming exercises.

Books: To be identified.

CA525 SOFTWARE ENGINEERING

Prerequisite: CA521 Programming Methodology; CA522 Data and File Structures

Aim: To introduce the principles, concepts and practices of software engineering

Course Content: Introduction to System Concepts, Software Engineering Concepts, SE Methodology, Life Cycle Models, Software Development Approaches, Need for Management and Role of Management in SE, Requirements Analysis, SADT, Alternative Analysis Techniques, Formal Approaches in SE, Design Techniques, Role of PL in Software Development, Coding Principles and Programming Techniques, Software Testing, Software Configuration Management, Software Maintenance and Current and Future trends in SE.

Books:
1. R. Pressman: Software Engineering - a practioner's approach, McGraw Hill - 1992.
2. Ghezi, etal: Fundamentals of SE, PHI New Delhi 1995.
3. P. Jalote: An Integrate approach to SE, Narosa Publishers, 1992.
4. Yourdon: Modern Structured Analysis, PHI New Delhi 1995.
5. Harwiz kwiz: Systems Analysis and Design, PHI New Delhi 1995.
6. Jag Sodhi: SE - Management Application and Tools, McGraw Hill, 1987.

CA526 DATA BASE MANAGEMENT SYSTEMS

Prerequisites: CA521 Programming Methodology, CA522 Data and File Structures, CA523 Operating Systems.

Aim: To teach database theory and applications.

Course Content:
Lecture:
Introduction: Aims and Objectives, Technology involved and current uses of the technology.
Data Models: Entity-Relationship model, Network model, Hierarchical model.
Database design: Normalization principles and their uses. Secondary data storage and retrieval techniques.
Query Processing: Studies on query processing strategies and cost estimation.
Transaction Processing: Defining Properties and studies on recovery and concurrency. Security and Integrity.
Distributed Databases: Introduction, Issues on design, concurrency, recovery, deadlock handling and co-ordinator selection.
Practical:
1. Practice on database designs and SQL programming.
2. One or Two mini-projects on design and development of database applications.

References:
1. H. F. Korth and A. Silberschatz: Database Systems & Concepts, McGrawHill Publications.
2. R. Elmasri, S. B. Navathe: Fundamentals of Database Systems, Benjamin / Cummings Publishing Company.
3. Stefano Ceri, G. Pellagatti: Distributed Databases Principles & Systems, McGrawHill.

Software Systems:
Oracle DBMS and MSACESS Database Management System.

CA527 COMPUTER NETWORKS

Pre-requisites: CA520 Computer Organisation and Architecture, CA522 Data Structures (CA523 Operating Systems – would be beneficial)

Aims and Objectives: This is a first course in computer networks introducing all the essential concepts and builds a basis for further courses such as Internet Technologies, Electronic Commerce and Multimedia. This course should be (ideally) run with a course on Network Programming where the programming and systems aspects of the network concepts are consolidated in a practical sense. (The network programming course could also follow this in a subsequent semester.)

Syllabus:
Communications Model: Communications model, data communications tasks; networking, layering and design issues, ISO-OSI model, protocols, services, standards, network goals and applications.

- Data Communication: Physical layer; transmission media, encoding, interfaces, switching and signaling methods, multiplexing and medium access control.
- Data Link Layer: Framing, error control, flow control, data link protocols, retransmission strategies and their performance.
- Network Layer: Routing and congestion control algorithms, inter-networking principles, Internet Protocol, bridges etc. devices.
- Transport Layer: Transport services, connection management, TCP, UDP, quality of service parameters, TCP/IP over ATM networks.
- Network Security: Data encryption strategies, authentication protocols, firewalls.
- Basic applications: telnet, rlogin, FTP. TFTP, NFS, DNS, SMTP, MIME, SNMP, HTTP etc.
- Network Infrastructure for advanced applications: E-commerce, multimedia, mobile and wireless computing.

Books and References:

1. Bertsekas, D and Gallager, B.: Data Networks, Prentice Hall of India 1992. (2nd Edition)
2. Black, U.D.: TCP/IP and Related Protocols, MacGraw Hill New York 1995.
3. Black, U.D.: Computer Networks, Protocols Standards and Interfaces, Prentice Hall International
4. Comer (includes Comer and Stevens, D.L. three Volumes): Internetworking with TCP/IP Principles protocols and architecture, Prentice Hall of India, 1995.
5. Goralski, W.J.: Introduction to ATM networking, McGraw Hill New York, 1995.
6. Keshav, S.: Computer Networks: an Engineering Approach, Addison-Wesley, Reading, 1997.
7. Stallings, W.: Network and Internetwork security, Prentice Hall International 1995.
8. Stallings, W. Data and Computer Communication 5th Edition, Prentice Hall of India, 1997.
9. Stevens, W.R: TCP/IP Illustrated (Three Volumes), Addison-Wesley, Reading, Mass. 1995
10. Tanenbaum, A.S.: Computer Networks Third Edition, Prentice Hall of India, 1997.

CA528 THEORY OF COMPUTATION

Prerequisite: Nil

Aim: First course in theory of computation leading up to the concepts of complexity and undecidability.

Course Content: Introduction, Graph Notation, Set theory, grammar and relations. Finite Automata: DFA, NFA, Regular Expressions and their Equivalencies, Moore and Melay machines. Regular Expressions: Properties, Pumping lemma, Minimizing the Automata. Context Free Grammars: Definitions, Derivation tree, Ambiguity, Chomsky and Greibach - Normal forms, Pumping Lemma for CFL. PDA: Definition and Equivalence of PDA and CFL. Introduction to Turing Machines, undecidability and complexity theory.

Book: Aho, Hopcraft & Ullman: Automata, Languages and Computation; Narosa.

CA529 ALGORITHMS

Prerequisite: CA522 Data and File Structures

Aim: This course builds on Data Structures and emphasizes design and analysis of algorithms.

Course Content: Efficiency of algorithms; Asymptotic Notation; Analysis of Algorithms; Solving recurrences; Application of data structures; Greedy Algorithms, Spanning trees, shortest paths, knapsack problem, scheduling problem; Divide-and-conquer, binary search, sorting; Dynamic programming principle of optimality; Graph Algorithms, BFS, DFS, Back tracking, Branch and Bound; Computation Complexity, reductions and introduction to NP-completeness; Examples and brief overview of heuristic, probablistic and parallel algorithms, String Matching methods.

Books:
1. Fundamentals of Algorithms, G.Brassard and P.Bratley, PH India 1997.
2. Fundamentals of Computer Algorithms, E.Horowitz and S.Sahani, Galgotia Publications.
3. Introduction to Algorithms, T.H.Cormen, CE Leigerson, R.Rivest, PH India 1998.

CA545 INTERNET TECHNOLOGIES

Pre-requisite: Computer Networks

Aims and Objectives: This is a first course on Internet and the World Wide Web. This exposes students to tools that could transform how we do the work in different domains of applications: Communication, Education, Information Access, Commerce, Healthcare etc.

Course Content: Review of computer networks, The Internet, Domains and addresses, options for connecting, S/W, modems etc., The internet toolkit: Electronic email, ftp, telnet, finger, etc. WWW, IRC, talk, MUDS, providing resources via internet. HTML, Javascript, CGI, Pearl and Introduction to JAVA.

Recommended Books:
1. Glee Harrah Cady, Pat McGregor: Mastering the Internet, BPB, Sybex 1996.
2. Alan Simpson: HTML Publishing Bible, IDG Books, Comdex Computer Publishing, A Division of Pusthak Mahal, 1996.
3. Bryan Pfaffenberger: Publish on the Web, AP Professional, 1996.
4. Clayton Walnum: Java by Example, Que 1996.
5. Marty Hall: The Core Web Programming, Prentice-Hall, 1998.
6. J. Niederst: Web Design in a Nutshell, O'Reilly Associates, 1999.

CA546 DATA WAREHOUSING

Prerequisite: CA522 Data and File Structures, CA526 Database Management Systems

Aim: The course emphasis will be on Algorithms and Database theory.

Course Content: General Introduction: Historical Perspective, characteristics of data warehousing. Data Warehousing: its architecture, logical design, multidimensional data model, OLAP, Data mart. Data mining vs Database, data mining as a component of data warehouse.

Text Books: The topics will be covered from a collection of research papers and textbooks. The students are expected to read research articles and undertake some programming assignments.

CA547 COMPUTER GRAPHICS AND VISUALIZATION

Prerequisite: CA521 Programming Methodology, CA522 Data and File Structures
Aim: This is first course introducing basics of computer graphics and various visualization techniques.

Course Content: Introduction: History, Advantages, Application, I/O Devices Graphic Packages, Languages. 2D Graphics: Drawing Elementary figures, Polygon Filling, Transformations, Windowing and clipping, Display file segmentation. Interactive Graphics: Interactive input techniques, Event handling, Input functions; 3D Graphics and Realism: Mathematical Preliminaries, Curves and Surfaces, Clipping, Hidden line and surface removal, rendering, real-time graphics; Introduction to Visualization, Tools for Visualization, Applications etc.

Books:

1. D. Hearn and M. P. Baker: Computer Graphics, IEEE, 1989.
2. Rogers: Mathematical elements for Computer Graphics, McGraw-Hill, 1985.
3. Newman and R. F. Sproull: Principles of Interactive Graphics, McGraw-Hill, 1979.
4. Harrington, Computer Graphics: A programming approach, McGraw-Hill, 1987.
5. M. Berger: Computer graphics with Pascal, Benjamin/Cummings, 1986.
6. Foley & A. Van Dam: Fundamentals of Interactive Computer Graphics, Addison Wesley, 1982.

CA548 INTRODUCTION TO AI

Aim: First course introducing the principles of AI.

Course Content: General introduction of AI, Intelligent systems, etc., Applications, Search techniques, Constraint satisfaction problems, Logic, modus ponens, Satisfiability, Resolution, Refutation, Unification. AI–planning, Uncertainty in AI, Case Studies of Applications.

Books:

1. N.J.Nilson: Principles of Artificial Intelligence, Narosa Publications.
2. D. W. Patterson: Introduction to AI & Expert System, PHI.
3. S. Russell and P. Norvig. AI: A Modern Approach, 2nd Edn., McGraw-Hill, 2003.

LAB COURSES (MCA)

CA510 Software Lab -I
Syllabus:
Intro to UNIX & C, H/W Installation

CA511 Software Lab - II
Syllabus:
ALP, C++ & Java

CA512 DBMS Lab
Syllabus:
DBMS Programming

CA513 Computer Networks Lab
Syllabus:
Network Programming

CA 519MCA PROJECT

II. Master in Technology (M.Tech)

Computer Science (CS), Artificial Intelligence (AI), Information Technology (IT)

I-Semester			II-Semester		
Code	**Course Title**	**Credits**	**Code**	**Course Title**	**Credits**
401	Advanced Operating Systems	4		Software Engineering	3
402	Algorithms	4		Optional core-III	3/4
	Optional core-I	3/4		Elective-II	3/4
	Optional core-II	3/4		Elective-III	3/4
	Elective -I	3/4		Elective-IV	3/4
403	*IT Lab –I*	2		*IT Lab-II**	2
404	*DS & Programming Lab*	2		*Software Engineering Lab*	2
				Communication Skills Lab	3
		21/24			**22/26**
III-Semester			**IV-Semester**		
Code	**Course Title**	**Credits**	**Code**	**Course Title**	**Credits**
	Project	6		Project	12

** Web Technologies Lab for M.Tech (CS&IT) and AI Programming Lab for M.Tech (AI)*

Course	Stream	Optional Core	
M.Tech Computer Science	Systems	System Security Virtualization	Computer Architecture Computer Networks
	Security	Cryptography Computer Networks	System Security Network Security
	HPC	Distributed Computing Parallel Computing	Advanced Architecture Virtualization Cloud Computing
M.Tech Artificial Intelligence		Problem Solving Methods Knowledge Representation & Reasoning	Human Computer Interaction Machine Learning
M.Tech Information Technology		Banking Technology & Payment Systems Data Engineering Computer Networks System Security	

CS/AI/IT 401 ADVANCED OPERATING SYSTEMS
Prerequisites: Operating Systems, C Programming

UNIT -I: PROCESSES AND SCHEDULING
Process States and System Call Interface; Life Cycle of a Process: Process Dynamics; Scheduler: working and implementation; Linux Process States and System Calls; Process Groups, Sessions, Foreground and Background Processes.

UNIT -II: INTERPROCESS COMMUNICATION AND SYNCHRONISATION

Signals, Pipes and Named Pipes (FIFOs); Threads and pthread library; Mutexes and Condition Variables; Semaphores; Producer-Consumer Problem and Solutions using mutexes, condition variables and semaphores.

UNIT -III: FILES AND FILE SYSTEMS
File and File Meta-data; File Naming Systems; File System Operations; File System Implementation;File System Structures; Booting an OS; File System Optimisation.

UNIT -IV: DEVICES AND DEVICE DRIVERS
Devices andTypes of Devices;Terminal, Disk, SCSI,Tape and CD devices; Unification of Files andDevices;DeviceDrivers: Concepts and Implementation Details.

UNIT -V: RESOURCE MANAGEMENT AND SECURITY
Resource Management Issues; Types of Resources; Integrated Resource Scheduling; Queuing Models of Scheduling; Protection of Resources – hardware, software, and attacks; Security Policies.

SUGGESTED ASSIGNMENTS:
1. Short programs with fork() and exec() family of system calls to create parent and child processs; impact on local, extern and static variables.
2. Study output of ps command in Linux and draw process trees, identify process groups, session and group leaders, foreground and background processes.
3. Write programs to explore the variety of signals and their behaviours.
4. Write programs for Interprocess communication with pipes and popen() calls; pipes across parent and child processes; pipes across threads.
5. Producer-Consumer problem: restricted and general versions; solutions using mutexes, condition variables and semaphores.
6. Exploring FILE structure in Linux and the fcntl() and ioctl() calls.
7. Writing a simple device driver for a parallel port; extension to USB port (optional).

TEXT BOOKS:
Recommended:
- Charles Crowley. *Operating Systems: A Design-Oriented Approach*,Tata McGraw-Hill (2001 or later)
- Richard Stevens, Stephen Rago. *Advanced Programming in the Unix Environment*, Addison-Wesley (2013).Available for free downloadin PDF.

References:
- Maekawa, M. and Arthur E. Oldehoeft and Oldehoeft, R.R. *Operating Systems: Advanced Concepts*, Benjamin Cummings (1987).Available through Google Books.
- David A.Rusling. *The Linux Kernel*, http://www.tldp.org/LDP/tlk/tlk.html

CS/AI/IT 402: ALGORITHMS

Objectives: Appreciate inherent hardness of a problem and learn strategies available for problem solving; design algorithms and give proof of correctness, implementation of the algorithms by choosing appropriate data structures; gaining skills to analyze the complexity of an algorithm by giving mathematical proofs where necessary.

At the end of the course, students should be able to appreciate the inherent structure/hardness of a problem and choose an appropriate strategy to solve the problem and design an algorithm that suits the time complexity requirements of the problem.

Pre-requisites: Data structures, Discrete mathematical structures, knowledge of sorting algorithms and basic search strategies

Syllabus

Analysis of Algorithms:

Asymptotic Notation; Best, worst and average case analysis of algorithms; Solving recurrence relations using substitution method, generating functions, Master's theorem etc.

Warm-up to complexity analysis: Heap data structure, priority queue application, Best, worst and average case analysis of a few sorting algorithms like heap sort, insertion, bubble, selection, counting and radix sort algorithms

Strategies for problem solving:

1. Divide and Conquer strategy: Time complexity analysis for Merge Sort and Quick Sort Algorithms.
2. Greedy strategy: Theoretical foundation of greedy strategy: Matroids Algorithms for solving problems like Knapsack Problem (Fractional), Minimum Spanning Tree problem; Shortest Paths, Job Scheduling, Hu man's code etc along with proofs of corrections and complexity analysis.
3. Dynamic Programming strategy: Identify situations in which greedy and divide and conquer strategies may not work. Understanding of optimality principle. Technique of memorization. Applications to problems like Coinchange, 0/1 and 0/n- Knapsack, Shortest Paths, Optimal Binary Search Tree(OBST), Chained Matrix Multiplication, Traveling Salesperson Problem(TSP) etc.
4. Backtracking and Branch & Bound strategies: State space tree construction, traversal techniques and solving problems like 0/1 and 0/n knapsack, TSP, Applications of Depth First Search: Topological sorting, Finding strongly connected components and game problems.

Theory of NP-Completeness: Complexity classes of P, NP, NP-Hard, NP-Complete, Polynomial reductions, Cook's theorem. Discussion of problems: Sastisfiability(SAT), CNF-SAT, Min-Vertex Cover, Max-Clique, Graph Coloring, NP-Completeness proofs.

Text books:

Introduction to Algorithms-T.Cormen, C.E.Leiserson, R.L.Rivest,PHI, 1998. Fundamentals of Algorithmics - G.Brassard and P.Bratley, PH, 1995

Reference books:

Algorithms- R.Johnsonbaugh and M.Schaefer, Pearson, 2004.

CS/AI/IT SOFTWARE ENGINEERING

Prerequisite: Programming Methodology

Aim: This course emphasizes software engineering principles and leans more toward the theoretical foundations.

Course Content:
Introduction to System Concepts, Software Engineering Concepts, SE Methodology, Life Cycle Models, Software Development Approaches: Waterfall model, Boehm's spiral model. Requirements Analysis, Specifications verification and validation, Coding Principles and Programming Techniques, Software Testing, Future trends in SE.

Books:

1. Ian Sommerville: Software Engineering, Addison-Wesley, 5th edition, 1998.

2. R. Pressman: Software Engineering - a practioner's approach, McGraw Hill - 1992. 3. Carlo Ghezzi, etal: Fundamentals of SE, PHI New Delhi 1995.

4. P. Jalote: An Integrate approach to SE, Narosa Publishers, 1992

CS/AI/IT SOFTWARE ENGINEERING LAB

Syllabus: Software engineering practices to be emphasized

CS/IT IT LAB-II (WEB TECHNOLOGIES)

Syllabus: Software engineering practices to be emphasized

HTML, Forms & CSS
Introduction To HTML5, WWW, W3C, web publishing,Introduction To Style sheet, types of style sheets-Inline, External, Embedded CSS, text formatting properties, CSS Box Model, CSS Border, margin properties, Positioning Use of classes in CSS, color properties, use of &, Layout Design using CSS.

JavaScript
Intro to script, types, intro of JavaScript, JavaScript identifiers, operators, control & Looping structure, Intro of Array, Array with methods, Math, String, Date Objects with methods User defined & Predefined functions, DOM objects, Window Navigator, History, Location, Event handling, Validations On Forms.

Representing Web Data: XML, JSON
XML, XML Schema and DTD document definitions, XSLT transformations and programming, XPath, XQuery, Introduction to JSON.

jQuery& AJAX
Introduction to jQuery, Syntax Overview, Anatomy of a jQuery Script, Creating first jQuery script, Traversing the DOM, Selecting Elements with jQuery, Refining & Filtering Selections, Selecting Form Elements, Working with Selections, Chaining, Getters & Setters, CSS, Styling, & Dimensions, Manipulating Elements, Getting and Setting Information about Elements, Moving, Copying, and Removing Elements, Creating New Elements, Manipulating Attributes, Utility Methods, Events, Connecting Event to Elements, Namespacing Events, Event handling, Triggering Event handlers, Event Delegation, Animating effects, animate(), click(), hover(), toggle(), Plugins , Create a basic plugin, Finding &Evaluating Plugins, Writing Plugins, Tabs, Panels and Panes

examples, jQuery UI and Forms, AJAX Overview, jQuery's AJAX related methods, Ajax and Forms, Ajax Events

Java based Server Side Programming

Introduction to Java Programming Language, Features of JAVA; Java Language Basics, Packages and Interfaces, Exception handling; Database Management through JDBC, Connecting to a database for creation or manipulation; Multithreading Programming, Introduction to Servelet, HTTP Servelet Class, Request Interface, Response Interface, Session Tracking, Database Connectivity from Servelet, Interservelet Communication, Servelet Collaboration, Overview of JSP, Relation of Applets and Servelets with JSP, Scripting Elements, JSP Expressions, JSP Scriplets, JSP Declarations, Predefined Variables, Creating Custom JSP Tag Libraries Using Nested Tags, Structuring Generated Servelet in JSP Pages, Including Files and Applets in JSP Documents, Integrating Servelet and JSP

Suggested Readings:

1. Internet and World Wide Web How to Program, P.J. Deitel, H.M. Deitel
2. Jeffrey C. Jackson, "Web Technologies—A Computer Science Perspective", Pearson Education, 2006.
3. Complete reference HTML.
4. JavaScript Bible
5. HTML, DHTML, JavaScript, Perl & CGI Ivan Bayross
6. XML: How to program Deitel&Deitel.

SYSTEM SECURITY (Credits: 03)

Prerequisites: Computer Networks, Operating Systems.

UNIT -I: An Overview of Computer Security:
Confidentiality, Integrity, Availability, Threats Policy and Mechanism, Goals of Security, Assumptions and Trust, Assurance, Specification, Design. Policies for security, confidentiality and integrity. Hybrid models

UNIT -II: Authentication, Entities and Systems for Enforcement
Authentication, Physical Security, Access Control systems, Biometrics, Identity,Trust

UNIT -III: Security in Operating Systems
Protected Objects and Methods of Protection, Secure Programs, Non-malicious Pro-gram Errors,Viruses and Other Malicious Code,Trusted Operating System Design, Secure Programming, File and Memory security, Attacks, Threats, kernel flaws and vulnerabilities. Backups and recovery, Hardening of systems,Robust Programming

UNIT -IV: Case Study of Operating System Security
Windows Security: Security components of Windows OS, Windows registry, Win-dows domains, Active Directory, Access Controls, Principals, Subjects Tokens, Security Identi.ers, Privileges, Objects, Security Descriptors, ACE Matching, Microsoft Malware Protection Engine (MSMPENG), Baseline security analysis. Unix/Linux Security: Types of attacks, Unix system security checklist, Integrity Management, Auditing and Logging, Protecting Against Programmed Threats,Wrappers and Prox-ies, SUID or SGID loopholes,Patching and updates to software. Android and other Mobile OS Security.

UNIT -V: Legal Ethical, Privacy Issues Audits and Administration of Security
Privacy Concepts, Privacy Principles and Policies, Computer Crime, Ethical Issues in Computer Use, Protecting Programs and Data,Forensics, Logging and Analysis, Security Planning, Risk Analysis, Organizational SecurityPolicies and enforcement

TEXTBOOKS/REFERENCES

1. Ross J. Anderson, Security Engineering: A Guide to Building Dependable Dis-tributed Systems, 2nd Edition, ISBN: 978-0-470-06852-6, 1080 pages, March 2008, Wiley.
2. CharlesP. P.eeger and Shari Lawrence P.eeger, Security in Computing, 4/E, ISBN-10: 0132390779 ISBN-13: 9780132390774, Pearson Education.
3. Matt Bishop, Computer Security: Art and Science ISBN 81-297-0184-7; 2003, PublisherPearson Education (Singapore) Pte. Ltd.
4. Simson Gar.nkel and Gene Spafford Practical UNIX & Internet Security, 2nd Edition ISBN 1-56592-148-8, 1996, O'Rielley

VIRTUALIZATION (Credits: 03)

1. Introduction

Objective: This is an advanced course and suggested reading is defined in the form of definitive research papers for every unit. Virtualization technologies allow decoupling of the user-perceived experience of hardware/software systems from a physical implementation. Presently every aspect of computing resources is being seen in with view of abstraction. Techniques exist to virtualize processing, networking, and storage. These are becoming pervasive in industry and are being used at a foundation level. The combination of virtualization technologies and ubiquitous network connectivity allows for the creation of virtual computers where processing, data and communication are distributed and decoupled from physical resources. This course is aimed to cover the basic mechanisms and techniques involved in resource virtualization from individual machines to vir tualized networked infrastructures. This course aims to give students an exposure of the theory and implementation aspects of virtualization.

2. Prerequisite

Computer Architecture, Operating Systems, Computer Networks

3. Course Outline

UNIT - I: Introduction

Why Virtualization? Trends in Virtualization. Formal Requirements for Virtualizable Third Generation Architectures (Popek and Goldberg, CACM, 1974).

UNIT - II: VMWare Workstation Design

1. Bringing Virtualization to the x86 Architecture with the Original VMware Workstation (Bugnion, Devine, Rosenblum, Sugerman, and Wang, TOCS, 2012
2. Disco: Running Commodity Operating Systems on Scalable Multiprocessors (Bugnion, Devine, and Rosenblum, SOSP, 1997).[Optional Reading]
3. The Evolution of an x86 Virtual Machine Monitor (Agesen, Garthwaite, Sheldon, and Subrahmanyan, OSR, 2010) [Optional Reading]

UNIT - III: x86 Virtualization Hardware

1. A comparison of software and hardware techniques for x86 virtualization (Adamsand Agesen, ASPLOS, 2006).

UNIT - IV: Binary Translation

1. Fast Dynamic Binary Translation for the Kernel (Kedia and Bansal, SOSP 2013)
2. Comprehensive Kernel Instrumentation via Dynamic Binary Translation (Feiner, Brown, and Goel, ASPLOS'12)
3. QEMU, a Fast and Portable Dynamic Translator (Fabrice Bellard, USENIX Annual Technical Conference 2005.)

UNIT - V: Paravirtualization, Virtualizing the VMM, KVM

1. Xen and Art of Virtualization (Barham, Dragovic, Fraser, Hand, Harris, Ho, Neugebaur, Pratt and War_eld, SOSP 2003).
2. The Turtles Project: Design and Implementation of Nested Virtualization (Ben-Yehuda, Day, Dubitzky, Factor, Har'El, Gordon, Liguori, Wasserman, and Yassour, OSDI 2010)
3. kvm: the Linux Virual Machine Monitor (Kivity, Kamay, Laor, Lublin, and Liguori, OLS 2007)

UNIT - VI: Memory and I/O Virtualization

1. AMD-V Nested Paging (AMD White Paper, July 2008)

2. Virtualizing I/O Devices on VMware Workstation's Hosted Virtual Machine Monitor (Sugerman et al. USENIX 2001)
3. virtio: Towards a De-Facto Standard For Virtual I/O Devices (Russell, OLS 2008)
4. Safe device assignment with VFIO (Corbet, LWN 2012)
5. ELI: Bare-Metal Performance for I/O Virtualization (Gordon, Amit, Har'El, Ben-Yehuda, Landau, Schuster, and Tsafrir, ASPLOS 2012)
6. vIOMMU: E_cient IOMMU Emulation (Amit, Ben-Yehuda, Tsafrir, and Schuster, USENIX 2011) [Optional Reading]

UNIT - VII: Virtualization-Aware File Systems and Virtual Disks

1. Virtualization Aware File Systems: Getting Beyond the Limitations of Virtual Disks (Pfa_, Gar_nkel, and Rosenblum, NSDI 2006)
2. Parallax: Virtual Disks for Virtual Machines (Meyer, Aggarwal, Cully, Lefeb-vre, Feeley, Hutchinson, and War_eld, EuroSys 2008)
3. IOFlow: A Software-De_ned Storage Architecture (Thereska, Ballani, O'Shea, Karagiannis, Rowstron, Talpey, Black, and Zhu, SOSP 2013) [Optional Reading]

Reading Material

Text Books

Virtualization Essentials, Matthew Portnoy, Copyright 2012 by John Wiley Sons, Inc., Indianapolis, Indiana, ISBN: 978-1-118-17671-9

References

1. Virtual Machines, Versatile Platforms for Systems and Processes James E. Smith and Ravi Nair, ISBN: 978-1-55860-910-5, 2005 Morgan Kaufman
2. Don Porter's Course on Virtualization at Stonybrook University http://www.cs.stonybrook.edu/porter/courses/cse591/s14/
3. Topics in Virtualization and Cloud Computing at IIT Bombay http://www.cse.iitb.ac.in/puru/courses/autumn12/cs695/lectureplan.html
4. Virtualization and Cloud Computing: I and II at IIT Delhi http://www.cse.iitd.ernet.in/sbansal/csl862-virt/readings.html http://www.cse.iitd.ernet.in/sbansal/csl862-virt/2010/

COMPUTER ARCHITECTURE (Credits: 03)

1. Prerequisite

Computer Organization, Basics of Computer Architecture, Operating Systems.

2. Course Outline

UNIT - I: Fundamentals of Quantitative Design and Analysis

Classes of computers, Trends in technology, Measuring and Reporting Performance, Power consumption and efficiency as the metric, Dependability, Quantitative Principles of Computer Design.

UNIT - II: Instruction Set Principles

Classifying Instruction Set Architectures, Memory Addressing, Addressing modes, Operations in the instruction set, Instructions for control flow, encoding an instruction set, Role of compilers.

UNIT - III: Memory Hierarchy Design

Cache performance review, Four basic memory hierarchy questions, Six basic optimizations of cache performance, Ten advanced optimizations of cache performance, Protection: virtual memory and virtual machines, memory technology and optimizations: SRAM, DRAM, Flash memory, Graphics Data RAMs.

UNIT - IV: Instruction-Level Parallelism and its Dynamic Exploitation
Instruction level parallelism: concepts and challenges, basics of pipelining, data hazards, structural hazards, control hazards, minimizing data hazards through forwarding, overcoming branch penalties by delayed branches, static and dynamic branch prediction, dealing with exceptions in pipelining, dynamic scheduling, Tomasulo's algorithm, speculative processors, high performance instruction delivery, VLIW approach, static and dynamic superscalar processors.

UNIT - V : Multiprocessors and Thread-Level Parallelism
Multithreading: exploiting thread-level parallelism within a processor, Symmetric shared-memory architectures and their performance, Distributed shared-memory architectures and their performance, synchronization, models of memory consistency.

3. Reading Material

Text Books

1. John L. Hennessey and David A. Patterson. Computer Architecture: A Quantitative Approach, 5E, Morgan-Kaufmann, 2012. ISBN-13: 978-0123838728.

Suggested Assignments

Assignments can primarily be exercises from Hennessy and Patterson with modifications to them.

1. Problems involving use of Amdahl's law.
2. Problems that use the timing diagram of pipelining to estimate the number of cycles taken for execution of a set of instructions.
3. Problems involving branch prediction and branch target buffers and estimating cycles taken for instruction with and without these optimizations.
4. Problems involving memory operations and improvement in performance through use of different cache optimizations.
5. Problems involving use of dynamic scheduling and speculation to compare the performance of the system with these optimizations versus regular pipelining.
6. Problems involving the centralized and distributed shared-memory architectures and operations involved in accessing different memory locations present in multiple processors

COMPUTER NETWORKS (Credits: 4)

Prerequisites: C programming, Basic Networking Principles, Data Communica-tions.

UNIT -I: DATA LINK LAYER
PPP, PPPoE, MAC Layer: Ethernet, Switched Ethernet, VLANs, Spanning Tree Protocol and its variants such as Rapid Spanning Tree.

UNIT -II: NETWORK LAYER: DATA PLANE
InternetProtocolAddressing: CIDR,InternetProtocolDatagram (including fragmentation and reassembly, routing options),IPForwardingAlgorithm,ARP,ICMP (includingICMPRedirect,ICMPPathMTUdiscovery,ICMPDestination Unreachable options).

UNIT -III: TRANSPORT LAYER
UDP,TCP sliding windowprotocol,TCP connection establishment,TCP reliability including cumulative and delayed acknowledgements, Nagle algorithm, Karn's algo-rithm for RTT and RTO estimation, TCP AIMD

Congestion Control Algorithm, TCP half-close connections including TCP keepalive timer and probe timer, TCP Fast Retransmit and Fast Recovery.

UNIT -IV: NETWORK LAYER: CONTROL PLANE

Distance Vector Algorithm and Routing Information Protocols V1 and V2, Link StateAlgorithm andOpenShortestPathFirstProtocol (OSPF).

UNIT -V: APPLICATION LAYER

DomainNamingSystem(DNS)andDynamicHost ConfigurationProtocol(DHCP).
Telnet,SSH,FTP,HTTP,SMTP,NetworkManagement usingSNMP,P2P(Bittorrent and DHT).

TEXTBOOKS

1. Douglas Comer. Computer Networks and Internets Sixth Edition, 2014. ISBN 0133587932/9780133587937, Pearson Education.
2. Douglas Comer. Internetworking With TCP/IP Volume 1: Principles Proto-cols, and Architecture, 6th edition, 2013. ISBN-10: 0-13-608530-X ISBN-13: 9780136085300, Pearson Education.
3. Kevin R. Fall and W.Richard Stevens. TCP/IP Illustrated, Volume 1: The Protocols, 2/E, 2012, ISBN-10: 0321336313 ISBN-13: 9780321336316, Pear-son Education.
4. James F. Kurose and Keith W. Ross. Computer Networking: A top-down approach, 6th edition, Pearson Education.
5. Radia Perlman. Interconnections: Bridges, Routers, Switches, and Internet-working Protocols, 2/E,2000,ISBN-10:0201634481 ISBN-13:9780201634488. Pearson Education.

SUGGESTED ASSIGNMENTS

1. Implement the IP fragmentation and reassembly algorithm.
2. Implement the IP forwarding algorithm.
3. Implement the simplest sliding window protocol of TCP.
4. Connect two systems using a switch and configure private IP addresses to the systems and ping them from each other. Using Wireshark, capture packets and analyze all the header information in the packets captured.
5. Convert a system with two network interface cards(NICs) into a router by configuring each NIC in a different LAN and enabling forwarding. Use two switches to connect one NIC each of the router to these two switches. Connect two other systems, one each to each switch. Now, we have two VLANs. Ping from one system to the other through the router after configuring the required default routes in the hosts and static routes in the router.
6. Install Telnet Server on one of the systems connected by a switch and telnet to it from the other system. Using Wireshark, capture the packets and analyze the TCP 3-way Handshake for connection establishment and tear down.
7. Use Mininet to create multiple computer nodes, multiple VMs in each computer node, an OVS to connect VMs in a compute node and one OVS that connects the nodes. Configure IP addresses to these VMs in different VLANs, configure static routes in the VMs and ping them from one another.
8. Once the initial Mininet assignment is successful, try commands like traceroute to trace the route from one VM to another.

CRYPTOGRAPHY (Credits: 4)

Prerequisites: NONE

UNIT -I: OVERVIEW, HISTORY AND CLASSICAL CIPHERS
Cryptography, steganography and cryptanalysis; History and development of cryptography; Classicalcryptosystems: shift, substitutionandVigen´ereciphers;Attacks on shift, substitution and Vigenere ciphers; Enigma cryptosystem and Role of WW-II; Designing a provably secure system, One -Time pads.

UNIT -II: SYMMETRICKEYCRYPTOSYSTEMSANDGSMSECURITY
Basics of number theory and algebra; Introduction to information theory, Shannon's axioms; DES and AES; Encryption in GSM communications, A5 family of algorithms.

UNIT -III: ASYMMETRICKEYCRYPTOSYSTEMSANDDIGITALSIGNATURES
Prime numbers, factorization and discrete algorithms; RSA and El Gamal cryptosystems; Signature schemes, hash functions and secret sharing schemes.

UNIT -IV: INTRODUCTIONTOCRYPTANALYSIS
Known plaintext, known cipher text, chosen plaintext and chosen cipher text attacks, man-in-the-middle attacks; Attacks on DES and AES, differential cryptanalysis; Attacks on RSA; Attacks on El Gamal; Attacks on A5 family.

UNIT -V: ADVANCED TOPICS
Zero knowledge proofs; Pseudo-random number generators; Industry standards and practices.

TEXTBOOKS:
Recommended:
1. Douglas Stinson. Cryptography: Theory and **Practice,** Third Edition or higher, Chap-man **&** Hall / CRC (Indian Edition) 2011.
2. Alfred Menezes, Paul C. van Oorschot and Scott A. Vanstone. Handbook of Applied Cryptography, CRC Press (2001). Free download in PDF available from http: / / cacr.uwaterloo.ca / hac /

References:
1. Johannes Buchmann. Introduction to Cryptography, Springer Pubs., 2nd Edition (2004) .
2. Lawrence C. Washington. Elliptic Curves, Number Theory and Cryptography, Chapman & Hall / CRC 2nd Edition (2008).
3. Simon Singh. The Code Book, 4th Estate Pubs. (2002)

NETWORK SECURITY

PART I SECURITY CHALLENGES TO COMPUTER NETWORKS

1. SECURITY THREATS TO COMPUTER NETWORKS Sources of Security Threats, Security Threat Motives,Security Threat Management, Security Threat Correlation, Security Threat Awareness.
2. COMPUTERNETWORKVULNERABILITIES Sources of vulnerabilities, Vulnerability Assessment**.**
3. HOSTILE SCRIPTS Introduction to the Common Gateway Interface (CGI), CGI Scripts in a Three – Way Handshake, Server – CGI Interface, CGI Script Security Issues, Web Script SecurityIssues, Dealing with the Script Security Problems, Scripting languages: server side, client side scripting languages

PARTII DEALING WITHNETWORK SECURITY CHALLENGES

4. ACCESSCONTROLANDAUTHORIZATION Access Rights, Access Control Systems, Authorization, Types of Authorization Systems, Authorization Principles, Authorization Granularity, Web Access and Authorization.
5. AUTHENTICATION: Authentication Elements, Types of Authentication, Authentication Methods, Developing an Authentication Policy.
6. FIREWALLS Types of Firewalls, Configuration and Implementation of a Firewall, Demilitarized Zone (DMZ), Firewall Services and Limitations.
7. SYSTEMINTRUSIONDETECTIONANDPREVENTION Intrusion Detection, Intrusion Detection Systems, Types of Intrusion Detection Systems, Challenges toIntrusion Detection Systems, Intrusion Prevention Systems

PART III WIRELESS NETWORKS

8. SECURITY IN WIRELESS NETWORKS AND DEVICES Cellular wireless Communication Network Infrastructure, Wireles LAN (WLAN) or Wireless Fidelity (Wi-Fi), Standards for wireless Networks, Security in Wireless Networks

PART IV PROTOCOLS AND STANDARDS

9. NETWORKSECURITYPROTOCOLSANDSTANDARDS Application Level Security: PGP, S/MIME, Secure HTTP, HTTPS, Secure Electronic Transactions (SET), Kerboros; Security in the Transport Layer: Secure Socket Layer (SSL), Transport Layer Security (TLS); Security in the Network Layer: Internet Protocol Security (IPSec), Virtual Private Networks (VPNs), Security in the Link Layer and over LANS: Point-to-Point Protocol (PPP), Remote Authentication Dial-In Service (RADIUS), TerminalAccess ControllerAccess Control System (TACACS+).

PARALLEL COMPUTING

Credit: 4 + 3Hrs/Week Lab

1. Introduction to Parallel Computing:
Why Parallel Computing & Scope of Parallel Computing, Sieve of Eratosthenes, Control and Data Approach, PRAM model of parallel computation, Design paradigms of Parallel Computing, examples, Bulk Synchronous Parallel (BSP) model, algorithms on PRAM and BSP model.

2. Practical Parallel Programming Paradigms:
Foster's design paradigm for Multi computing programming, Programmability Issues, Programming Models: Message passing, Message passing standards: PVM (Parallel Virtual Machine), MPI (Message Passing Interface) and its routines, Advanced Features of MPI, Load balancing techniques. Programming on Multiprocessors: Introduction to OpenMP (History, Overview, Programming Model, OpenMP Constructs, Performance Issues and examples, Explicit Parallelism: Advanced Features of OpenMP).

3. Threading on Intel Multi-Core Processors

Hardware-based Threading, Hyper-Threading Technology , Difference between Multiprocessor and Hyper-Threading, Technology, Hyper-Threading Technology Architecture, Multi-Core Processors, Architectural Details, Comparison between Multiprocessors and Multi-Core, Processors, Multiple Processor Interaction, Inter-Processor Communication and Multi-threaded Programming, Power Consumption, Power Metrics.

4. Introduction to Heterogeneous Multi-Core Processors

Introduction to Many cores Programming, Cell Processor Multinode Computing, The Early Days of GPGPU Coding, GPU Hardware, Alternatives to CUDA, OpenCL, Direct Compute
CPU alternatives, Directives and libraries, Understanding Parallelism with GPUs.

5. Heterogeneous Multi-Core Programming with CUDA

Introduction to GPU Computing, CUDA Programming Model, CUDA API, Simple Matrix Multiplication in CUDA, CUDA Memory Model, Shared Memory Matrix Multiplication, Additional CUDA API Features, Threading Hardware, Memory Hardware, Memory Bank Conflicts, Parallel Thread Execution, Control Flow, Precision.

Text books:

1. Quinn, M. J., Parallel Computing: Theory and Practice (McGraw-Hill Inc.).
2. Bary Wilkinson and Michael Allen: Parallel Programming Techniques using Networked of workstations and Parallel Computers, Prentice Hall, 1999.
3. W. Gropp, E. Lusk, N. Doss, A. Skjellum, A high performance portable implementation of the message passing Interface (MPI) standard, Parallel Computing 22 (6), Sep 1996.
4. Gibbons, A., W. Rytter, Efficient Parallel Algorithms (Cambridge Uni. Press).
5. Programming Massively Parallel Processors: A Hands-on Approach, authors, David B. Kirk, Wen-mei W. Hwu, Morgan Kaufmann, 2010 (This book is only on NVIDIA GPUs and CUDA programming despite its title)
6. CUDA by Example: An Introduction to General-Purpose GPU Programming by Jason Sanders and Edwards Kandrot Addison-Wesley, 2011.
7. CUDA Programming A Developer's Guide to Parallel Computing with GPUs Shane Cook, Morgan Kaufmann

***DISTRIBUTED COMPUTING (*Credit: 3)**

Unit-I

1. **Introduction.**
   Distributed computing Concepts, Basic network concepts, Basic operating system concepts.
2. **Inter process Communication.**
   Basic model, Primitives (operations): connect, send, receive, disconnect, Connection-oriented/connectionless, Data marshalling: data flattening, data representation, serialization, Event synchronization, Event diagram, sequence diagram.
3. **Distributed Computing Paradigms.**
   Message passing, client server, P2P, message system, RPC, Distributed Object Paradigm, Object Space, Mobile agent, Network services, Groupware paradigms, SOA, Overview & comparison of each paradigm.

Unit-II

4. **The Socket API.**
   The basic model, Stream-mode (connection-oriented) socket, Datagram socket (connectionless) socket, Java socket API, Using socket to implement a client.
   Using socket to implement a server, A simple middleware using sockets, Secure sockets and the Java secure socket extension API.
5. **The Client-server Paradigm.**
   The daytime protocol and a sample client-server suite, The echo protocol and a sample client-server suite, Connection-oriented client-server, Connectionless client-server, Iterative server and concurrent server, Stateful server and stateless server.
6. **Group Communications.**
   Unicast versus multicast, Basic model of group communications, The Java multicast API.
   Sample multicast sender program, Sample multicast listener program, Multicast and message ordering, Reliable multicast/broadcast.

Unit-III

7. **Distributed objects.**
   Message passing versus distributed objects, The basic model, Remote procedure call, Remote method invocation, CORBA Historical Perspective
8. **Advanced Remote Method Invocations (RMI).**
   RMI stub downloading, Security policy, Callback.
9. **Internet applications.**
   Basic components and protocols: HTTP, HTML, XML, MIME, web server, browser, web forms, Web document types: static, dynamic, executable, active, CGI: background; interaction and passing of data among browser, web server, and script(s), HTTP Session state information: hidden tags, cookies, session objects, Client-side programming: Applets, JavaScript, Server-side programming: common gateway Interface (CGI), servlets, server pages, Applets, Servlets; session data maintenance, Introduction to Web services and the Simple Object Access Protocol (SOAP), REST Protocol.

Text books:

1. Distributed Computing: Principles and Applications, M L Liu, Pearson Publisher.
2. Distributed Systems Concept and Design, George Coulouris, Jean Dollimore and Tim Kindberg, Pearson Publisher.

CLOUD COMPUTING

Credit: 4 + 3 Hr. /Week Lab

1. Basics of Web Services:
Extensible Mark-up Language XML Introduction, some key aspects of XML, Document-centric XML Data-centric XML, XML-based Web Services, Simple Object Access Protocol (SOAP), Web Service Definition Language (WSDL), UDDI (Universal Description Discovery and Integration) discovery that form a basis for Web Services, exploring JAXR, jUDDI, UDDI4J etc. Technologies include HTML, HTTP, XML, SOAP, and WSDL, Development of Java Web Services.

2. Introduction to Cloud Computing
Definition, Characteristics, Components, Cloud provider, SAAS, PAAS, IAAS and Others, Organizational scenarios of clouds, Administering & Monitoring cloud services, benefits and limitations, Deploy application over cloud, Comparison among SAAS, PAAS, IAAS Cloud computing platforms: Infrastructure as service: Amazon EC2,Platform as Service: Google App Engine, Microsoft Azure, Utility Computing, Elastic Computing

3. Virtualization and Resource Provisioning in Clouds
Introduction to Cloud Technologies, Study of Hypervisors Virtualization Technology: Virtual machine technology, virtualization applications in enterprises, Pitfalls of virtualization Multitenant software: Multi-entity support, Multi-schema approach, Multi-tenancy using cloud data stores, Data access control for enterprise applications

4. Data Management in Clouds
Data in the cloud: Relational databases, Cloud file systems: GFS and HDFS, BigTable, HBase and Dynamo. Map-Reduce and extensions: Parallel computing, Introduction to cloud development, Example / Application of MapReduce, Features and comparisons among GFS, HDFS etc, Map-Reduce model.

5. Security in Clouds
Cloud security fundamentals, Vulnerability assessment tool for cloud, Privacy and Security in cloud Computing security architecture: Architectural Considerations- General Issues, Trusted Cloud computing, Secure Execution Environments and Communications, Micro-architectures; Identity Management and Access control-Identity management, Access control, Autonomic Security Cloud computing security challenges: Virtualization security management- virtual threats, VM Security Recommendations, VM-Specific Security techniques,Secure Execution Environments and Communications in cloud.

6. Programming Enterprise Clouds using Aneka
Introduction, Aneka Architecture, Aneka Deployment, Parallel Programming Models, Thread Programming using Aneka, Task Programming using Aneka, and MapReduce Programming using Aneka, Parallel Algorithms, Parallel Data mining, Parallel Mandelbrot, and Image Processing.

7. Advanced Topics and Cloud Applications
Cloud computing platforms, Installing cloud platforms & performance evaluation. Features and functions of cloud platforms: Xen Cloud Platform, Eucalyptus, OpenNebula, Nimbus, Apache Virtual Computing Lab(VCL)

Book (Web Services)

1. Beginning Java web services, Henry Bequet et. al., a! press
2. Programming web services with SOAP, James Snell et. al., O' Reilly publisher

Books (Cloud)

1. Rajkumar Buyya, Christian Vecchiola, and Thamarai Selvi, Mastering Cloud Computing, Tata McGraw Hill, New Delhi, India, 2013.
2. Distributed and Cloud Computing: From Parallel Processing to the Internet of Things Kai Hwang , Jack Dongarra , Geoffrey C. Fox.

AI405 PROBLEM SOLVING METHODS

Prerequisite: Basic computer science background or instructor's permission.
Aim: First course introducing the principles of AI.

Course Content: General introduction of AI, Intelligent systems, etc., Applications, Search techniques, Constraint satisfaction problems, Logic (avoiding overlap with AI-712 Knowledge Representation and Reasoning), modus ponens, Satisfiability, Resolution, Refutation, Unification. AI–planning, Distributed AI, Market-oriented programming. Other related topics such as speech, vision, neural networks, etc.

Books:
4. N.J.Nilsson: Principles of Artificial Intelligence, Narosa Publications.
5. D. W. Patterson: Introduction to AI & Expert System, PHI.
6. S. Russell and P. Norvig. AI: A Modern Approach, 2nd Edn., McGraw-Hill, 2003.

KNOWLEDGE REPRESENTATION AND REASONING

Prerequisite: Basic computer science background or instructor's permission.
Aim: First course introducing the principles of knowledge representation and reasoning.

Course Content: Survey of Representation techniques: representation schemes: Logic: Procedural representations: Semantic networks: Conceptual structures: Production systems: Analogical representation: Semantics primitives: Frames and Scripts: conceptual Dependency: Applications of Knowledge Representation. Languages, Syntax and well-formed formulas (wffs), Semantics, Properties of Wffs. Formal deduction - Inference Rules, Logical Axioms, Formal Proofs, Theories and Theorem Proving Lowentheim-skolem Theorems, Classical first order logics-Propositional logic, Predicate Calculus. Non-classical Logics and their application to knowledge representation and processing.
Brief Introduction - Many sorted Logics, Non-monotonic Logics, Multi-valued Logics, Fuzzy Logic, Model Logic, Temporal Logic, and Intentional Logic.

MACHINE LEARNING

Prerequisite: Basic computer science background or instructor's permission.
Aim: First course introducing various techniques of machine learning.

Course Content: Review Basic Tasks, Methods and underlying problems of Machine Learning.
Learningmethods such as role, analogical, EBG, EBL, Chunking. Learning by examples - Version space algorithm and ID3 algorithm. Important systems and applications to the problem of knowledge acquisition for expert system.

Books:
1. Michalsky, T. Mitchell, J.Corbonell, Machine Learning Springer-Verlag.
2. T. M. Mitchell. Machine Learning, McGraw-Hill, 1997.

COMPUTATIONAL INTELLIGENCE

Prerequisites: Calculus, Differential equations, Linear algebra (Vectors, matrices), Logic, Set theory, Programming skills (familiarity with Matlab or any programming language)

Aim: This course introduces the concepts of computational intelligence / soft computing including neural networks (NN), evolutionary and genetic algorithms (GA), fuzzy logic, neuro-fuzzy techniques and rough set

theory. The coverage of topics will be in the following proportion: 60% NN, 20% GA and 20% Fuzzy and Rough Sets.

Syllabus:
Introduction to Computational Intelligence / Soft computing: Soft versus Hard Computing, Various paradigms of computing

Foundations of Biological Neural Networks: Introduction to Neural Networks, Humans and Computers, Organization of the Brain, Biological Neuron, Biological and Artificial Neuron Models, Hodgkin-Huxley Neuron Model, Integrate-and-Fire Neuron Model, Spiking Neuron Model, Characteristics of ANN (Learning, Generalization, Memory, Abstraction, Applications), McCulloch-Pitts Model, Historical Developments

Essentials of Artificial Neural Networks: Introduction, Artificial Neuron Model, Operations of Artificial Neuron, Types of Neuron Activation Function, ANN Architectures, Classification Taxonomy of ANN – Connectivity (Feed forward, feedback, Single and Multi-layer), Neural Dynamics (Activation and Synaptic), Learning Strategy (Supervised, Unsupervised, Reinforcement), Learning Rules (Error Correction, Hebbian, Competitive, Stochastic), Types of Application (Pattern Classification, Pattern Clustering, Pattern Association / Memory, Function Approximation, Prediction, Optimization)

Neural Architectures with Supervised Learning: Single Layer Feed Forward Neural Networks (Perceptron), Multilayer Feed forward Neural Networks (Back propagation learning), Radial Basis Function Networks, Support Vector Machines, Simulated Annealing, Boltzmann Machine, Feedback (Recurrent) Networks and Dynamical Systems

Associative Memories: Matrix memories, Bidirectional Associative Memory, Hopfield Neural Network,

Neural Architectures with Unsupervised Learning: Competitive learning, Principal Component Analysis Networks (PCA), Kohonen's Self-Organizing Maps, Linear Vector Quantization, Adaptive Resonance Theory (ART) Networks, Independent Component Analysis Networks (ICA)

Reinforcement Learning: Markov Decision Processes, Value Functions, Bellman Optimality Criterion, Policy and Value Iterations, Q-Learning, TD Learning

Fuzzy Logic: Basic concepts, fuzzy set theory, basic operations, fuzzification, defuzzification, neurofuzzy approach, applications

Evolutionary and Genetic Algorithms: Basic concepts of evolutionary computing, genetic operators, fitness function and selection, genetic programming, other models of evolution and learning, ant colony systems, swarm intelligence, applications

Rough Set Theory: Basic concepts, indiscernability relation, lower and upper approximation, decision systems based on rough approximation, applications

Partial Set of References:

1. Jacek M. Zurada. Introduction to Artificial Neural Systems, Jaico Publishers, 1992.
2. S. Haykin. Neural Networks: A Comprehensive Foundation, Prentice Hall, 1999
3. P. S. Churchland and T. J. Sejnowski. The Computational Brain. MIT Press, 1992.
4. A. M. Ibrahim. Introduction to Applied Fuzzy Electronics. PHI, 2004
5. Z. Pawlak. Rough Sets, Kluwer Academic Publishers, 1991.

AI PROGRAMMING LAB

Syllabus: LISP; PROLOG; SCRIPTING (PYTHON, PERL); ES SHELLS

BANKING TECHNOLOGY & PAYMENT SYSTEMS (Credits: 4)

Brief description of the course: This course is intended to provide the students an insight into the role played by technology in enhancing the effectiveness of the banking sector and also to provide strong foundation in the various technologies used for delivering Banking & Financial services. Apart from tracing the evolution of Banking Technology, this course will focus on current technologies as well as banking technologies of the future. Ultimately, it will enable the students to envision the current and future requirements, architectures of banks and accordingly develop roadmap and strategies. It will help students appreciate the fact that technology cannot be viewed in isolation, which will be a crucial step in integrating the technology and business goals of banks.

Module-A: Banking Operations-Overview: Introduction to Banking, Evolution of Banking Technology, Impact of Technology on Banking operations. Centralized Banking- concepts and opportunities, Centralized Banking – Architectures, Challenges and Implementation & management Issues.

Module-B: Delivery Channels: Products, Services & Delivery Technologies. ATM- technology and operations, Electronic Cards- debit and credits, Smart cards in banking/e-money Internet Banking Architecture and Implementation, Internet Banking/ Mobile Banking management, Phone banking and call centres, Electronic Delivery Channels Integration.

Module-C: Back office Operations: Credit appraisal system, Forex management/SWIFT, Treasury management, Asset Liability management, Risk management- Operational risk, MIS/DSS/EIS for Banks, Data Centre and Business continuity management, Internal workflow operations, Corporate Intranet and Knowledge management, Technology & Human Resource management, IT Governance.

Module-D: Electronic & Mobile Commerce: Introduction to Electronic Commerce, Business Models, Market Research and E-Commerce, Advertising in E-Commerce, Legal & Public policy issues relating to E-Commerce, Introduction to Mobile Commerce, Mobile Payments, Mobile banking, Mobile micro payments and mobile macro payments, Auctions, Agents in E-Commerce, E-Trading, B2B,B2C.

Module-E: Payment Systems: Introduction to Payment Systems, Payments through the Internet- privacy issues- Card based, net based payment systems, SET Protocol MICR, ECS, EFT, Global Payment Scenario – Interbank/Intrabank, RTGS, History of Money/Electronic Money/ Electronic cheques, Micro payments.

References:

1. Bank 3.0, Brett king, John wiley, 2013.
2. The Art of Better Retail Banking, Hugh Croxford, Frank Abramson, Alex Jablonowski, John Wiley 2005
3. Business knowledge for IT in Retail Banking-Bizle Professional series, UK Edition, Essvale Corporation Ltd 2007.
4. Financial Services Information System, Jessica Keyes, Auerbach, 2000.
5. Technology management in financial services, Ross, McGill, Palgrave Macmillan, 2008
6. Financial Technology management, Vol.1, Gulati, V.P., Srivasvatava, Shilpa; ICFAI University Press, 2008
7. Financial Technology management, Vol.2, Gulati, V.P., Srivasvatava, Shilpa; ICFAI University Press, 2008
8. Information Systems for Banks, Bhaskaran R, Taxmann, IIBF, 2005
9. Electronic Commerce: A Managerial Perspective, Efrain Turban, Jae Lee, David King H, Michael Chang, Pearson Education, New Delhi 2001
10. Electronic Commerce, Bhaskar, Bharat, Tata McGraw Hill, New Delhi-2008.
11. M-Commerce: technologies, services and business models, Sadeh, Norman, John Wiley & Sons, 2002
12. Electronic Payment Systems for E-Commerce, Mahony D, Pierece M, Tiwari H, Artech House Computer Security Series, 2001

DATA ENGINEERING (Credits: 4)

Although relational database systems are almost commodity software now, researches are even more fascinated by general data management issues. This course exposes students to use data as the means for understanding a process and learn advanced data management design principles and concepts

COURSE CONTENTS

Module 1: Relational data model, Relational Database Design, Indexing, Storage and File structure, Indexing & Hashing, Query processing, Query optimizations, Transactions, Concurrency, Recovery systems.

Module 2: Foundations of NO SQL, Data models, Distribution models, Consistency, Map-reduce, Key value databases, Document databases, Column-Family stores, Graph databases, Schema migrations, Beyond No-SQL

Module 3: Database Security with general Security Landscape and a Defense-in-Dept strategy, Databases as a Networked server, Authentication and Password Security, Application Security, Using Granular Access Control, Security database-to-database communications, Encryption, Regulations and Compliance, Auditing Categories, Auditing Architectures.

Module 4: Fundamentals of Big data and big data analytics, concepts of Hadoop, Related Technologies, Applications.

Module 5: Introduction to Data Quality, Data Quality dimensions, Models for Data Quality, Activities and Techniques for Data Quality, Data Quality issues in Data Integration Systems, Methodologies for Data Quality Measurement and Improvement, Tools for Data Quality, Open Problems, Case Studies.

TEXT BOOKS & REFERENCES:

1. Readings in Database Systems (4th Ed.) by Michael Stonebraker and Joe Hellerstein, Morgan Kaufmann. The MIT Press (2005)
2. Database Systems Concepts (6th Ed.) Avi Silberschatz, Hank Korth and S.Sudarshan McGraw Hill, 2010
3. Implementing Database Security & Auditing: A guide for DBAs, Information Security Administrators and Auditors, Ron Ben Natan 2005. ISBN: 978-1-55558-334-7
4. NOSQL Distilled : A Brief Guide to Emerging World of Plyglot Persistence, Pramod J Sadalage, Martin Fowler. Addison Wesley 2012
5. Principles of Big Data: Preparing, Sharing and Analyzing Complex Information, Jules J. Burman, Morgan Kaufmann (2013).
6. Data Quality: Concepts, Methodologies & Techniques. Carlo Batini, Monica Scannapieco. Springer 2006.

SUGGESTED ASSIGNMENT

Developing mini projects using RDBMS, NoSQL and Hadoop

5-Year Integrated Master in Technology (CS)

I-Semester			II-Semester		
Code	**Course Title**	**Credits**	**Code**	**Course Title**	**Credits**
EN101	English-I	4-0-0	EN151	English-II	4-0-0
MM103	Math-I	4-0-0	PY151	Waves & Oscillations, Sound & Light theory	4-0-0
SB101	Environmental Science	3-0-0		Math-II	4-0-0
SB102	Foundation Biology	3-0-0	CA500	Mathematical Foundations of Computer Science	3-0-0
EC101	Introduction to Economics	4-0-0	PY152	*Waves, Oscillations & Optics Lab*	3
MM203	Probability & Statistics	3-0-0	CA521	Programming Methodology	3-0-0
	IT Workshop	2	CA510	*PM Lab*	2
		23			**23**
III-Semester			**IV-Semester**		
Code	**Course Title**	**Credits**	**Code**	**Course Title**	**Credits**
MM202	Math-III	4-0-0	CA502	Computer Based Optimization Techniques	3-0-0
	Electronics Devices & Circuits (EDC)	4-0-0	CA522	Data & File Structures	3-1-0
CA501	Computer Based Numerical Methods	3-0-0	CA524	Object Oriented Design	3-0-0
CA520	Computer Organization & Architecture	4-0-0	CA528	Theory of Computation	3-0-0
CSxxx	*IT Lab(Numerical methods)*	2	CSxxx	Signals & Systems	3-0-0
	EDC Lab	2	CSxxx	*Java Lab*	2
	Information Security	3-0-0	CSxxx	*IT Lab(DFS)*	2
			CS711	*Communication Skills Lab*	2
		22			**22**
V-Semester			**VI-Semester**		
Code	**Course Title**	**Credits**	**Code**	**Course Title**	**Credits**
CA523	Operating Systems	3-0-1	CA525	Software Engineering	3-0-0
CA545	Internet Technologies	3-0-0	CA527	Computer Networks	3-0-0
CA526	Data Base Management System	3-0-0	CA547	Computer Graphics & Visualization	3-0-1
CA529	Algorithms	3-1-0	CSxxx	Compiler Design	3-0-1
CSxxx	Principles of Programming Languages	3-0-0		Elective –I	3 or 4
CA512	*DBMS Lab*	2	CS712	*Software Engineering Lab*	2
CSxxx	*IT Lab (Internet Technologies)*	2	CSxxx	*IT Lab (CN)*	2
				Summer Internship	
		22			**21/22**

VII-Semester			VIII-Semester		
Code	**Course Title**	**Credits**	**Code**	**Course Title**	**Credits**
CS786	Network Programming	3-0-0	CSxxx	Virtualization	3-0-0
AI720	Essentials of AI	3-0-0		Elective –V	3 or 4
CSxxx	Advanced Computer Architecture	3-0-0		Elective – VI	3 or 4
	Elective –II	3 or 4		Elective – VII	3 or 4
	Elective –III	3 or 4		Elective –VIII	3 or 4
IT711	*UNP Lab*	2	CSxxx	Virtualization *Lab*	2
CSxxx	*IT Lab(AI)*	2		*Project*	3-0-0
CS710	*RMCS Lab*	2			
		21 / 23			20 / 24

IX-Semester			X-Semester		
Code	**Course Title**	**Credits**	**Code**	**Course Title**	**Credits**
	Elective – IX (Graduate Seminar Course	3	CS719	Project	12
CS718	Project	6			
		9			12

Total Credits: 196 / 203

MATH-I

1. Credits: 4-0-0

2. Course Outline

UNIT - I: Matrices
Basic concepts of matrices, multiplication of matrices by scalars, addition and multiplication of matrices, transpose, trace, determinant of a matrix, rank and inverse of a matrix, special matrices such as Hermitian, unitary matrices, system of linear equations, solution by Crammer's rule, existence and general properties of solutions, eigenvalues, eigenvectors, diagonalization of matrices, functions of matrices and Caley-Hamilton theorem.

UNIT - II: Elementary functions
Definition and examples of sequences and series. Using these, study Trigonometric functions, logarithmic, exponential function, hyperbolic trigonometric functions

UNIT – III: Analytical geometry in 3-D
Cartesian co-ordinates in 3-D, distance between two points, direction cosines, direction ratios and their properties, equation of plane using given data, equation of straight line in different forms, image of a point with respect to a plane, distance between a point and a plane along a straight line, equation of sphere, circle.

UNIT – IV: Complex numbers, vector algebra
Algebra of complex numbers, polar form, argand diagram, triangle inequality, curves and regions in complex plane. Addition of vectors, dot product, cross product and their geometric interpretation, triple product, area, volume given in terms of vector products**.**

Reference:

1. Linear Algebra, Kenneth Hoffman and Ray Kunze,pearson,1971
2. Linear Algebra: A geometric approach, S Kumaresan,Pre…hall of.. 2004
3. Calculas and analytic geometry , George Thomas & Ross Finney..1995

ENVIRONMENTAL STUDIES

1. Credits: 4-0-0

2. Course Outline

UNIT - I:The multidisciplinary nature of environmental studies
Definition, Scope and importance Environmental Milestones

UNIT - II:**Ecosystems**
Concept of an ecosystem (Abiotic and biotic environment), Structure and function of an ecosystemProducers, Consumers and decomposers.Energy flow in the ecosystem, (Nutrient cycle in the ecosystem) Ecological succession Food chain, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystems: Forest ecosystem,Grassl and ecosystem, Desert ecosystem aquatic ecosystems (ponds,streams,lakes,rivers,ocean estuaries).

UNIT – III:Biodiversity
Conservation: Introduction, Definition: genetic, species and ecosystem diversity, Hot spots of biodiversity, Threats to biodiversity: habitat loss, poaching of wildlife, man wildlife conflicts. Endangered

and endemic species of India, Conservation of biodiversity: In- situ and Ex-situ conservation of biodiversity.

UNIT – IV:
Natural Resources and non-renewable resources An overview of natural resources and associated problems with references to a) Forest resources b) Water resources c) Mineral resources d) Food resources e)Energy resources f)Land resources.

UNIT – V: Environmental Pollution
Definition a) Air pollution b) Water pollution c) Soil pollution d)Marine pollution e) Noise pollution f) Thermal pollution g) Nuclear pollution Solid waste management: Causes, effects and control measures of urban and industrial wastes.Environmental impact assessment.

UNIT – VI:
Environment: Socio-Political Issues: Environmental Ethics: Science / Nature Debate) Global Environmental Issues a) Global Warming, Climate Change, Acid Rain, Ozone layer depletion, Pollution) Global Environmental Issues a) Deforestation, Loss of Biodiversity, Desertification, Land Degradation) Global Conventation on Environment: Indian environmental Laws.

UNIT – VII: Human –Environment Interaction
Modes of Resource Use, Development and Environment Population growth and Environment, Environment and Human Health. Unit 8: Project Work (Group of....) Select List of Themes: Study of simple ecosystem: pond / lake / rocks, iodiversity Register of Campus Pollution Energy sources Water Conservation Waste Disposal and Recycling GM crops.

FOUNDATION BIOLOGY

1. Credits: 3-0-0
Objective: A course to expose students to basics of biology

2. Course Outline
UNIT - I: Biological kingdoms, comparative account of prokaryotes and eukaryotes at cellular level;

UNIT - II:Overview of interactions between prokaryotes and eukaryotes;

UNIT – III:Cells, organization, and functions of organelles; Principles of genetics or patterns of inheritance, theory of evolution;

UNIT – IV: Biomolecules: water, sugars, amino acids, nucleotides, carbohydrates, lipids, proteins and nucleic acids;

UNIT – V:Enzymes, chemical reactions, glycolysis, respiration, fermentation photosynthesis, nitrogen fixation, transpiration, osmosis Overview of development;

UNIT – VI: Digestive system, circulatory system, nervous system, endocrine glands, reproductive system.

3. Reading Material
Reference Books:

1. Biological Science, Cambridge Low Price Edition, by N.P.O. Green, G.W. Stout, D.J. Taylor, Editor: R. Soper. XI and XII Biology CBSE Books

PROBABILITY AND STATISTICS

1. Credits: 4-0-0

2. Course Outline

Random Experiments Sample spaces, Events, probability measures on events- definition, properties, examples. Conditional probability-definition, properties, examples, Bayes theorem, independent events.

Definition of random variables, standard discrete and continuous random variables-viz. Bernoulli, Binomial, Geometric, Poisson, Exponential, Gamma, Normal their probability distributions, . Expectation, variance, other properties. Definition of bivariate random variables, joint distributions, covariance and correlation between two random variables, independence, distributions of sums

Data collection methods, types of data, graphical summaries of data, numerical summaries of univariate data, bivariate summaries, measures of association. Introduction to statistical inference, population parameters, variable(s) of interest, statistic, estimators as random variables.

3. Reading Material

1. Ross, S. A First Course in Probability, sixth edition, Pearson Education, 2007.
2. Ramachandran, K.M. and Tsokos, C.P. Mathematical Statistics with applications, Academic Press, 2009.
3. Daniels, W.W. Biostatistics: a foundation for analysis in the health sciences, 9th edition, John Wiley & Sons, 2008
4. Moore, D.S. The Basic Practice of Statistics, W. H. Freeman, 2003.

IT WORKSHOP

1. Credits: 2

2. Course Outline

UNIT - I: Hardware: Identifying the various hardware components of a computer.

UNIT - II: Operating System Installation: Installation of a dual-boot operating system – Windows and Linux.

UNIT - III: Linux Commands: File manipulation commands (mkdir, rmdir, cp, mv, ls, rm, pwd, chmod, chown, umask),Process related commands (ps, top, kill, fg, bg), Environment (env, ˙bashrc,˙bash profile,export), Piping and redirection (|,>,>>,<,<<), Miscellaneous com-mands (sort, wc, alias, locate, whereis, which, pushd, popd, who, whoami, echo,cut, paste) Searching for files and contents of files (find, grep, awk, sed)

UNIT - IV: Document Preparation with Latex: Basic documents with sectioning, figures and tables, captioning, cross-referencing,multi-column and classes of documents, mathematical formulae, table of contents, Title page, Numbering, Page breaks, Boxes.

UNIT - V: Presentations with Beamer: Basic presentations using beamer, overlays, animation, using tables, figures and columns in presentations, boxes for definitions etc.

UNIT - VI: Data Analysis with Spreadsheets: Using basic sheet column definition, calculating simple statistics such as Average, Standard Deviation etc., setting up formulae for calculation of values of columns using regular formulae and/ or VLOOKUP, using pivot tables, drawing charts (bar, pie) and graphs using the data in the sheet.

UNIT - VII: Drawing Tools: Using tools such as OODRAW or Xfig or Calligra to draw figures to include in documents by exporting to .eps format.

3. Reading Material

Text Books

1. Stephen G. Cochan and Patrick Wood. Unix Shell Programming, 2003.
2. Brian W. Kernighan and Rob Pike. The Unix Programming Environment.
3. Leslie Lamport. A Document Preparation System: LATEX, User's Guide and Reference Manual, Pearson Education.
4. Ellen Siever, Stephen Figgins, Robert Love, Arnold Robbins. Linux in a Nut- shell, 6th edition, O'Reilly Publishers, 2009.
5. Xfig reference manual.

Suggested Assignments

1. List all directories in a directory that start with a particular letter.
2. Count the number of files in a directory.
3. Find all files with a given substring in the name.
4. Prepare a document about your favourite scientist with the title, author name (i.e., student name) and reg. no. in the first page which includes photos, text about the person referring to the photos.
5. Add tables to a document, formulae and refer to all these in the text of the document. Create a table of contents for the document from its sections and sub-sections limiting the TOC to two levels.
6. Using different schemes of Beamer, overlays, columns and boxes, create a presentation.
7. Give data sets such as marks of students and ask that the excel sheet be set up to calculate totals based on the columns, grade table set up using VLOOKUP.
8. Give data sets that let students generate pie charts, bar charts and other graphs.
9. Using Xfig or OODRAW, draw flowcharts, graphs, paths in graphs etc.

WAVES, OSCILLATIONS, SOUND & LIGHT

1. Credits: 4-0-0

2. Course Outline

Simple harmonic motion, Angular simple harmonic oscillator, damped harmonic oscillator, Forced oscillations and Resonance; Simple coupled oscillators.Traveling waves, Superposition principle, Wave speed, Power and intensity in wave motion, Interference of sound waves, Stationary waves, Beats, Waves on strings and surfaces, Audible, ultrasonic and infrasonic waves, Propagation and speed of longitudinal waves, Vibrating systems and sources of sound, Musical instruments, The Doppler effect, Shock waves, Velocity of sound and its measurement, factors affecting the speed of sound Nature and propagation of light, Images, Defects of images, Spherical and Chromatic aberrations, Achromatism of two thin lenses separated by a distance, Optical instruments (Microscopes and Telescopes), Velocity of light and its measurement.

3. Reading Material

1. Fundamentals of Physics by Resnick, Halliday and Walker, 6th Wiley
2. University Physics by Sears and Zemansky, 10thedition, Addison –Wesley series
3. Fundamentals of Optics, Jenkins and White
4. Light by K. G. Mazumdar
5. Geometrical and Physical Optics by P. K. Chakraborty
6. Opticsby B. K. Mathur.

MATH-II

1. Credits: 3-0-0

2. Course Outline

UNIT - I:Multivariable calculus

Brief introduction to co-ordinate systems- spherical and cylindrical systems- double integral over a rectangle, double integral over a region, change of order of integration, triple integrals, change of variables and Jacobian. Vector fields, gradient, divergence, curl, vector calculus identities, parametric curves, line integrals, path dependence, fundamental theorems of line integrals, conservative fields, application of Greens theorem in 2-D, parametric surfaces, surface of revolution, surface integrals, applications of Stokes theorem and Gauss divergence theorem, Green's identities, statement of integration by parts.

UNIT - II:Mathematical Analysis

Rational numbers, sequences, subsequences, monotonicity, boundedness, convergence, limit of a sequence, Cauchy criteria, series, different tests of convergence, power series, radius of convergence

MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE

1. Credits: 3-0-0

Objective: The purpose of this course is to understand basic concepts of mathematics (definitions, proofs, sets, functions, and relations) and use (abstract) discrete structures(integers, bits, strings, trees, and graphs) that are backbones of computer science.

2. Course Outline

UNIT - I: Logic: Propositional logic, logical equivalence, predicates & quantifiers, and logical reasoning. Boolean Algebra

UNIT - II: Sets, Relations &Functions: Basics, set operations, Properties, Combining relations, Closures, Equivalence, partial ordering, One-to-one, onto, inverse, composition, graphs

UNIT - III: Algorithms on Integers: Greatest common divisor, Euclidean algorithm.

UNIT - IV: Mathematical reasoning: Proof strategies, Mathematical Induction, Recursive definitions, Structural Induction

UNIT - V: Counting: Basic rules, Pigeonhole principle, Permutations and combinations, Binomial coefficients and Pascal triangle

UNIT - VI: Probability: Discrete probability. Expected values and variance

UNIT - VII: Graph Theory: Paths, degree sequences, trees, minimum spanning trees, shortest path, bipartite matching, Tutte's theorem, connectivity, flows, graph coloring

3. Reading Material

Text Books

1. Discrete mathematics and its application: K H Rosen

References

1. Discrete and Combinatorial mathematics : Grimaldi
2. Concrete mathematics: Donald Knuth
3. Discrete mathematics with applications: Sussana Epp

WAVES, OSCILLATIONS, SOUND & LIGHT LAB

1. Credits: 3

2. Course Outline

Lab Exercise:

1. Coupled Oscillator- Measurement of Normal Mode Frequencies
2. KUNDT'S TUBE Determination of Velocity of Sound in Air
3. SONOMETER –Resonance Modes of a Stretched String & Velocity of Wave Propagation
4. BREWSTER ANGLE METHOD –Measurement of Refractive Index of Dielectric Material
5. FRESNEL BIPRISM –Determination of Wavelength of Light by Interference
6. NEWTON'S RINGS –Determination of Radius of Curvature of a Lens
7. FABRY –PEROT INTERFEROMETER –Measurement of AirgapThickness
8. DIFFRACTION GRATING –Determination of Wavelengths of mercury vapour lamp.

PROGRAMMING METHODOLOGY

1. Credits: 03

Objective: This course teaches the basics of solving problems by writing computer programs. At the end of the course, a student will be able to think programmatically and write programs in a procedural / imperative language. The primary language used for programming is 'C.'

2. **Course Outline**

UNIT – I: Introduction to problem solving; Problems and problem instances; Informal approach to program design: generalisation, special cases, algorithms, breaking down a problem into functions, input and output.

UNIT – II: Introduction to the 'C' programming language; program structure; main() function; unnamed and named blocks; basic data types, variables, declaration and definition; initialisation and assignment; arithmetic operators and precedence; implicit and explicit type conversions; arrays; boolean variables and logical operators.

UNIT – III: Control structures: branching and iteration; functions and parameters; break(), return() and exit() functions; local and global variables; function prototypes.

UNIT – IV: Pointer variables and dynamic structures; static and dynamic (run-time) memory structures; static variables; breaking a program across multiple files; creating and linking libraries.

UNIT – V: Detecting and correcting common errors; debugging and debuggers; documenting programs; good programming practices; programming exercise (writing a program of at least 200 lines split across multiple files).

3. Reading Material

Text Books

1. Brian W. Kernighan, Dennis M. Ritchie. "The C Programming Language, 2nd Edition," Prentice-Hall India.

Additional Readings

1. G. Michael Schneider. "Introductionto Programmingand Problem SolvingwithPASCAL," JohnWiley and Sons.
2. Brian W. Kernighan and R. Pike. "The Unix Programming Environment," Prentice-Hall India.
3. Chakravarthy Bhagvati. "How to Program (An Informal Guide)," http://dcis.uohyd.ernet.in/~chakcs/howtoprogram.pdf

Suggested Assignments

1. Write a program for *Collatz Conjecture*.

Input: An integer x(< 10^7)
Problem: If x is *even*, x = x / 2 If x is *odd*, then x =3x +1 Repeat the above step untilx =1.
Output: The number of times the above step is repeated until x =1.

2. Write a program to verify if an input string is a valid vehicle number.
Note that a vehicle number is of the form: CCDDCDDDD or CCDDCCDDDD where 'C' stands for a single letter and 'D' stands for a digit.
3. Read "AdditionalReading3" carefully; follow the steps given there and writea program to produce a 4 × 4 Magic Square.

MATH- III

1. Credits: 4 -0-0

2. Course Outline

UNIT - I: Ordinary Differential Equations: Order and degree of a differential equation, first order equations: variables separable method, homogeneous equations of degree zero, nonhomogeneous equations, exact equations, integrating factor, linear equations, Bernoulli's equation. Higher order homogeneous linear equations with constant coefficients, second order homogeneous linear equation with variable coefficients, variation of parameters, 2 x2 autonomous system of equations, power series solution, meaning of existence and uniqueness of a solution and some counter examples.

UNIT - II: Laplace Transforms: Definition, L.T. of some elementary function, e_ect of L.T. on translation, scaling, convolution. Inverse Laplace transform, applications of L.T. to ODE.

UNIT - III: Fourier series: Fourier series of a periodic function, half range Fourier series.

UNIT - IV: Sets, relations and functions: Sets, relations, equivalence, partial ordered relations, mathematical induction, elements of

ELECTRONICS DEVICES & CIRCUITS

1. Credits: 4-0-0

2. **Course Outline**

UNIT – I: ElectronicDevices and Circuits: Voltage and current sources, Kirchhoff's voltage and current law, Superposition theorem, Thevnin's theorem, Norton's theorem, Maximim power transfer theorem.

UNIT – II: Diode: Semiconductors, p-n junction Diode, Working principle and characteristics of p-n junction diode, Zener diode, LED, Photo-diode, Half-Wave, Full-Wave and Bridge rectifiers, efficiency, ripple factor, voltage regulation. Clipping, clamping, voltage doublers and multipliers.

UNIT – III: Transistors: pnp and npn structures; CE,CB and CC configuration, input and output characteristics, α β and γ, cut off, active and saturation regions, biasing and bias stability, load line and Q-point, Transistor as an amplifier (CE), Transistor as a switch, Types of FET, construction of junction FET, output characteristics, biasing, operating region, pinchoff voltage, MOSFET: enhancement and depletion type, construction, principle of operation and characteristics, elementary idea on CMOS, MOS inverter.

UNIT – IV:Amplifiers: Voltage and current amplifiers, principle of feedback, positive and negative feedback, advantages of negative feedback, multistage amplifier, RC coupled amplifier: frequency response, gain and band- width, class A, class B, Class AB and class C amplifiers, Introduction to Op-Amp.

UNIT – V: Digital Electronics: Decimal, binary and hexadecimal numbers, binary arithmetic, Boolean algebra, logic gates: OR, AND, NOT, NAND, NOR and exclusive¬OR, universal gate, de¬Morgan's theorems, 1's and 2's complement, Boolean simplifications, sum¬ of¬ product and product¬ of¬ sum form, Karnaugh map

3. Reading Material

Text Books

1. Integrated Electronics – J. Millman and C. Halkias (Mc Graw Hill).
2. Microelectronics – J.Millman ((Mc Graw Hill).
3. Electronics Fundamentals and Applications – J. D. Ryder (PHI Pvt. Ltd).
4. Electronic Device and Circuit Theory – R. Boylestad and L. Nashelsky (Prentice –Hall).
5. Operational Amplifier & Linear IC – Gayakwad (TMH)
6. Digital Principles & Applications – Malvino and Leach (TMH)
7. Digital Design by Moris Mano
8. Electronics Principles – A.P.Malvino (TMH).

COMPUTER BASED NUMERICAL METHODS

1. Credits: 3-0-0

Objective: To understand Computation and to make use the computers effectively for solving problems. DesigningFlowcharts, algorithms for providing apt computation. Students are expected to have functions to provide solutions to numerical problems, which will be useful in their other courses as well as project works

Upon successful completion of this course, the student will be able to:

- Quantify absolute and relative errors.
- Distinguish between round-off and truncation errors.
- Interconvert binary and base-10 number representations.
- Define and use floating-point representations.
- Quantify how errors propagate through arithmetic operations.
- Implement the bisection method for solving equations.
- Implement both Newton-Raphson and secant methods.
- Perform basic matrix operations.
- Define and perform Gaussian elimination to solve a linear system.
- Identify pitfalls of Gaussian elimination.
- Define and perform Gauss-Seidel method for solving a linear system.
- Define and identify special types of matrices.
- Use LU decomposition to find the inverse of a matrix.
- Define and perform singular value decomposition; explain the significance of singular value decomposition.
- Define interpolation.
- Define and use direct interpolation to approximate data and find derivatives.
- Define and use Newton's divided difference method of interpolation.
- Define and use Lagrange and spline interpolation.
- Derive and apply the trapezoidal rule and Simpson's rule of integration.
- Distinguish Simpson's method from the trapezoidal rule.
- Estimate errors in trapezoidal and Simpson integration.
- Derive and apply Romberg and Gaussian quadrature for integration.
- Investigate how step size affects accuracy in Euler's method.
- Implement and use the Runge-Kutta 2nd order method for solving ordinary differential equations.

2. Prerequisites

Finite representation of numbers, Flowchart, exposure to algorithms, Real Analysis, one of the programing Languages.

3. Course Outline

UNIT - I: Transcendental and Polynomial equations
UNIT - II: System of Linear Algebraic equations and eigenvalue problems
UNIT - III: Interpolation and Approximation
UNIT - IV: Differentiation and Integration
UNIT - V: Ordinary differential equations

4. Reading Material

Text Books

1. M.K. Jain, S.R.K. Iyengar and R.K. Jain (1993) "Numerical Methods for Scientific and Engineering Computation" Wiley Eastern Limited

References

1. Erwin Kreyszig (1993) "Advanced Engineering Mathematics" Wiley
2. Press, Teukolsky, Vellerling and Flannery (1992) "Numerical Recipes in C - the Art of Scientific Computing" Cambridge
3. Abromowitx and Stegum (1972) "Handbook of Mathematical Functions with formulas, Graphs and Methematical Tables" National Bureau of Standards Applied Mathematics Series . 55 Siperintendent of Documents U.S. Government Printing Office Washington, DC 20402
4. Jaan Kiusalaas (2009) " Numerical Methods in Engineering with MATLAB" Cambridge University Press (http://mhbb2012.persiangig.com/.uxdhABZETd/Numerical%20Methods%20in%20Engineering%20with%20MATLAB,%202nd%20Edition%20Sep%202009.pdf)

Note: Recommended to use MATLAB for Demos explaining/visualizing the concepts

COMPUTER ORGANIZATION AND ARCHITECTURE

1. Credits: 4-0-0

Objective: To build up foundation for the study of hardware organization of digital computers. To understand the structure, function and characteristics of computer systems including various building blocks of computers, without being specific to any particular architecture. Understand importance of interaction between hardware and system software

2. Course Outline

UNIT - I: Computer Evolution & Arithmetic: A Brief History of computers, Designing for Performance, Von Neumann Architecture, Hardware architecture, Computer Components, Interconnection Structures, Bus Interconnection, Scalar Data Types, Fixed and Floating point numbers, Signed numbers, Integer Arithmetic, 2's Complement method for multiplication, Booths Algorithm, Hardware Implementation, Division, Restoring and Non Restoring algorithms, Floating point representations, IEEE standards, Floating point arithmetic

.

UNIT - II: The Central Processing Unit: Machine Instruction characteristics, types of operands, types of operations, Addressing modes, Instruction formats, Instruction types, Processor organization, Processor as running example, Programmers model of , max/min mode, Register Organization, Instruction cycles, Read Write cycles, assembly instruction examples to explain addressing modes

UNIT - III: The Control Unit: Single Bus Organization, Control Unit Operations: Instruction sequencing, Micro operations and Register Transfer. Hardwired Control: Design methods – State table and classical method, Design Examples - Multiplier CU. Micro-programmed Control: Basic concepts, Microinstructions and micro- program sequencing

UNIT - IV: Memory Organization: Characteristics of memory systems, Internal and External Memory, Types of memories: ROM: PROM, EPROM, EEPROM, RAM: SRAM, DRAM, SDRAM, RDRAM
High-Speed Memories: Cache Memory, Organization and Mapping Techniques, Replacement Algorithms, Cache Coherence, Virtual Memory: Main Memory allocation, Segmentation, Paging, Address Translation Virtual to Physical.
Secondary Storage: Magnetic Disk, Tape, DAT, RAID, Optical memory, CDROM, DVD

UNIT - V: I/O Organization: Input/Output Systems (features and principles), Programmed I/O, Interrupt Driven I/O, Interrupt structure, Direct Memory Access (DMA), features Buses and standard Interfaces: Synchronous, Asynchronous, Parallel I/O features, Serial I/O features, PCI, SCSI, USB Ports Working mechanisms of Peripherals: Keyboard, Mouse, Scanners, Video Displays, Touch Screen panel, Dot Matrix, Desk-jet and Laser Printers.

UNIT - VI: Case Studies: Concepts RISC: Instruction execution characteristics,, RISC architecture and pipelining. RISC Vs CISC. ARM and Embedded Systems PowerPC, Intel X86 Evolution from 32bit to 64bit architectures. AMD Opteron

3. Reading Material

Text Books

1. Pattersen D.A. & Hennesy J.L., Computer Organisation & Design: The Hardware/Software Interface

Reference Books

1. Computer Organization and Architecture, 10/E William Stallings ISBN-10: 0134101618 • ISBN-13: 9780134101613- See more at: http://www.pearsonhighered.com/pearsonhigheredus/educator/product/products_detail.page?isbn=9780134101613&forced_logout=forced_logged_out#sthash.WVVJbZUb.dpuf

IT LAB (NUMERICAL METHODS)

1. Credits: 2

2. Course Outline

UNIT - I: Transcendental and Polynomial equations

Practical problems:

(i) Bisection Method
(ii) Newton's Method
(iii) Iteration Methods

.

UNIT – II:Systemof Linear Algebraic equations and eigenvalue problems

Practical problems:

(iv) L U decomposition
(v) Gauss Elimination Method
(vi) Computation of eigenvalues and eigenvectors

UNIT - III: Interpolation and Approximation

Practical problems:

(vii) Lagrange Interpolation
(viii) Hermite Interpolation
(ix) Least Square Approximation
(x) Rational Approximation

UNIT - IV: Differentiation and Integration

Practical problems:

(xi) Numerical Integration based on Interpolation

(xii) Romberg Integration
(xiii) Quadrature method

UNIT – V:Ordinary differential equations
Practical problems:
(xiv) Single step and multiple step method
(xv) Predictor-Corrector Methods

ELECTRONICS DEVICES & CIRCUITS Lab
Credits: 2

Outline:
1. P-N junction diode
    a. I~V characterisitics,b) half wave rectifier, c) full wave rectifier d) clipper
2. Bipolar Junction Transistor
    a. Transistor characteristics , Transistor application as an amplifier (Common Emitter configuration)
3. Truth table verification – Universal gate realization
4. Adder / substractor
5. Seven segment display interface to adder / subtractor.

(Circuit level simulation of above experiments using circuit simulator)

INFORMATION SECURITY

1. Credits: 3-0-0
Objective: This course aims at imparting good understanding of information security, workstation & network security and introduction to various security and cryptography technologies

2. Course Outline

- Introduction to Computer Security &Hackers .
- Security Concepts Confidentiality, Integrity, Authority, Privilege and Basics of Defense
- Network Technology OSI layer model, TCP model, Overview of networked systems, Network design and topology**.**
- Legal Issues
- Basics of Hacking
- Security Policies
- Access Control, Permissions & Passwords
- Risk and Risk Analysis
- E-mail & Phishing
- Viruses, Spyware, and Malware
- Incident Response
- Computer Forensics
- The Human Element
- Cryptography

3. Reading Material
Text Books
1. Principles of Computer Security: Conklin, White, Cothren, Williams, and Davis. McGraw Hill.

Reference Books
1. Cryptography and Network Security: W Stallings. PHI.
2. Cryptography Theory and Practice: D R Stinson. CRC.

Suggested Assignments

1. Installing windows and linux
2. Network ports and communication
3. Hacking Practices
4. Cracking Passwords
5. E-Mail Phishing
6. Basic Computer Forensics Lab

COMPUTER BASED OPTIMIZATION TECHNIQUES

1. Credits: 3-0-0

Objective: To become familiar with various optimization techniques

2. Course Outline

UNIT - I: Linear Programming: Mathematical formulation of Linear Programming problem, Canonical and standard forms of Linear Programming problem, Solution by Graphical and Simplex methods, Revised Simplex method, Two phase & Big M – method, Duality, Primal – Dual relationship, Dual Simplex method

.

UNIT – II:Special Types of Linear Programming Problem: Transportation problem, Northwest corner method, Stepping stone method, Unbalanced transportation problem, Assignment problem, The Hungarian method

UNIT - III: Integer Programming: Integer Linear Programming problem, Mixed Integer Linear Programming problem, Cutting Plane method, Branch and Bound Technique

UNIT - IV: Dynamic Programming: Bellman's Principle of optimality, General theory of solving multistage decision problems using Dynamic Programming, Application of General Theory to specific problems such as the Traveling Salesman problem.

3. Reading Material

Text Books

1. F S Hillier and G J Lieberman, Introduction to Operations Research, 7th edition, McGraw Hill, 2000
2. H A Taha, Operations Research – An Introduction, 8th Edition, Pearson Prentice Hall, 2007

Reference Books

1. G Hadley, Linear Programming, Narosa Publishing
2. Harvir Singh Kasana and K D Kumar, Introductory Operations Research: Theory andApplications, Springer Science & Business Media, 2004
3.

Suggested Assignments

Computer implementation of

1. Simplex method and its various other forms
2. Northwest corner method, Stepping stone method
3. Hungarian method
4. Cutting plane method
5. Recursive solution of travelling salesman problem using Dynamic Programming

DATA AND FILE STRUCTURES

1. Credits: 3-1-0

Objective: The course would equips the students with knowledge about various basic data structures and their appropriate use in specific applications.

2. Course Outline

UNIT - I: Introduction: Introduction to data structures and data types, Tracing of the algorithms, Time complexity analysis of algorithms with respect to data structure operations

UNIT – II:Linear data structures: Arrays, Row-major and Column major order, Polynomial Manipulations Stacks, Recursion with examples from mathematics, graphics, and languages, Infix to Postfix conversion Queues, Priority queues , Linked Lists and their variations (Circular linked list, Double linked list)

UNIT - III: Non-linear Data Structures: Trees, Traversals, Binary Search Trees, Heaps, Splay trees, Graphs, Representations of the graphs, Graph Traversals

UNIT - IV: Search Mechanisms: Linear Search, Binary Search, Hash Tables

UNIT - V: Sorting: Bubble sort, Selection sort, Merge Sort, Heap sort

UNIT - VI: File structures:Indexing, B-trees, B^+ trees

3. Reading Material

Reference Books

1. An introduction to Data Structures with Applications (Second edition), Tremblay and Sorenson, Tata Mecgrahill.
2. Data Structures and Algorithms in Java (4th edition), Michael T. Goodrich and Roberto Tamassia, John Wiley and sons
3. A Practical Introduction to Data Structures and Algorithm Analysis, Clifford A Schaffer, Prentice Hall

Suggested Assignments

Construction of a city database using a linked list and binary search tree and the appropriateness of these structures under various demands for the data. Some problems of similar nature.

OBJECT ORIENTED DESIGN

1. Credits: 3-0-0

2. Course Outline

UNIT - I: Object Oriented Fundamentals and Modeling: Need for OOP paradigm, What is object orientation and OO Development, Modelling, Abstraction, Three models of OOD, Object and class concepts, Links and Association Concepts, Generalization and Inheritance, N-ary associations, Aggregation, Abstract classes, multiple inheritance, metadata, Reification, Constraints, Derived data, packages.

UNIT - II: Java Basics: History of Java, java data types, variables, scope and life time of variables, arrays, operators, expressions, control statements, type conversion and casting, simple java program, concepts of classes, objects, constructors, methods, access control, this keyword, garbage collection, overloading methods and constructors, parameter passing, recursion, nested and inner classes, exploring string class.

Defining, Creating and Accessing a Package, Understanding CLASSPATH, importing packages, differences between classes and interfaces, defining an interface, implementing interface, applying interfaces, variables in interface and extending interfaces. Exploring java.io.

UNIT - III: State Modelling and Interaction Modelling: Events, states, Transitions and Conditions, State Diagram, Nested state diagram, Concurrency
Use-Case model, Sequence model, Activity model, procedural sequence model, Relation between class, state model and interaction model

UNIT - IV: Hierarchical abstractions, Generalization and Aggregation, Base class object, subclass, subtype, substitutability, forms of inheritance- specialization, specification, construction, extension, limitation, combination, benefits of inheritance, costs of inheritance. Member access rules, super uses, using final with inheritance, polymorphism- method overriding, abstract classes, the Object class
Exception handling in Java:
Concepts of exception handling, benefits of exception handling, Termination or resumptive models, exception hierarchy, usage of try, catch, throw, throws and finally, built in exceptions, creating own exception sub classes. String handling, Exploring java.util

UNIT - V: System Design, Class Design and Implementation Modelling: Overview of system design, performance estimation, reuse plan, Subsystems, Management of data storage and global resources, software control strategy and boundary conditions
Overview of class design, Realizing use-cases, designing algorithms, refactoring and design optimization, Overview of implementation, fine tuning of classes, generalization, and realizing associations

3. Reading Material

Text Books

1. Java: The complete reference, Herbert Schildt, McGrawhill
2. Understanding OOP with Java, T. Budd, Pearson Education
3. Object Oriented Modelling and Design with UML, 2nd edition, Michael Blaha and James Rambaugh, Eastern Economy Edition

THEORY OF COMPUTATION

1. Credits: 3-0-0

Objective: This course aims to give an understanding of the theoretical foundations of computer science. Study of simple models of computation leading to the model for the modern world digital computer, the Turing machine, is one of the primary goals along with understanding limits of computability.

2. Course Outline

UNIT - I: Preliminaries on Alphabets and Languages: Finite and infinite sets, fundamental proof techniques.

UNIT - II: Regular Languages (RL): Definition and examples; Regular expressions (RE), Non-deterministic Finite automata (NFA), ε -NFA and Deterministic Finite automata (DFA); Equivalence of RE, NFA and DFA; Conversions from RE to (ε -) NFA to DFA to RE; Minimal DFA; Moore machine, Melay machine; Closure properties of RL; Pumping lemma for RL.

UNIT - III: Context-Free Languages (CFL): Definition and examples; Grammar formalism for regular languages, Context free grammar (CFG), Derivation trees, Ambiguity, Normal forms; Push down automata(PDA) (deterministic and non-deterministic); Equivalence of CFG and PDA; Closure properties of CFL; Pumping lemma for CFL.

UNIT - IV: Turing Machine (TM): Definition of TM; Examples; Variants of TM: Multi-tape and other versions of TM; Nondeterministic TM; Equivalence; Church-Turing Thesis; Universal Turing Machine

UNIT - V: Decidability and Undecidability: Definition of decidability; decidable problems concerning RL, CFL; Recursive and recursively enumerable (re); Undecidability; The Halting problem; Cantor's diagonalization argument; Examples of undecidable problems: Post's correspondence problem.

3. Reading Material

Text Books

1. Introduction to Automata Theory, Languages and Computation, by John. E. Hopcroft, Rajeev Motwani, J. D. Ullman, published by Pearson Education Asia, 2006.
2. Introduction to Languages and the Theory of Computation, by John C. Martin, published by Tata McGraw Hill, 2003

Reference Books:

1. Elements of the Theory of Computation, by H.R. Lewis and C.H.Papadimitrou, published by Prentice Hall Inc, 1981.
2. Introduction to Computer Theory by Daniel I.A. Cohen, published by Wiley India, 1991.

Suggested Assignments:

Construction of DFA, Regular expression, CFG, PDA, TM for a specified language.

Sample assignments:

1. Write a regular expression and construct DFA for the set of all strings $\{0,1\}^+$ in which each block of _ve consecutive symbols contains at least two 0's. Minimize your DFA.
2. Devise a Context free grammar that recognizes the language $\{w \varepsilon \{a, b, c\}^+ : n_a(w) < n_b(w)\}$ where $n_x(w)$ denotes the number of occurrences of the symbol x in w explaining each rule. Construct a push down automaton that recognizes this language.
3. Construct a Turing machine that recognizes the language $\{w \varepsilon \{a, b, c\}^+ : n_a(w) < n_b(w) < n_c(w)\}$. First write the idea behind the machine and then show the δ-function

SIGNALS AND SYSTEMS

1. Credits: 3-0-0

Objective: The aim of the course is to introduce students to mathematical foundations of signals, systems and algorithms to process signals. At the end of the course students will be able to use MATLAB to generate signals and process the same using various types of filters and systems. The practical aspects will be explained through a series of lab assignments on MATLAB

2. Course Outline

UNIT - I: Introduction to signals: Brief introduction to signals and their applications. Analog and digital signals.Continuous and discrete signals. Types of signals: Constant, Step, Ramp, Impulse, Dirac, periodic, exponential. Operations on Signals: Magnitude Scaling, Time shifting, Sampling.

UNIT - II: Introduction to systems: Properties: Memory less, stability, Linearity, Causality, Time invariance. Linear Time invariant systems, Causality and Causal Systems, system stability Integration of systems: Cascading, parallel, feedback.

UNIT - III: Mathematical Concepts: Review of probability, statistics and differential equations. Introduction to Random Variables, Probability and Cumulative distribution curves, Correlation, Covariance, Convolution of signals

UNIT - IV: Signal Processing Techniques: Fourier Transforms, Fourier Series, Z-Transforms and Laplace Transforms and their applications

UNIT - V: Digital signal Processing: Types of Filters, Signal responses to filters, Finite Impulse Response (FIR) and Infinite Impulse Response (IIR). Nyquist criterion, Fast Fourier Transform, Discrete Fourier Transforms, decimation-in-time (DIT) FFT, Inverse Fourier transforms, Types of window functions and frequency responses.

3. Reading Material

Text Books

1. Signals and Systems– by Simon Haykin (Author), Barry Van Veen (Author), 820 pages,
2. Fundamentals of Signals and Systems Using the Web and Matlab– by Edward W.Kamen (Author), Bonnie S Heck (Author), 632 pages, Publisher: Pearson Education (2007)

Reference Books:

1. **Communication Systems–** by Simon Haykin (Author), Michael Moher (Author), 436 pages Publisher: Wiley; Fifth edition (25 June 2009.
2. **Signals and Systems –** by Oppenheim Alan V. (Author), Willsky Alan S. (Author), Nawab S. Hamid (Author), 992 pages, PHI; 2 edition (1997)

Suggested Assignments

Weekly assignments based on MATLAB programming may be provided to help students to better understand design aspects and visualize results. Assignments may be designed around concepts like generation of different types of signals, processing them using functions provided in MATLAB, A brief introduction to Simulink Tool boxes (in MATLAB) may be provided. Assignments may be designed to augment topics taught in classroom.

JAVA LAB

1. Credits: 2

Objective: To master the skills of programming in Core Java. The course emphasis on implementation of object oriented principles using Java language along with getting exposure to Java language features and packages.

2. Course Outline

UNIT - I: To understand the basic features of Java programming language. (2 Lab Sessions)

Topics:

- Java Development Environment
- Java Fundamentals
  - Class with main function
  - Primitive Variable Types, Operators (Arithmetic, Logical, Relational)
  - Control Structures, Loops
  - Arrays

UNIT - II: Writing Classes and working with objects. (2 Lab Sessions)

Topics:

- Class, Methods, Access Modifiers, Object Creation
- Constructor, Constructor Overloading, Copy Constructor
- finalize method and Garbage Collector
- Working with frequently used Java Classes like java.lang.String, java.lang.Math

UNIT - III: Using Inheritance and Polymorphism in Java (4 Lab Sessions)

Topics:

- Writing a Sub class
  - Super key word, Constructors in Sub Class
  - Method Overriding
  - Overriding Object class methods
- Understanding Class Hierarchy: Packages
- Polymorphism
- Abstract Classes and Inheritance
- Interfaces and Inheritance
- Case Study depicting OO application design using polymorphism and inheritance
  - (for example) Developing a Solitaire Application (Chapter 8 of "Introduction to Object Oriented Programming by Timothy Budd")

UNIT - IV: Exception Handling (2 Lab Session)
Topics:

- Exception Class Hierarchy
- Exception Handling Mechanism
  - Catching an Exception, Multiple Catch Blocks, finally block
  - Throwing an exception
- Writing own exception class

UNIT - V: Exploring Java IO Package (2 to 3 Lab Sessions)
Topics:

- IO Package Class Overview
- Input/Output Stream Classes
- Readers and Writers
- File I/O
- Serialization
  - Object Input and Output Streams
- Utility of Scanner class

Unit VI:Programming Applets (2 Lab Sessions)
Topics:

- Life Cycle of Applet
- Passing Parameters to Applet
- Event Handling in Applet

Unit VII:Miscellaneous Topics
Topics:

- Generics
- Exploring java.util package
- Collections Framework

3. Reading Material
Text Books

1. Java: A Beginner's Guide, by Herbert Schildt, McGraw Hill Education (India) Private Limited.
2. Thinking in Java by Bruce Eckle, Prentice Hall.

Reference Books:

1. Java: The Complete Reference by Herbert Schildt, McGraw Hill Education.
2. Effective Java by Joshua Bloch, Createspace Independent Pub. Head First Java by Kathy Siera, O'Reilly Media

OPERATING SYSTEMS

1. Credits: 3-0-1

Objective: In this course, a detailed view of the kernel is given. This includes a detailed description of the way system calls work, the extended process state diagram in process management, detailed file system management description including the
data structures such as *inodes* used to maintain metadata and introduction to device drivers as part of the I/O subsystem.

This course excludes user space application development programming such as using IPC or thread-based programming. This is included in the *Network Programming* **course**.

2. Prerequisites

C programming, Data and File Structures.

3. Course Outline

UNIT - I: Introduction and Operating System Structures: Operating Systems Functionality, Computer Organization and Architecture, OS Operations, Kernel Data Structures, OS Services, User interfaces to OS, Programmer interfaces to OS, OS Structure, System Boot.

UNIT - II: Process and Thread Management: Process Concept, Process operations, Process Scheduling, Extended Process State Diagram (To be done from Stallings, Operating Systems: Internals and Design Principles), Process Context Switch in detail including System Call inter- face and implementation (To be done from Crowley: Operating Systems: A design-oriented approach), Interprocess Communication: Pipes, Named Pipes, Shared Memory, Process Synchronization: Signals, Mutexes, Semaphores, Monitors (To be done from Silberschatz et al. and Stevens), Thread Management: thread creation, thread scheduling, thread synchronization, Deadlocks: Resource Allocation Graphs, deadlock detection, prevention and avoidance, recovery from deadlock**.**

UNIT - III: Memory Management: Memory allocation techniques: paging and segmentation, Swapping, structure of the page table, Virtual memory: demand paging, copy-on-write, Page replacement, allocation of frames, kernel memory allocation, thrashing, memory-mapped files, Translation-Lookaside Buffer (TLB), multiprocessor concerns.

UNIT - IV: File System Management: Disk management: formatting, boot block, swap-space management, RAID structure, Disk scheduling algorithms: elevator, C-SCAN, File concept, Access methods,Directory structure, File system mount and unmount operations, file sharing, protection, file system structure, file system implementation: file system metadata storage structures such as inode (To be done from Bach: The Design of the Unix OS), allocation methods, free space management, efficiency and performance including disk cache and recovery from failures.

UNIT - V: I/O Management: I/O devices: polling, interrupt-driven, DMA, Application I/O interface: character and block devices, network devices, clocks and timers, non-blocking and asynchronous I/O, vectored I/O, Kernel I/O interface: I/O scheduling, Buffering, Caching, Spooling and device reservation, error handling, I/O protection, Kernel data structures Transforming I/O requests to hardware operations, Performance.

UNIT - VI: Case Studies1: Linux, Unix: Solaris / AIX, Windows 7.

4. Reading Material

Text Books

1. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne. Operating System Concepts , 9th edition, Wiley

Reference Books

1. Charles Crowley. Operating Systems: A Design-Oriented Approach, Prentice-Hall India.
2. W. Richard Stevens, . Advanced Programming in Unix Environment, Pearson Education.
3. W. Richard Stevens. Unix Network Programming, vol. 2, Pearson Education.
4. William Stallings. Operating Systems: Internals and Design Principles, Pearson Education.
5. Maurice J. Bach. The Design of the Unix Operating System, Prentice-Hall India.
6. Robert Love. Linux Kernel Development, Pearson Education.
7. Thomas Anderson and Michael Dahlin. Operating Systems: Principles and Practice, 2nd edition, Recursive Books.

Suggested Assignments

1. Modify the kernel to include the statement "Hello, World", compile the kernel and modify the boot loader to add the new version.
2. Compare the popular file systems: ext3, NTFS and XFS.
3. Implement small modifications of Producer-Consumer problem.
4. Implement a user level ps command by walking through the /proc directory.
5. Implement page tables and virtual-physical address mapping using the page tables. In this, the input can consist of a file containing the processor arch. (16/32/64-bit), page size, available RAM. For each process the file will contain the size of the executable and/or page no. and permissions on it and the frame start address. Then a set of virtual addresses with the operation (r/w/x) are input to the program for which the corresponding physical address must be returned if it is a valid virtual address and also whether the operation attempted is legal as per the permissions on the page.
6. Go through the /etc/fstab and manipulate it to mount partitions with different settings and/or use mount/umount commands to mount and unmount partitions and understand the concept of logical volumes.
7. Implement a simple file system such as FAT using FUSE API.
8. Implement a simple software device driver.

INTERNET TECHNOLOGIES

1. Credits: 3-0-0

2. Course Outline

UNIT - I: Application Layer Protocols: HTTP, Proxy Servers, SMTP, POP, IMAP, SSH, FTP, Peer-to-Peer protocols such as BitTorrent, Distributed Hash Tables..

UNIT - II: Client-Side Technologies: HTML, CSS, PHP, JavaScript, XML, Document Object Model (DOM), Dynamic Content, Cookies.

UNIT - III: Connection to Server and Server-Side Technologies: Databases (MySQL / MongoDB) and JDBC, Servlets, JSP, NodeJS..

UNIT - IV: Advanced Client-Side Technologies: Asynchronous JavaScript and XML (AJAX), JQuery, JavaScript Object Notation (JSON), Google Web Toolkit, [Ruby on Rails1], GoJS, Firebug.

UNIT - V: Advanced Web Applications: Search Engines and their algorithms, Google Maps and building your own Google Maps, Keyhole Markup Language (KML) on Google Earth.

3. Reading Material

Text Books

1. Core Servlets and Java Server Pages (JSP), by Marty Hall, Prentice Hall, 2nd edition (2003).

2. Processing XML with Java: A Guide to SAX, DOM, JDOM, JAXP, and TrAX by Elliotte Rusty Harold, Addison-Wesley Pub Co; 1st edition, 2002. (: Available online at http://cafeconleche.org/books/xmljava/

References

1. http://www.andrew.cmu.edu/user/mm6/95-733/schedule.html
2. http://cs.nyu.edu/courses/spring05/V22.0480-001/
3. http://web.stanford.edu/class/cs193c/lectures.html
4. http://www.sei.cmu.edu/library/assets/presentations/nelson-saturn2013.pdf
5. http://getfirebug.com/
6. http://gojs.net/latest/index.html

DATABASE MANAGEMENT SYSTEMS

1. Credits: 3-0-0

Objective: The course mainly covers database design and the use of databases in applications, with a short introduction to back-end structure of database systems. It includes extensive coverage of the relational model, relational algebra, and SQL. The course also features database design, and relational design principles based on dependencies and normal forms. Many additional key database topics from the design and application-building perspective are also covered: indexes, views, transactions, authorization, integrity constraints, triggers, Emerging NoSQL systems like Cassandra and MapReduce will also be covered

2. Course Outline

UNIT - I: Introduction : Characteristics of the Database Approach , Advantages of Using the DBMS Approach, A Brief History of Database Applications, Data Models, Schemas, Instances, Three-Schema Architecture and Data Independence , Database Languages and Interfaces, The Database System Environment, Centralized and Client/Server Architectures for DBMS, Classification of Database Management Systems

UNIT - II: Data Modeling using the ER/EER model (If needed): Entity Types, Entity Sets, Attributes, and Keys , Relationship Types, Relationship Sets, Roles, Structural Constraints, Weak Entity Types, ER Diagrams, Naming Conventions, and Design Issues , Relationship Types of Degree Higher than Two, Subclasses, Superclasses, and Inheritance , Specialization and Generalization, Constraints and Characteristics of Specialization and Generalization Hierarchies, Modeling of UNION Types Using Categories.

UNIT - III: Relational model (ER/EER to relational mapping): The relational model, Relational Model Constraints, Relational Database Schemas, Update Operations, Transactions, and Dealing with Constraint Violations, Querying relational databases, Relational Database Design Using ER-to-Relational Mapping, Mapping EER Model Constructs to Relations.

UNIT - IV: Relational Algebra: Relational Algebra operations from set theory, Binary Relational Operations: join and division, Additional Relational Operations, Examples of Queries in Relational Algebra, The Tuple Relational Calculus, he Domain Relational Calculus(Select, project, join) (Set operators, renaming, notation).

UNIT - V: Functional Dependencies & Normalisation: Functional Dependencies, Normal Forms Based on Primary Keys, General Definitions of Second and Third Normal Forms, Boyce-Codd Normal Form , Multivalued Dependency and Fourth Normal Form, Join Dependencies and Fifth Normal form, Inference Rules, Equivalence, and Minimal Cover Properties of Relational Decompositions, Algorithms for Relational Database Schema Design, About Nulls, Dangling Tuples, and Alternative Relational Designs Further Discussion of Multivalued Dependencies and 4NF, Other Dependencies and Normal Forms.

UNIT - VI: SQL: Introduction to SQL, Basic SELECT statement, Table variables and set operators, Subqueries in WHERE clause, Subequeries in FROM and SELECT, The JOIN family of operators, Aggregation, NULL

values, Data modification statements, Constraints and Triggers, Constraints of several types, Referential integrity, Views, Defining and using views, View modifications – introduction, View modifications using triggers, Automatic view modifications, Materialized views.

UNIT - VII: Concurrency and Parallelism: Transactions, properties of transactions, scheduling definitions, Locking, Lock based concurrency control, using strict 2hase locking and serialisability, Deadlocks, dealock prevention / detection, multiple granularity locking.

UNIT - VIII: Indexing: Index motivation, what is stored in an index, operations on an index, datafile with several index files, high level of index structures, B-trees, Hash tables, B+trees, clustered vs unclustered index, sorting.

UNIT - IX: NoSQL, NewSQL, and Not-yet-SQL: Distributed storage using DHT's (Routing, joining, replication), NoSql overview (ACID vs BASE, Datamodel, Key value stores, Document stores, Extensible Record stores, Scalable relational systems, sort case studies-Dynamo, Cassandra)
OLAP and Cubes and Graph Processing are other topics which could be addressed if we take out ER/EER module.

3. Reading Material

Text Books

1. Fundamentals of Database Systems (6th edition) by Elmasri and Navathe

Reference Books

1. A First Course in Database Systems (3rd edition) by Ullman and Widom (same material and sections as Database Systems: The Complete Book (2nd edition) by Garcia-Molina, Ullman, and Widom)
2. Database Management Systems (3rd edition) by Ramakrishnan and Gehrke
3. Database System Concepts (6th edition) by Silberschatz, Korth, and Sudarshan

ALGORITHMS

1. Credits: 3-0-0

Objective: Learn classic algorithms designed for classic problems, analyzing an Algorithm, learn techniques to design algorithms, computational tractability (NP-completeness)

2. Prerequisite : Data Structures, Discrete mathematics

3. Course Outline

- Introduction to algorithms, Asymptotical Notations, Solving Recurrences, Master Theorem
- Divide-and-Conquer: Strassen's Algorithm, Quicksort, Randomized Quicksort, Linear time sorting, Medians and Order Statistics
- Greedy Algorithms: Activity-Selection, Kruskal , Prim
- Dynamic Programming: Shortest Paths in DAG, Matrix-Chain Multiplication, Bellman-Ford, Floyd-Warshall, Dijkstra
  Network Flow, Ford-Fulkerson Method, Max-Flow-Min-Cut Week , Maximum Matching,
- NP-Completeness, Reductions
- Linear Programming, Duality
- Randomized Algorithms
  Approximation Algorithms

4. Reading Material

Text Books

1. Introduction to Algorithms" by Cormen et al, Third edition

References

1. " Algorithm Design" by Kleinberg and Tardos
2. Algorithms, 4th Edition by Robert Sedgewick and Kevin Wayne
3. "The Art of computer programming" by Donald Knuth

PRINCIPLES OF PROGRAMMING LANGUAGES

1. Credits: 3-0-0

Objective: The aim of this course is to provide students an understanding of the concepts underlying design and implementation of programming languages. The evolution of these concepts will be presented through the study of languages from FORTRAN to Java. The course will make the student understand the underlying differences and common features of procedural, functional, logic, object-oriented and scripting languages.

2. Course Outline

UNIT – I : Basics of programming languages; language design and implementation issues; impact of machine architectures; what makes a good (or successful) language.

UNIT – II : Common features of programming; elementary data types; encapsulation; inheritance; sequence control.

UNIT – III: Subprogram control; storage management and run-time structures; distributed processing and network programming.

UNIT – IV: Summaries of popular proceduraland object-oriented languages;FORTRAN,C; Smalltalk,C++, Java;

UNIT – V: Summaries of popular logic and functional languages; LISP, ML; Prolog; specialised languages such asPostscript,PHP.

3. Reading Material

Text Books

1. T.W. Pratt andM.V. Zelkowitz. "Programming Languages: Design and Implementation," 4th Edition, Prentice-Hall India (2001).

Additional Readings

1. Robert W. Sebesta. "Concepts of Programming Languages," 10th Edition, Pearson Publishing (2009).

DBMS LAB

1. Credits: 2

2. Course Outline

UNIT - I: ER -Modelling tools: Starting with Erwin, Adding Entity Types, Adding relationships, forward engineering, supertype/subtype example. ERWin, a popular data modeling software that allows database designers to represent Entity-Relationship diagrams and automatically generate relational SQL code to create the database in one of several commercial relational database management systems such as Oracle or Microsoft SQLServer.

UNIT - II: Abstract query languages: Creating the database, relational algebra interpreter, Relational Algebra Syntax, Naming of Intermediate Relations and Attributes, relational algebraic operator supported by the RA-Interpreter, Examples, Domain Relational Calculus Syntax, Safe DRC Queries, Datalog interpreter, datalog query examples. The three interpreters that can be used to execute queries in Relational Algebra, Domain Relational Calculus, and Datalog. These interpreters are part of a Java package that includes a rudimentary database engine capable of storing relations and able to perform basic relational algebraic operations on these relations. It is hoped that these interpreters will allow the student to get a better understanding of abstract query languages.

UNIT - III: Relational Database management System- MYSQL: Company Database, MySql utility, MySql and PHP programming, Online address book. Programming Web applications in PhP that accesses MySQL databases is introduced with a complete database browser application for the COMPANY database as well as a complete Online Address Book application.

UNIT - IV: Database design (DBD) toolkit: The toolkit allows the student to work with numerous concepts and algorithms that deal with functional dependency theory and data normalization. The student may use DBD to verify answers to many questions related to functional dependency theory and normalization algorithms.

UNIT - V: Object-oriented database management Systems: DB4O: A popular open source Object-Oriented Database Management system. Creating and populating objects in db4o is covered as well various methods to query and retrieve data from the object-oriented database is introduced.

UNIT - VI: XML: XML and its related technologies will be taught. Query languages XPath and XQuery are covered as well as schema specification language XML Schema.

Projects
Projects may be implemented in Java, PhP or any other favorite programming language and may access Oracle, MySQL or any other relational database management system.

SOFTWARE ENGINEERING

1. Credits: 3-0-0
Objective: Intends to introduce software engineering principles and techniques required for automation and quality production of software systems

2. Course Outline
UNIT - I: Introduction: Software Development - an engineering process, Short History of Software Engineering, Software Development Life Cycle, Engineers in Software Development Cycle, Systems Engineering, Software Engineering and other branches of study, Identifying Issues in Software Engineering.
Defining Software: Its Nature and Qualities: Representative Qualities, Types of Systems and Quality Requirements, Software Engineering and maintenance of qualities.
Software Engineering Principles: Rigor and Formality, Separation of Concerns, Modularity, Abstraction, Change Management, Incrementality, Generality

UNIT - II: Requirement Engineering: Software requirements, Requirement Engineering Process, Software Requirements Specification (SRS), Techniques for Requirements Elicitation, Specifying Software Requirements, Formal and Rigour based Specification: Use cases, Activity Diagrams, FSM, Petri Nets, Algebraic And Logic Based Specifications.

UNIT - III: UML-based Design: UML Based Object-Oriented Design: Class, Sequence, State, Architectural and Deployment Diagrams.

Design with Reuse: Introducing Design Patterns
User-Interface Design: Aesthetic and Technical Issues.
Concerns Real-Time System Design
Modularization
Software Architectural Design, Software Design Document

UNIT - IV: Verification: Requirement Verification: Completeness and Correctness of Software Requirements. Introducing Model Checking and Symbolic Execution, Software Test Planning
Software Testing: Static and Dynamic Testing Techniques, Levels of Testing.
Testing a Process: Introducing Tools to Automate Testing

UNIT - V: Project Management: Software Production Process, Overview of Software Process Models, Cost Estimation, Project Management, Risk Management, Quality Management:
CMM: Capability Maturity Model, Agile Method. Software Project Management Plan (SPMP)

UNIT - VI: Tools: Introducing Software Engineering Tools, Diagramming Tool, Analysis Tool, Code Generation Tool, Testing Tool, Management Tool, Process Support Tool, General Idea on Tool Development Technique

UNIT - VII: Evolution: Legacy Systems, Software Reverse Engineering, Re-engineering, Configuration Management

3. Reading Material

Text Books

1. Fundamentals of Software Engineering; Carlo Ghezzi, Mehdi Jazayeri, Dine Madrioli, Pearson Education Asia, Low Priced Edition.

Reference Books

1. Software Engineering, Ian Sommerville; Pearson Education Asia, Low Priced Edition.
2. The Unified Modeling Language User Guide, Grady Booch, James Rumbaugh, Ivar Jacobson; Pearson Education Asia, Low Priced Edition.
3. Fundamentals of Software Testing, Aditya P Mathur; Pearson.

Suggested Assignments

1. List the qualities software should have and explain the usefulness of each clearly.
2. Discuss on requirement Engineering Process
3. List the techniques for requirement elicitation.
4. Define Module, relations. And show use of relations uses, isComposedOf in giving modular architecture of a software system. (use TDN and graphic design notations)
5. Justify use of models: FSM and PetriNet With examples illustrate your view point.
6. Write the steps to be followed for writing algebraic formal specification.
7. Write the steps to be followed for writing logic-based formal specification.
8. Present a system architecture for a tool to automate Usecase based requirement engineering.
9. "Traceability is a quality maintainable by engineering principle." Justify the statement.
10. Derive test cases from a state diagram.

COMPUTER NETWORKS

1. Credits: 3-0-0

2. **Prerequisite:** C programming, Operating Systems.

3. Course Outline

UNIT - I: Physical Layer: Modulation Techniques: Amplitude, Frequency and Phase, ADSL, Multiplexing Techniques: Frequency division multiplexing, Time division multiplexing, wave length division multiplexing, Differential PCM, Switching Techniques: Circuit, message and packet switching.

UNIT - II: Data Link Layer: PPP, PPPoE, MAC Layer: Ethernet (incl. manchester encoding), Switched Ethernet, VLANs, Spanning Tree Protocol.

UNIT - III: Network Layer: Data Plane: Internet Protocol Addressing: CIDR, Internet Protocol Datagram (including fragmentation and reassembly, routing options), IP Forwarding Algorithm, ARP, ICMP (including ICMP Redirect, ICMP Path MTU discovery, ICMP Destination Unreachable options).

UNIT - IV: Transport Layer: UDP, TCP sliding window protocol, TCP connection establishment, TCP reliability including cumulative and delayed acknowledgements, Nagle algorithm, Karn's algorithm for RTT and RTO estimation, TCP AIMD Congestion Control Algorithm, TCP half-close connections including TCP keepalive timer and probe timer, TCP Fast Retransmit and Fast Recovery.

UNIT - V: Network Layer: Control Plane: Distance Vector Algorithm and Routing Information Protocols V1 and V2, Link State Algorithm and Open Shortest Path First Protocol (OSPF).

UNIT - VI: Application Layer: Domain Naming System (DNS) and Dynamic Host Configuration Protocol (DHCP), Network Management using SNMP.

4. Reading Material

Text Books

1. James F. Kurose and Keith W. Ross. Computer Networking: A top-down approach, 6th edition, Pearson Education..

Reference Books

1. Douglas Comer. Computer Networks And Internets Sixth Edition, 2014. ISBN 0133587932 / 9780133587937, Pearson Education.
2. Douglas Comer. Internetworking With TCP / IP Volume 1: Principles Protocols, and Architecture, 6th edition, 2013. ISBN-10: 0-13-608530-X ISBN-13: 9780136085300, Pearson Education.
3. Kevin R. Fall and W.Richard Stevens. TCP / IP Illustrated, Volume 1: The Protocols, 2 / E, 2012, ISBN-10: 0321336313 ISBN-13: 9780321336316, Pearson Education.
4. Radia Perlman. Interconnections: Bridges, Routers, Switches, and Internetworking Protocols, 2 / E, 2000, ISBN-10: 0201634481 ISBN-13: 9780201634488.Pearson Education.

Suggested Assignments

1. Implement the IP fragmentation and reassembly algorithm.
2. Implement the IP forwarding algorithm.
3. Implement the simplest sliding window protocol of TCP.
4. Connect two systems using a switch and configure private IP addresses to the systems and ping them from each other. Using Wireshark, capture packets and analyze all the header information in the packets captured.
5. Convert a system with two network interface cards (NICs) into a router by configuring each NIC in a different LAN and enabling forwarding. Use two switches to connect one NIC each of the router to these two switches. Connect two other systems, one each to each switch. Now, we have two VLANs. Ping from one system to the other through the router after configuring the required default routes in the hosts and static routes in the router.
6. Install Telnet Server on one of the systems connected by a switch and telnet to it from the other system. Using Wireshark, capture the packets and analyze the TCP 3-way Handshake for connection establishment and tear down.

7. Use Mininet to create multiple compute nodes, multiple VMs in each compute node, an OVS to connect VMs in a compute node and one OVS that connects the nodes. Configure IP addresses to these VMs in different VLANs, configure static routes in the VMs and ping them from one another.
8. Once the initial Mininet assignment is successful, try commands like traceroute to trace the route from one VM to another.

COMPUTER GRAPHICS

1. Credits: 3-0-1

Objective: This being the first course in computer graphics introduces the basics of the subject.

2. Course Outline

UNIT - I: Introduction: History, Advantages, Applications, Graphics I/O Devices, Raster Graphics, Graphics Packages and Libraries, Line and Circle Drawing Algorithms, Scan Conversion, Polygon Filling.

UNIT - II: GeometricTransformations and Clipping: 2D Transformations, Homogeneous Coordinate System, 3D Transformations, Plane Geometric. Projections, Viewing Transformations, Line and Polygon Clipping..

UNIT - III: Curves and Surfaces: Parametric Representation of Curves, Cubic Splines, Bezier Curves, B-Splines, Parametric Surfaces, Surfaces of Revolution, Sweep Surfaces, Quadric Surfaces, Fractal Curves and Surfaces.

UNIT - IV: Realism in 3D Graphics: Hidden Line and Hidden Surface Removal Algorithms, Illumination Models, Phong and Gouraud Shading.

3. Reading Material

Text Books

1. D. F. Rogers: Procedural Elements for Computer Graphics, Tata McGraw Hill
2. D. F. Rogers and J.A. Adams: Mathematical Elements for Computer Graphics, Tata McGraw Hill
3. J. D. Foley, A. VanDam, S.K. Feiner. and J.F. Hughes: Computer Graphics: Principle and Practice, Pearson Education.
4. Z. Xiang and R. Plastock: Computer Graphics, Tata McGraw Hilledition, Pearson Education.

Reference Books

1. E. Angel: OpenGL - A Primer, Pearson Education
2. D. Shreiner, G. Sellers,J. Kessenich, B. Licea-Kane: OpenGL Programming Guide, Pearson Education.
3. T. McReynolds and D. Blythe: Advanced Graphics Programming Using OpenGL, ElsevierNehe OpenGL Tutorials @ http: / / nehe.gamedev.net..

Suggested Assignments

Programming Assignments Based on Line and Circle Drawing, Polygon Filling Algorithms, 2D, 3D & Viewing Transformations, Fractal Curves, Hidden Line / Hidden Surface

COMPILER DESIGN

1. Credits: 3-0-1

Objective: To teach basics of compiler principles and design.

2. Course Outline

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

UNIT - II: Lexical Analysis: Interface with input program, parser and symbol table, token, lexeme and patterns, difficulties in lexical analysis, error reporting, implementation, regular definition, transition diagrams.

UNIT - III: Syntax Analysis: CFGs, ambiguity, error detection and recovery, top down parsing, recursive descent parsing,transformation on the grammars, predictive parsing, bottom up parsing, operator precedence parsing, LR parsers (SLR, LALR, LR).

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

UNIT - V: Type Checking: Type systems, type expressions, structural and name equivalence of types, type conversion, overloaded functions and operators, polymorphic functions.

UNIT - VI: Run time Environments: Source language issues, storage organization, activation tree, activation record, stack allocation of activation records, parameter passing mechanisms, symbol tables, dynamic storage allocationtechniques.

UNIT - VII: Intermediate Code Generation: Intermediate representations, translation of declarations, assignments, control flow, booleanexpressions and procedure calls. Implementation issues.

UNIT - VIII: Code Generation and Instruction Selection: Issues, basic blocks and flow graphs, register allocation, code generation, DAG representation of programs, code generation from DAGs, peep hole optimization.

UNIT - IX : Code Optimizations: Principal Sources of Optimization, Optimization of basic blocks, Introduction to Dataflow Analysis (Reaching Definitions and Live Variable Analysis).

3. Reading Material

Text Books

1. AV Aho, MS Lam, R Sethi, JD Ullman: Compiler Design: Principles, Techniques and Tools,Pearson Education

Reference Books

1. AW Appel, M Ginsburg: Modern Compiler Implementation in C, Cambridge University Press
2. K Cooper, L Torczon: Engineering a Compiler, Morgan Kaufmann
3. J.P. Tremblay, P.G. Sorenson: Theory and Practice of Compiler Writing, McGraw Hill

Suggested Assignments

Programming assignments based on lexical analysis, construction of predictive/operator precedence/SLR parsing table and parser, symbol table, dynamic storage allocation strategies, syntax directed translation, data flow analysis

SOFTWARE ENGINEERING LAB

1. Credits: 2

Objective: Develop an Application using tool.

The Lab includes a project component wherein the students have to put into practice the software engineering methods learned to develop a software solution to a given problem by performing all the SDLC activities viz. requirements analysis & design by using appropriate CASE tools, coding, testing, project management and configuration management along with doing the necessary technical documentation based on standard templates.

2. Course Outline

UNIT - I: SRS (deliverable: SRS document)
UNIT - II: High Level Design (deliverable: HLD document)
UNIT - III: Detailed Design (deliverable: DD document)
UNIT – IV: Unit test case and integrated test case design
(Deliverables: UTP and ITP documents)
UNIT - V Implementation (deliverable: working demo of the code)

3. Reading Material

Suggested Projects

- Online Event Management System
- Online Health care System
- Vehicle Tracking System
- E-Governance application

References

1. http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=278253
2. http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=5981339
3. http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=4578383
4. http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=5167255
5. http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=1488512
6. http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=741937

NETWORK PROGRAMMING

1. Credits: 3-0-0

Objective: Sockets provide the application layer level interface for two systems to communicate over Network. The primary objective of the course is to learn basics and advanced techniques of socket based client server programming. Berkeley Socket API based network programming using C language in Unix environment is taught in the course.

2. **Prerequisite:** Unix System Programming (Covered as part of OS Course), C Programming.

3. Course Outline

UNIT – I (Ten Hours): To review Unix System Programming and OS concepts relevant for Network Programming.

Topics:

- Process Control (fork, vfork, wait, exec system calls, user ids and related system calls),
- Reliable Signal Implementation (signal, sigaction, sigprocmask, sigsuspend, sigpending system calls, handling SIGCHLD)
- Pthreads

UNIT – II (Two Hours):
Overview of TCP / IP Protocol Suite and Internet Applications
Topics:

- Overview of TCP / IP Protocols
  - TCP (State Transitions)
  - UDP
  - IP
- Popular Internet Applications and their protocol usage

UNIT – III (Three Hours):
For introducing fundamentals of sockets and common functions used in any Client / Server application.
Topics:

- Socket
  - Introduction, role as an application programming interface
  - Address Structure and address management functions for IPv4, IPv6
- Common functions
  - Byte Ordering, byte manipulation functions
  - readn, writen, readline functions

UNIT – IV (Five Hours):
Basics of TCP Client / Server application development
Topics:

- Client / Server Paradigm
- Iterative TCP Server
  - Socket, Bind, Listen, Accept, read, write, close system calls
- TCP Client
  - Socket, Bind, Connect, read, write, close system calls
- Concurrent TCP Server
  - Using fork
  - Using pthreads
- Example of TCP Client / Server Application

UNIT - V (Three Hours) :
Basics of UDP Client / Server application development
Topics:

- UDP Server and UDP Client
  - recvfrom, sendto system calls
- connect system call in UDP Client and asynchronous errors

UNIT - VI (8 Hours) :
Miscellaneous topics for building more sophisticated client / server applications
Topics:

- Data representation issues
- I / O Multiplexing
  - select or poll system call
  - Design of TCP, UDP Servers using select or poll system call
- Socket Options
  - getsockopt, setsockopt system calls
  - Few examples of SOCKET, TCP, UDP, IP options and their role in client / server applications
  - Using fcntl
- DNS related functions

UNIT - VII (4 Hours):

Understanding the mechanisms for logging messages, making a server as a daemon server and developing server programs to be used by inetd super server.
Topics:

- syslogd server and syslog system call
- Daemon server using daemon_init function
- inetd super server

UNIT - VIII (4 Hours):
Debugging client server applications and understanding an implementation of application protocol
Topics:

- Tools for debugging TCP, UDP applications

o tcpdump, tcpflow, netstat, ethereal

- Detailed analysis of implementation of an application layer protocol's client and server programs (like HTTP Server, HTTP Client)

.
UNIT - IX :
Advanced Network Programming topics (optional)
Topics;

- Broadcasting
- Multicasting
- Routing Sockets
- Raw Sockets
- Data link access and design of packet filters.

4. Reading Material

Text Books

1. Richard Stevens: "Advanced Programming in Unix Environement", Pearson Education Asia. (For review topics)
2. Richard Stevens: "Unix Network Programming Volume I (Networking APIs: Sockets and XTI)", Pearson Education Asia.

Reference Books

1. Douglas E. Comer and David L. Stevens: "Internetworking with TCP/IP Volume III: Client-Server Programming and Applications, Linux/POSIX Sockets Version", Prentice Hall.

ESSENTIALS OF AI

1. Credits:3-0-0

Objective: To have an appreciation for and understanding of both the achievements of AI and the theory underlying those achievements. To have an appreciation for the engineering issues underlying the design of AI systems. To have a basic proficiency in a traditional AI language including an ability to write simple to intermediate programs and an ability to understand code written in that language. To have an understanding of the basic issues of knowledge representation and blind and heuristic search, as well as an understanding of other topics such as minimax, resolution, etc. that play an important role in AI programs.

Course Description: This course will introduce the basic principles in artificial intelligence research. It will cover simple representation schemes, problem solving paradigms, constraint propagation, and search strategies. Areas of application such as knowledge representation, natural language processing, expert systems, vision and robotics will be explored.

2. Course Outline

UNIT - I: Introduction: What is AI, Foundations of AI, History of AI.

UNIT - II: Intelligent Agents: Agents and Environments, Structure of Agents.

UNIT - III: Problem Solving by Searching: Problem Solving Agents, Searching for Solutions, Uninformed Search Strategies: Breadth-First Search, Depth-First Search, Depth-limited Search, Iterative Deepening Depth-first Search, Comparison of Uninformed Search Strategies.

UNIT - IV: Informed Search and Exploration: Informed (Heuristic) Search Strategies: Greedy Best-first Search, A* Search, Heuristic Functions, Local Search Algorithms and Optimization Problems.

UNIT - V : Constraint Satisfaction Problems: Backtracking Search for CSPs, Local Search for CSPs.

UNIT - VI : Adversarial Search: Games, Minimax Algorithm, Alpha-Beta Pruning

UNIT - VII : Reasoning and Knowledge Representation: Introduction to Reasoning and Knowledge Representation, PropositionalLogic, First-order Logic, Semantic Nets, Other Knowledge Representation Schemes.

UNIT - VIII : Automated Planning: Planning with state-space search, partial-order planning, planning graphs, planning with propositional logic

UNIT - IX : Reasoning with Uncertainty & Probabilistic Reasoning: Acting Under Uncertainty, Bayes' Rule, Representing Knowledge in an Uncertain Domain, Bayesian Networks.

UNIT - X : Making simple & complex decisions : Hidden Markov Models, Utility and decision theory, Markov Decision Processes (MDP), Partially Observable Markov Decision Processes (POMDP)

3. Reading Material

Text Books

1. Artificial Intelligence: A Modern Approach, 2nd edition, by Russell and Norvig, Prentice Hall

References

1. What is AI? (by John McCarthy)
2. History and Promise of AI (by David Waltz)
3. The Human Intelligence Enterprise. Why I am Optimist (by Patrick Winston)

IV. ELECTIVES

CS770 NETWORK PROGRAMMING

Prerequisite: Computer Networks, Operating Systems, Programming Methodology (or their equivalents)

Syllabus: Unix operating systems, processes, process control block, system calls for process control, inter-process communication, synchronization primitives, sockets, socket options, daemons, network applications, client-server architectures.

Books:

1. Unix Network Programming Vols. I and II, Richard W. Stevens
2. Advanced Unix Programming, Richard W. Stevens

CS771 LANGUAGE PROCESSORS

Prerequisites: Theory of Computation, Data and File Structures, Programming Methodology

Aim: To teach basics of compiler principles and design.

Course Content: Analysis–Synthesis model of a compiler, lexical analysis, syntactic analysis, DCFGs, LL & LR grammars & parsing techniques, syntax directed translation, code generation, code optimization, introduction to assemblers, linkers, loaders, macro processors, etc.

Course Format: Students to implement all major algorithms covered. Also, a compiler for a subset of a programming language should be developed by each student using tools such as LEX and YACC.

Books:

1. V. Aho, Ravi Sethi, and J. D. Ullman: Compilers: principles, techniques and tools, Addison-Wesley Publishers.
2. Holub: Compiler design in C.

CS773 DECISION SUPPORT SYSTEMS

Prerequisite: Nil

Aims and Objective: This course deals with mainly model building for decision situations in functional areas of management like, finance, marketing, production, planning and control etc. As such the emphasis is on model building and using a computer as a tool. The course emphasises substantial code writing on a pertinent application programme as well.

Course Content:Open systems and closed systems. Conversion of open system into a closed system. Problems involved in dealing with the quantitative parameters and qualitative parameters in such conversions from open system to closed system. Cost aspects involved in building a Decision Support System.
DIS versus MIS: The comparison and contrast of DSS with MIS. Emphasis of DSS as management of Models.
Application problems with DSS in functional areas of management as follows:

(i) Financial Management: Applications in investment theory. Applications in portfolio management.

(ii) Marketing : Applications in research areas of marketing like, significant forecasting models, eg., Box-Jenkins, ARIMA (Auto Regressive Integrated Moving Average) models.

(iii) Production Planning and Control : Applications in significant areas like, inventory management, assembly line balancing etc.,

(iv) Applications to macro-economic problems.

A class room project is envisaged as a vehicle through which the student will be working on a significant DSS application problem that calls for substantial amount of coding.

Course Format: Formal lectures aided by supplementary readings from original literature recommended by the course teacher.

CS774 GEOGRAPHICAL INFORMATION SYSTEM & SPATIAL DECISION SUPPORT SYSTEM

Prerequisite: As per instructor's permission

Aim: To learn aspects of geographical information storage and retrieval systems.

Course Content: GIS vs. IS, SDSS vs. DSS, Spatial Data Structure and Representation, Data input for GIS, Data Storage for GIS, Data analysis & algorithms for GIS, Terrain Analysis, Network Analysis, Overlay Analysis, Digital Mapping & Cartography, Remote Sensing, Spatial Reasoning, KBGIS, Object oriented GIS, SDSS

Reading Material

Literature from Journals

- Int. Jr. of GIS
- IEEE Jr. Remote Sensing

CS775 GRAPH THEORY

Syllabus: includes graph problems, analysis of time-complexities of graph problems.

CS776 NUMBER THEORY

Syllabus: integers, primes and composites, fundamental theorem of arithmetic, factorization, discrete logarithm problem, etc.

CS778 ENTERPRISE RESOURSE PLANNING

Pre-requisite: As suggested by the Course Co-ordinator

1. ERP Overview: Integrated management information systems, Supply chain management, Integrated data model, Benefits of ERP, Evolution of ERP and Modern enterprise, BPR (Business Process Reengineering) & ERP, Business modeling for ERP.
2. Customer Service:
3. Production Planning and execution
4. Purchasing and goods receipt
5. Financial and other metrics
6. ERP Packages
7. Case studies
   Insurance industry, Banking industry, Pharmaceutical industry, Health care, Consumer products, Retail industry, University, Transport Industry, Telecom industry, Public Sector Industry

CS779 E-COMMERCE

Prerequisites: Students are expected to know basic Network concepts - ISO/OSI and TCP/IP architectures. LAN -Ethernet, Token ring, ATM, FDDI. Understanding of bridges, Routers and Gateways.

Introduction to Electronic Commerce
The Network Infrastructure for Electronic Commerce
Economics of Electronic Commerce
Transactions and Accounting Costs
Pricing of Goods and Services on the Internet
Electronic Retailing
Web Based Business Models
Purchasing Agents
Online Shopping
Marketing and Advertising on the Net
Emerging marketing and advertising models
Network Security
Firewalls
Encryption and Transaction Security (Secret Key and Public Key Cryptography)
Digital Signatures, Certificates, Certificate Authorities
SET and SSL protocols
Electronic Payment Systems
Tokenized vs. Notational systems
Credit Card based systems
Electronic Checks
Electronic Cash and Micro transactions
Smart Cards
Protocols and Standards

The Social Impacts of Electronic Cash
Privacy, Anonymity, and traceable E-money
Legal Issues
Electronic Contracting and Digital Signatures
Intellectual Property
Copyright, Trademark, and Patents
Cybercrime and Money Laundering
Public Policy Issues: What is the Government's role?
Electronic Commerce and Financial Services
Banking, Securities and Brokerage
International Issues in Electronic Commerce
Commodification of Information
Property Rights vs. Freedom of Information
Electronic publishing and digital copyrights

References:

"Electronic Money: Toward a virtual wallet", Tekla S. Perry, IEEE Spectrum, February 1997
"E-Money (That's What I Want)" by Steven Levy, Wired (2.12, 12/94)
A Framework for Global Electronic Commerce, National Information Infrastructure Task Force, Draft for Public Comment, and a response by the Internet Society.
Selected Tax Policy Implications of Global Electronic Commerce, Department of the Treasury Office of Tax Policy, November 1996 and from another perspective, Vince Cate's view of a "Tax free Cyberspace"

Options for Promoting Privacy on the National Information Infrastructure, Draft for Public Comment, Information Policy Committee, National Information Infrastructure Task Force, April 1997

"Electronic Commerce and the Banking Industry: The Requirement and Opportunities for New Payment Systems Using the Internet", Andreas Crede, Science Policy Research Unit University of Sussex

The Copyright Grab, Pamela Samuelson, published in Wired in reaction to the Administration's White Paper on Intellectual Property and the NII. See further Debate on the White Paper.

Trusted Systems (technology based intellectual property management), Mark Stefik, Scientific American, March 1997

A Politics of Intellectual Property James Boyle

"Frontiers of Electronic Commerce" , Ravi Kalakota , Andrew B. Whinston.

CS782 CURRENT TRENDS IN DATABASES

Prerequisite: Database Management Systems

Aim: The course emphasis will be on Algorithms and Database theory.

Course Content: General Introduction: Historical Perspective, characteristics of data mining and data warehousing. Data Warehousing: its architecture, logical design, multidimensional data model, OLAP, Data mart. Data mining vs Database, data mining as a component of data warehouse, data mining applications. Data mining Techniques: Association rules, clustering, decision trees, neural networks, fuzzy sets and rough sets. Overview of Advanced topics: Text mining, spatial mining, web mining, sequence mining. Data preparation and visualisation.

Text Books: The topics will be covered from a collection of research papers and textbooks. The students are expected to read research articles and undertake some programming assignments.

CS783 CURRENT TRENDS IN PROGRAMMING

Prerequisites: Programming Methodology, Object-oriented programming

Aim: Advanced level course introducing the current trends in programming such as object oriented programming, etc.

Course Content: Object Oriented Design, Object modeling technique, Unified modeling technique, Object oriented programming, C++, JAVA, Usages of CASE tool in OOD. Theory of object-oriented programming, Quality in object oriented S/W. Introduction to software pattern and distributed object programming, Re-engineering, OOD to Real-time application, Fault-tolerance. Assertion based prog, Agent based prog.

Books:

1) Any C++ book
2) Naughton et al.: The complete reference Java.
3) Netscape & Java Script, Omder pub.
4) Java in nutshell
5) Rambough et al.: Object Oriented Design .
6) UML reference Manual

CS745 THEORY OF COMPUTATION

Prerequisite: Nil

Aim: Introductory course on theory of computation with advanced topics suitable for MTech students.

Course Content: Syllabus is similar to CA528 (Theory of Computation) with the following additional topics: Turing machine and computability, undecidability, Chomsky hierarchy, computational complexity theory.

Books: (in addition to books recommended for CS-515 Theory of Computation)
1. H. R. Lewis and C. H. Papadimitriou: Elements of Theory of Computation, PHI.
2. P. Ling: An introduction to formal languages and automata, 2nd edition, Narosa.

CS746 SOFTWARE TECHNOLOGY AND MANAGEMENT

Prerequisites: Software Engineering

Aim: This course is more applied in nature, emphasizing the technological and management aspects of software projects.

Course Content: Software Selection, Software Quality Assurance and Standards - ISO standards, IEEE standards, as also the CMM of CMU Software Tools and Software Re-engineering. Advances in SE such as OOA, OOD, OOSE, etc., Software Metrics.
Software Projects: Risk analysis and Risk Management in Software Projects. Productivity circle laws and cost-estimation models. Basics of software technology for the internet applications and web site development software products, development and marketing strategies.

Books:
1. Handbook of SE
2. Handbook on SQA
3. Research Papers on SE and Software Management

Course format: Formal lectures, reading assignments from current literature, a class project of some depth dealing with any of the topics.

CS747 FORMAL METHODS IN SOFTWARE ENGINEERING

Prerequisites: CA521 Programming Methodology, CA500 Mathematical Foundations of Computer Science or equivalents.

Aims: at introducing mathematical concepts in software design and development.

Course Content: Introduction: Formal Specifications, Structured Analysis & Design, Uses of formal specifications, scope and motivation of the study. Applicative Specifications: Basic concepts on types, modules, axioms, binding, products, functions, sets, lists, maps, subtypes, variants. Case, let expressions. Union, sort, overloading and user defined operators, under specifications and non-determinism. Imperative specifications: Assignment, sequencing, repetitive expressions, Functions, Quantification on states, Pre and post conditions. Concurrency: Basic concepts, channel, function with channel access, communication expressions, composing parallel expressions, hiding channels, internal and external choice, specifying distributed systems. Uses of formal specifications in system development Refinement of Schemes, Objects, Variables, Channels, and modules. Verification and validation. Structured Analysis & Formal Methods, Formal methods in object modelling techniques and structured analysis. Uses of formal specifications in Web computing, Business re-engineering and software testing. The above concepts are introduced through RSL specification language supported by United Nations University / International Institute of Software Technology, Macau.
Practical: Writing Formal Specifications in RSL. Writing of Hybrid specifications using both Structured Analysis Technique and RSL. Translating formal specifications to Java. Developing tools for different uses of formal specifications like translating to Prog. Language and Test Case generation.

Books:
1. The RAISE Specification Language, The RAISE Group.
2. The RAISE Development Method, The RAISE Group.
3. Z Specification Language.
4. UNITY: A Specification Language, Jaydev Mishra and K.M.Chandy

Journals:
1. IEEE Tr. Software Engineering.
2. ACM Transactions on Programming Language and Systems.
3. And similar journals and conference proceedings on software engineering.

CS749 EMBEDDED SYSTEMS

Prerequisite: Operating Systems or equivalent

1. A Review of Basics: What is Embedded System? Categories, Requirement, Challenges, Trends and Applications, Analog and Digital Circuits, Data Representation etc.
2. Computer Hardware: CPU, Memory, I/O Interfaces, Architecture Issues
3. Microprocessors and Interfacing
    a. CSIC, RISC architecture based, 80XXX processors, DSP Processors and systems
    b. System interfacing techniques
4. Real-time operating systems: Task Management, IPC facility, real-time clock server, interrupt services, kernel architecture, scheduling, synchronization, types of embedded OS
5. Embedded System Development Process
    a. Requirement Specification: Co-design
    b. Design of system architecture
    c. Choosing an OS
    d. Choosing the development environment
    e. Testing
6. High-level Language Support
    a. C and C Cross compilers uses
    b. Java 2
    c. Jini
7. Programming Embedded Controllers
    a. Characteristics of embedded routines
    b. Initialization of hardware
    c. Perform error recovery, exception processing
    d. Scheduling of tasks
    e. Sequencing
    f. Co-routines
    g. Pre-emptive
    h. Foreground / Background task etc
8. Application of Embedded Systems
    a. Consumer electronics
    b. Data Communication
    c. Networking and Telecommunication
    d. Biomedical Systems
9. Case Studies

BOOKS:
1. Real Time Systems, Pearson Education, Asia

2. Building Embedded Linux Systems, O'Relly
3. Micro C/OS-II: The Real Time Kernel, R&D Books, Jean J. Labrosse
4. Linux Device Drivers, O'Relly
5. Real Time Systems Design & Analysis, PHI
6. Designing Embedded Hardware, O'Relly
7. Programming Embedded Systems in C & C++, O'Relly
8. Programming for Embedded Systems, Wiley Dreamtech

CS750 SIMULATION AND MODELLING

Prerequisites: Computer based Numerical and Statistical Techniques or equivalent

Aim: To design, develop and analyse simulation systems

Course Content: Lectures: Introduction: Models, Behaviours, Uses of simulations and motivations. Analytical system simulation techniques: Monte-Carlo methods, Numerical computation techniques, Lag models, distribute lag model and cob-web model. Discrete system simulation: Different Queuing models and studies. Simulation languages: Simscript and GPSS. Simulation system building paradigms: time-oriented and event-oriented, message-oriented, knowledge–based. Simulation engine development. Analysis of simulation output: Estimation methods, simulation statistics, replication of runs, batch means, regenerative techniques, time series analysis, spectral analysis and autoregressive means. Simulation of business applications: equipment maintenance, warehouse management, facility utilisation, workflow management, project management.

Course Format: Assignments on computations, literature collection, study and seminar presentations.

References:
Books:
1. G. Gordon: System simulation, Prentice Hall
2. J. M. Caroll: Simulation using personal computers; 001.64044, C239.
3. B. S. Gottfried: Elements of stochastic process simulation, 001.424, G71E

Journals:
1. Simulation
2. Proceedings of Conferences on Simulation.

CS751 PARALLEL COMPUTING

Introduction to Parallel Computing: Why Parallel Computing & Scope of Parallel Computing, Sieve of Eratosthenes, Control and Data Approach, PRAM model of parallel computation, Relative strength of the models, Design paradigms of Parallel Computing, examples

Classification: Taxonomies: MPP, SMP, CC-NUMA, cluster: dedicated high performance (HP), high availability (HA), CoPs, PoPs, CoWs; distributed, on-demand, high-throughput, collaborative, data-intensive computing, Interconnection networks, Flynn's Taxonomy

An overview of Parallel Programming Paradigms: Programmability Issues, Programming Models: Message passing, client-server, peer-to-peer, broker computing, code shipping, proxy computing, mobile agents.

Storage and file problems: Network RAM, RAID and software RAID. Distributed File systems: NFS, AFS, OSF-DSF, RSF

Message passing standards: PVM (Parallel Virtual Machine), MPI (Message Passing Interface) Message Passing Interface (MPI) and its routines, Advanced Features of MPI: MPI advanced point-to-point communication MPI Communication modes; MPI Collective Communication and Computations; MPI Derived Datatypes;

Performance Metrics & Speed Up: Types of Performance requirements, Basic Performance metrics; Workload Speed Metrics; Performance of Parallel Computers-Parallelism and interaction overheads; Overhead Quantification and measurement methods; Performance of parallel programs; Performance metrics; Scalability and Speed-up Analysis

Overview of Programming with Shared Memory: OpenMP (History, Overview, Programming Model, OpenMP Constructs, Performance Issues and examples, Explicit Parallelism: Advanced Features of OpenMP),

Cluster Computing: Clustering of Computers, Beowulf Supercomputer, Use of MPI in Cluster Computing. Debugging, Evaluating and tuning of Cluster Programs, Partitioning and Divide and Conquer Strategies.

Applications: Cluster Based algorithms and applications for Sorting, Numerical Algorithms like Matrix Addition, Matrix Multiplication, Solving linear system, Image Processing Algorithms. Shared Memory Programming

References:

1. Quinn, M. J., Parallel Computing: Theory and Practice (McGraw-Hill Inc.)
2. Bary Wilkinson and Michael Allen: Parallel Programming Techniques using Networked of workstations and Parallel Computers, Prentice Hall, 1999.
3. R. Buyya (ed.) High Performance Cluster Computing: Programming and Applications, Prentice Hall, 1999.
4. Ernst L. Leiss, Parallel and Vector Computing A practical Introduction, McGraw-Hill Series on Computer Engineering, Newyork (1995).
5. William Gropp, Rusty Lusk, Tuning MPI Applications for Peak Performance, Pittsburgh (1996)
6. Ian T. Foster, Designing and Building Parallel Programs, Concepts and tools for Parallel Software Engineering, Addison-Wesley Publishing Company (1995).
7. Kai Hwang, Zhiwei Xu, Scalable Parallel Computing (Technology Architecture Programming) McGraw Hill Newyork (2004)
8. David E Culler,Jaswinder Pal Singh with Anoop Gupta, Parallel Computer Architecture, A Hardware / Software Approach, Morgan Kaufmann Publishers, Inc, (1999)
9. W.Gropp, E. Lusk, N.Doss, A. Skjellum, A high performance portable implementation of the message passing Interface (mpi) standard, Parallel Computing 22 (6), Sep 1996.
10. Akl, S.G., The Design and Analysis of Parallel Algorithms (PHP)
11. Gibbons, A., W. Rytter, Efficient Parallel Algorithms (Cambridge Uni. Press)
12. Kumar V., et al., Introduction to Parallel Computing, Design and Analysis of Parallel Algorithms, Benjamin / Cummings, 1994

CS752 GRID COMPUTING

Prerequisite: Knowledge of Introductory Algorithms, Networks, Java / C / C++, and Unix / Linux.

Objective: This course is proposed for M.Tech. (CS / AI / IT / CT) and MCA students. By the end of the semester, students should be able to develop the following skills:

(i) Should be able to write and deploy web services using Java or other technology.
(ii) Should be able to write and deploy grid services using Globus toolkit.
(iii) Given a practical application, identify the issues and apply suitable techniques studied in the course to it effectively.

More specific objectives will also be given later for each lecture.

Course Outline: Here is a preliminary and non-exhaustive list of topics we will be or might be covering. This is subject to change with advanced notice, partly based on the understanding of the students.

Introduction to High Performance Computing: Why Parallel Computing, Control and Data Approach, PRAM model of parallel computation, Classification: Taxonomies: An overview of Parallel Programming Paradigms: Programmability Issues, Programming Models: Message passing MPI (Message Passing Interface) Message Passing Interface (MPI) and its routines Overview of Programming with Shared Memory OpenMP

Client-Server Architecture: Definitions, Basic Mechanics of Client-Server, Issues, concurrency Protocol, Error Checking, Logging, Stateful vs Stateless services, Distributed Objects, Basics RMI Introduction, RMI Configuration, Remote Object Activation.

Web Services: Extensible Mark-up Language XML Introduction, some key aspects of XML–Document-centric XML Data-centric XML, XML-based Web Services, Simple Object Access Protocol (SOAP), Web Service Definition Language (WSDL), UDDI (Universal Description Discovery and Integration) The topics covered include: Web software architectures; languages and standards for data and applications on the World Wide Web; protocols for data exchange, program invocation, self-description, and discovery that form a basis for Web Services. Technologies include HTML, HTTP, XML, SOAP, and WSDL. The development platform will be Java Web Services platform. The use of these technologies for creating simple/advanced client-server and distributed applications will also be discussed.

Grid Services: Introduction to Grid Computing with Globus Toolkit, Overview of Grid Middleware Distributed Object Technology for Grid computing (OGSA, WSRF) Grid Middleware: JavaCoG, GSI etc. Developing Grid Services.

Applications: Deployment of web and Grid based services for Geo Applications using Geon Portal, design of framework for grid services, design of Grid Portals.

Web sites: (Not Exhaustive)
http://www.w3.org/TR/soap/
http://www.w3schools.com/xml/xml_whatis.asp
http://gdp.globus.org/gt4-tutorial/multiplehtml/v
http://www3.niu.edu/mpi/
http://www.pankaj-k.net/axis4tag/
http://www.ammai.com/webservices

Assignments: Students will be given assignments based on the course contents. They are expected to write and deploy web services, multi threaded web services on multiple machines in LAN or on Grid for some real applications like GEON.

CS758 INTELLIGENT AND COOPERATIVE INFORMATION SYSTEMS

Pre-requisites: Data Base Management systems or equivalent
Desirable: Problem Solving Techniques OR Expert Systems OR Foundations of AI, Computer Networks and Distributed Processing.

1. Review of DBMS Concepts, Distributed Data bases, File systems, Replication and Partitioning, Transaction Processing.
2. Intelligent Data base access and interaction, Query processing and Optimisation.

3. Distributed Intelligent systems, Distributed Problem Solving. Multi-Agent systems, Problem Decomposition, Co-ordination and Collaboration, Negotiation, Decision making and Inference.
4. Enhancement of DBMS to support Co-operative Problem Solving, Expert Data bases, Knowledge Base management.
5. Performance enhancement for real-time applications, Approaches to planning, inference etc, representing temporal information.
6. Case studies.

References:

1. Distributed systems (ed Sape Mullender), ACM Press, 1990
2. Distributed Artificial Intelligence (Vols 1 and 2), (ed Michalel Huhns) Morgan Kaufmann, 1987 and 1988.
3. Decentralised Artificial Intelligence (Vols 1 to 3), (ed Yves Demaxeau and J-P Muller), Springer Verlag, 1990-93.
4. Readings in Distributed Artificial Intelligence (ed Gasser and Bond), Morgan Kaufmann, 1988.

Articles from Journals

1. International Journal of Intelligent and Cooperative Information Systems
2. IEEE Transactions on Knowledge and Data Engineering
3. Journal of Parallel and Distributed Computing
4. Decision Support Systems
5. Journal of Software Engineering and Knowledge Engineering
6. IEEE Trans on SMC
7. Artificial Intelligence

AI745 NATURAL LANGUAGE PROCESSING

Prerequisites: Data Structures, Theory of Computation, Programming Methodology (programming skills).

Aim: To develop a good understanding of all aspects of Natural Language Processing (NLP) from both linguistic and statistical point of view and to provide solid grounding in selected topics.

Course Content: Introduction, origins and history. Current status and future challenges. Corpus processing, computational lexicography, morphology and syntax with an emphasis on English as well as Indian Languages. Selected topics in semantics and pragmatics. Applications to MT, NL interfaces, Information Retrieval (IR), etc.

Course Format: Lectures and Lab assignments.

Books:

1. James Allen: Natural Language Understanding, The Benjamin / Cummings Publishing Co, Inc.
2. Eugene Cherniak: Statistical Language Learning, MIT Press, 1993.
3. Michael P. Oakes: Statistics for Corpus Linguistics, Edinburgh University Press, 1998.

AI746 PATTERN RECOGNITION

One Semester Course (Approx. 30 lecture hours, 1.5 hours each)

Part - 1 STATISTICAL PATTERN RECOGNITION

Introduction, Gaussian model, discriminant functions, classifier performance, risk and errors;

Supervised learning using parametric and nonparametric approaches: ML estimation, Bayesian parameter estimation approach, Parzen Windows, k-nn estimation;
Unsupervised learning and clustering: the clustering concept, c-means algorithm, learning vector quantization, clustering strategies, a hierarchical clustering procedure.

Part - 2 SYNTACTIC PATTERN RECOGNITION

Introduction to formal languages;
String languages for pattern recognition: selection of pattern primitives, patterns grammars, PDL,. Transition network grammar for pattern description, Automated transition nets (ATNs);
Higher dimensional grammars: Web and graph grammars, tree grammars, grammar describing 3-D objects;
Syntax analysis as a recognition procedure: parsing, top-down parsing, bottom-up parsing, Cocke-Youngee Kasami (CKY) parsing algorithm, Earley's parsing algorithms, LL(k) and LR(k) grammars;
Stochastic languages for syntactic pattern recognition: basic formulation, probability measures associated with linear and context-free grammar, languages accepted by stochastic automata, stochastic programmed and indexed grammars.

Part - 3 STRUCTURAL PATTERN RECOGNITION

Imaging model: radiometric models, geometric models, sampling and quantization, tessellation, image models;
Graphs and grid: fundamentals of graph theory, basic algorithms for graphs, fundamentals of discrete geometry, connectivity and topology;
Segmentation: edge, region and texture;
Boundary representation: projection, Fourier descriptors;
Region representation: shape descriptors, mask and moments, thinning, MAT: Scene analysis methods.

Text Books: R.Schalkoff, Pattern Recognition: Statistical, Structural and Neural Approaches, John Wiley & Sons, NY, 1992.

Reference Books:

1. Duda R O and P E Hart, Patten classification and scene analysis, John Wiley & Sons, NY 1973
2. K.S.Fu, Syntactic pattern recognition and applications, Prentice Hall, NJ, 1982
3. T.Pavlidis, Structural pattern recognition, Springer-Verlag, NY, 1977
4. D.H.Ballad and C.M.Brown, Algorithms for computer vision, Prentice Hall, 1982

AI747 DOCUMENT ANALYSIS AND RECOGNITION

Prerequisite: This is an advanced level course where some knowledge of AI and or Neural Networks will be beneficial.

Aim: The aim is to provide an overview of methods in document processing technology.

Course Content:Introduction to documents and processing: Introduction; to documents and models of document processing, top-down, bottom up approaches, document understanding approaches, image extraction and foreground background separation, layout analysis, text and graphics separation, form document processing. Classification Principles: Patterns and feature vectors, Bayesian classification, clustering, neural classifiers, other classifiers, including string and edit distances. Optical Character Recognition:
Categories of text, printed and handwriting, printed fixed and variable font methods, numeral recognition, recognition of hand-written cursive scripts, holistic and analytic methods. Graphics Recognition Methods: Region segmentation, vectorization, feature extraction, graphics recognition and interpretation. Tools and Techniques: Statistical PR Lib, OCR Software, Image Processing Library Applications: Application to Kannada,

Devanagari Scripts, multi lingual form analysis, Forensic document examination: examining signatures, handwriting, obliterations erasures and overwriting etc.,

Course Format: Students will be required to make independent reading of reference material and actively participate in class discussions, presentations etc., Credit will be given for mini project implementations.

Books:

1. Duda and Hart: " Pattern Classification and Scene Analysis", J.Wiley and Sons.
2. Earl Gose et al: "Pattern Recognition and Image Analysis", Prentice Hall of India, New Delhi, 1998.
3. Chen, Pau and Wang (Eds): "Handbook of Pattern Recognition", World Scientific Press, Singapore 1993, Chapters 1.1, 1.2, 1.5, 3.6
4. Baird, Bunke and Yamamoto. (Eds): "Structured Document Image Analysis", Chapters on understanding of printed documents and graphics recognition. Springer Verlag 1992.
5. L. O'Gorman and R. Kasturi: "Document Image Analysis: An Executive Briefing", IEEE Computer Society Press 1998.
6. H. Bunke and P. S. P. Wang (Eds.): "Handbook of Character Recognition and Document Image Analysis" World Scientific Press, Singapore 1997.

AI748 LOGIC AND ENGINEERING

Prerequisite: As per instructor's approval.

Aim: In this course, a survey is done of various applications of logic in Computer science, and Artificial Intelligence.

Course Content: We study various applications from the main areas; databases, logic programming, program specification, and verification, and knowledge representation. We will be selecting the study material from the research monographs, and journals, and conference proceedings.

The following are the suggested journals, and books.

1. P. Smets, et al: Non-standard Logics for Automated Reasoning, Academic Press, 1988.
2. R. Demolombe, Imielinski, P.: Nonstandard queries, and Nonstandard answers, Oxford University Press, 1994.
3. S. Ceri, G. Gotlab, L. Tanca: Logic programming and databases, Springer Verlag, 1989.
4. Pascal van Hentenryck: Constraint satisfaction in Logic programming, MIT Press, 1987.
5. Z. Manna, A Pneuli: The Temporal logic of reactive, and concurred systems, Springer Verlag, 1991.

JournalsIEEE Trans. Software Engineering; Journal of AI

AI749 NEURAL NETWORKS

Introduction: History of Neurocomputing (The Beginning First Successes, The Quest Years Neurocomputing Takes off). The biological prototype, The neural node (MCP Neuron)

The Perception, linear separable function, Madaline

Learning Laws: Self Adaption Equations (Training), Coincidence Learning, Performance Learning, Competitive Learning, Filter Learning, Spatiotemporal Learning.

Associative Networks: Linear Associator Network, (feedforward) autoassociativity Recurrent Associate Networks (The Hopfield Nets, The Brain state in a Box Network, Associative Network Theorem) BAM's (hetro associativity)

Multilayer-Network: The Backpropagation Networks, Self-organizing Maps, Counter propagation Networks, GMDH (Group Method of Data Handling), Hamming Network.
Frontiers of Neurocomputing: Spatio temporal, Stochastic (Boltzmann) and Hierarchical Networks (Neocognitron) – Knowledge-Based Neural Networks.

Neurocomputers: Machines for Implementing Neural Network.

Neurocomputing Applications

Suggested Readings:

1. Artificial Neural Networks, B.Yegnanarayana, Publishers PHI, 1999
2. Artificial Neural Networks by Robert J Schalkoff, McGraw Hill, 1997
3. Introduction to Neural Computing, Igor Alek Sander & Helen Morton Chapman & Hall, 1990
4. Neural Computing: Theory & Practice, P.D.Wasserman, Van Nostrand Reinhold, NY, 1989 Explorations in Microstructure of Cognition
5. Parallel Distributed Processing: Vol. 1&2, D.E.Rumelhart and J.L.McCelland(Ed) MIT Press, 1986
6. Artificial Neural Networks: Theoretical Concepts, IEEE Computer Society Press, NJ, 1988, Vemuri, V.(Ed.)
7. The Computing Neuron, R.Durbin, C.Miall, G.Mitchison(Eds.) Addison-Wesley Publishing Company, Reading, MA, 1989
8. Neural Networks an Natural Intelligence, S.Grossberg (Ed.) MIT Press, 1988
9. Artificial Neural Systems: Special Issue, IEEE Computer, March 1988
10. Neurocomputing, J.Anderson & E.Rosenfeld (Eds.), MIT Press, 1988
11. Neurocomputing Robert Hecht-Nieisen, Addison-Wesley Pub. Co., 1990
12. Carpenter G.A.Grossberg S "Pattern Recognition by Self-organizing Neural Networks", 1991 Cambridge, MA MIT Press
13. Introduction to Artificial Neural System: Jacek M. Zurada A Jaico Book, 1994.

AI754 TEXT PROCESSING

Prerequisite: Data Structures, Theory of Computation, Programming Methodology (programming skills)

Aim: To develop a good understanding of all aspects of Text Processing and to provide solid grounding in selected topics.

Course Content:String Processing - Efficient techniques for string processing. String searching algorithms - Knuth-Morris-Pratt, Boyer-Moore and Rabin-Karp algorithms. Processing binary strings. Incremental search techniques. Pattern Matching - Regular Expressions, regular grammars, deterministic and non-deterministic finite state machines for pattern matching. Corpus Analysis - Corpus creation. Storage and indexing tgechniques. Morpheme, word and sentence level statistics. Zipf's law. Corpus indexing techniques. Word and sentence level n-grams. Analysis for Hidden Morkov models. Text tagging. Computational Techniques in Lexicography - From corpus to lexicon. Lexical knowledge bases - Electronic dictionaries and thesauri. Efficient storage and retrieval - B-Trees, TRIE, and Hashing. Dictionary analysis tools. Internal consistency and validation techniques. Dictionary updation and maintenance tools. Word Processing - Text layout - Justification, placement of figures, equations, etc. Paragraph and page formatting. Table of Contents, Index, and Bibliography creation. Footnotes and cross references. Spell Checking, Grammar Checking and Style Checking - Statistical and linguistic approaches to better writing tools. Isolated and context dependent spell and grammar checking tools. Introduction to Grammars and Parsers. Active Chart Parsing. Acceptance based, Relaxation based and Expectation based techniques. Multi-Script and Multi-lingual text processing - Scripts and Fonts - Multi-Script processing and GIST technology. Fonts and font libraries. Bilingual and Multi-

lingual dictionaries, thesauri and word processors. Cryptology - Techniques for text encryption and decryption. Text Compression for efficient storage and transmission of textual data.
Applications to Natural Language processing, Speech Recognition, Optical Character Recognition, Information Retrieval and Office Automation.

Books & References:

1. Gerald Salton, "Automatic Text Processing", Addison-Wesley, 1989.
2. Bran Boguraev, Ted Briscoe (Eds), Computational Lexicography for Natural Language Processing, Longman, 1989.
3. Robert Sedgewick, "Algorithms in C", Addison Wesley, 1990-
4. J.E. Hopcroft and J.D.Ullman, "Automata Theory, Languages and Computation", Narosa, 1992.
5. A V Aho, Ravi Sethi, J D Ullman, "Compilers: Principles, Techniques and Tools", Addison-Wesley, 1986.
6. S.N. Srihari, "Computer Text Recognition and Error Correction", IEEE Computer Soceity Press, 1984.

AI755 SPEECH PROCESSING-I

Signal Processing Background

1.Propaedeutic

Review of DSP Concepts and Notation, Review of Probability and Stochastic Processes, Topics in Statistical Recognition, Information and Entropy, Phasors and Steady-State Solutions.

Speech Production and Modeling

2.Fundamentals of Speech Science

Preamble, Speech Communication, Anatomy and Physiology of the Speech Production System Phonemics and Phonetics

3.Modeling Speech Production

Preamble, Acoustic Theory of Speech Production, Discrete-Time Modeling.

Analysis Techniques

4.Short-Term Processing of Speech

Introduction, Short-Term Measures from Long-Term Concepts, Example Short-Term Features and Applications

5.Linear Prediction Analysis

Preamble, Long-Term LP Analysis by System, How Good is the LP Model? Short-Term LP Analysis, Alternative Representation of the LP Coefficients, Applications of LP in Speech

6.Crystal Analysis

Introduction, “Real” Cepstrum, Complex Cepstrum, A Critical Analysis of the Cepstrum

References

Text Books:

1. Discrete Time Processing of Speech Signals, John R Deller, Jr., John G.Proakis and John H.L.Hansen, Macmillian Publishing Company, 1993.
2. Speech Communication: Human and Machine, Douglass O’Shaughnessy, Addison Wesley 1987.
3. Digital Processing of Speech Signals, L.R.Rabiner and R.W.Schafer, Englewood Cliffs, N.J., Prentice Hall, 1978.
4. Fundamentals of Speech Recognition, L.Rabiner and B.H.Juang, Englewood Cliffs, Prentice Hall,1993.

Journals:

1. IEEE Transactions of Speech Processing
2. Speech Communication

AI756 SPEECH PROCESSING-II

Coding, Enhancement and Quality Assessment

1.Speech Coding and Synthesis

Introduction, Optimum Scalar and Vector Quantization, Waveform Coding, Vocoders Measuring the Quality of Speech Compression Techniques.

2.Speech Enhancement

Introduction, Classification of Speech Enhancement Methods, Short-Term Spectral Amplitude Techniques, Speech Modeling and Wiener Filtering, Adaptive Noise Canceling, Systems based on Fundamental Frequency Tracking, Performance Evaluation.

3.Speech Quality Assessment

Introduction, Subjective Quality, Objective Quality Measures, Objective Versus Subjective Measures

Recognition

4.The Speech Recognition Problem

Introduction, The "Dimensions of Difficulty", Related Problems and Approaches

5.Dynamic Time Warping

Introduction, Dynamic Programming, Dynamic Time Warping Applied to IWR, DTW Applied to CSR, Training Issues in DTW Algorithms.

6.The Hidden Markov Model

Introduction, Theoretical Developments, Practical Issues, First View of Recognition Systems Based on HMMs.

7. Language Modeling

Introduction, Formal Tools for Linguistic Processing, HMMs, Finite State Automata, and Regular, A "Bottom-UP" Parsing Example, Principles of "Top-Down" Recognizers, Other Language Models, IWR As "CSR", Standard Databases for Speech-Recognition Research, A Survey of Language-Model-Based Systems.

8.The Artificial Neural Networks

Introduction, The Artificial Neuron, Network Principles and Paradigms, Applications of ANNs in Speech Recognition.

References

Text Books:

1. Discrete Time Processing of Speech Signals, John R Deller, Jr., John G.Proakis and John H.L.Hansen, Macmillian Publishing Company, 1993.
2. Speech Communication: Human and Machine, Douglass O'Shaughnessy, Addison Wesley 1987.
3. Digital Processing of Speech Signals, L.R.Rabiner and R.W.Schafer, Englewood Cliffs, N.J., Prentice Hall, 1978.
4. Fundamentals of Speech Recognition, L.Rabiner and B.H.Juang, Englewood Cliffs, Prentice Hall,1993.

Journals:

1. IEEE Transactions of Speech Processing
2. Speech Communication

AI757 IMAGE PROCESSING (IP)

Prerequisites: Data Structures (or FOCS), Mathematics at Engineering Level including Linear Systems Theory (Fourier Analysis).

Aim: Image processing is an advanced course offered as elective to students interested in learning the theory, techniques and applications of the subject. It also aims to stimulate interest in current research areas in image processing and in developing tools for use in research as well as in multimedia applications.

Course Content: Introduction to Image processing, Fundamentals of Imaging, Imaging systems, Projection Geometry, Image File Formats, Colour Maps and Tables, Spatial Operations including point Processes, Frequency Domain Operations, Mathematical Morphology, Basic Algorithms, Advanced Topics and Applications. Advanced Topics and Applications change each time the course is offered based on hot areas of research, projects available in the School, etc.

Course Format: There are two distinct parts - Class-room lectures during the first part, Student seminars, presentations and group discussions during the second part. The second part covers advanced topics and applications. In addition, there is a lab component where students implement 2-3 short projects on advanced topics and applications. Typical break-up is classroom lectures: 12, seminars and discussions: 12, lab classes: 3.

Books: Textbooks are used only during the first part (see course Format below)

1. Digital Image Processing by Gonzalez and Woods, Addison-Wesley.
2. Fundamentals of Digital Image Processing by A.K. Jain, Prentice Hall India.
3. Extracts from various journals and periodicals for seminars and group discussions.

AI758 COLOUR IMAGE PROCESSING

Prerequisite: Image Processing
(meet the instructors if you want to take the course but did not do image processing earlier)

Syllabus

1. Introduction to colour: the physical basis of colour, the human vision system, and the concepts of colour and intensity of light
2. Colour representation: tristimulus responses, colour models and colour spaces, CIE chromaticity diagram, Munsell's colour chart, and description by primary colours and combinations
3. Digital representation of colour: different colour representations such as RGB,CMY, CMYK, HSV, etc., their origins, strengths and weaknesses
4. Quantization and dithering: the need to reduce colour information, quantization and dithering algorithms, and their uses in reduced-colour images, photocopiers, colour faxes, etc.
5. Colour image enhancement and restoration: why mere extensions from grayscale processing such as histogram stretching and equalization are unsuitable, new operations such as colour polarization, saturation and hue corrections, colour noise removal, etc.
6. Spatial colour filters: extensions of smoothing, sharpening and edge-detecting filters, and new operations specific to colour images
7. Colour similarity: measuring colour similarities and differences (much more complex than measuring intensity differences), MacAdam ellipses, perceptual uniformity and perceptually uniform colour spaces, various colour distance measures
8. Interesting colour image processing examples: colour image processing filter that mimics a physical filter, transforming a colour image into a cartoon-type colouring scheme, newsprint/teletype filter, day-time to night-time filter, and others
9. Applications of colour image processing: colour similarity measures in Content Based Image Retrieval, forensic analysis of documents, watermarking and steganography, and others

Useful Websites:

1. Munsell Color Science Laboratory, Rochester Institute of Technology, http://www.cis.rit.edu/mcsl
2. Charles Poynton's Color Links, http://www.poynton.com
3. Color Science, http://members.cox.net/astro7/color.html

AI759 APPLIED ARTIFICIAL INTELLIGENCE

Prerequisites: Efficiency in Programming, Understandings on Data structures, Operating systems are required. Further, candidate must have courses on knowledge representation and reasoning.

Aim: To teach building of Knowledge Base Systems and their applications.

Course Content:
Lectures: Introduction to Knowledge based systems, AI Problem-solving concepts, Expert systems: Match-Select-Act cycle, uncertainty management, explanation Knowledge engineering: knowledge acquisition and compilation. Expert system development process, Real-time expert system design and development, 2nd generation expert systems. Networking of expert systems, Object oriented expert systems.
Practical: Laboratory: Two Mini Projects on Design and Development of a Knowledge–based system and an application of the developed systems. Seminar & Assignments: Talks on trends of knowledge-based system development technique and their uses in databases, software engineering, internet, and business reengineering.

Books:

1. DW Rolston: Principles of AI & Expert Systems, McGrawHill.
2. B. Buchanan, E. Shortliffe (eds): Rule-based expert systems, Addison-Wesley.
3. D. Lenat, R. Davis: Knowledge–based systems in Artificial Intelligence, McGraw Hill.
4. H. W. Winston: Artificial Intelligence, Addison Wesley.

Journals:IEEE Expert, Artificial Intelligence, IEEE Tr. on Knowledge & Data Engineering.

QUANTITATIVE TECHNIQUES IN FINANCE **(Credit: 3)**

Prerequisite: Mathematics and Statistics

Brief description:
The course on Quantitative Techniques in Finance (QTF) deals with fundamental concepts and models of quantitative measures required for scientific decision making with specific examples and case studies relevant to the Banking and Financial Sector. It covers topics of statistics, probability, numerical techniques and operations research models to develop necessary skills to understand, formulate, analyze and handle important real-life financial problems through examples, exercises and case studies. Analytical tools such as MS-EXCEL, MATLAB and R would be used for the analysis and solution of formulated problems.

Course Contents:
Module-A: Valuation Techniques:
Bond Characteristics and valuation, Cash flows, Simple and Compound Interest, Discounting, Present and Future value for single and multiple periods, EMI, Yield to Maturity, Duration, Modified Duration, Financial Markets, Yield Curve, balance sheet analysis, Profit and Loss Account Analysis, Financial Ratios, Statutory Liquidity Ratio, Cash Reserve Ratio, Prime Lending Rate, Base Rate, Repo Rate, Reverse Repo Rate, Forex Rate and analysis, Risks in Banks, Asset Liability Management, Interest Rate Risk and Liquidity Risk computation using Gap and Duration Gap Models.

Module-B: Forecasting Techniques
Statistical measures, Continuous and Discrete Probability distributions, Linear and Non-linear Interpolation, Regression, Time series, Least square and Maximum Likelihood estimation, Random Number Generation, Simulation and its applications, Variance and Co-variance Computation, Variance reduction, Volatility Models (ARCH, GARCH), Credit Risk Measures, Credit Rating, Value at Risk Computation, CAPM, Transfer pricing Models.

Module-C: Linear and Non-Linear Programming Techniques

LPP and NLPP Formulation and Solution, Application to various financial decision problems, Network optimization problems, Multi-Stage Financial Decisions, Dynamic Programming, Supply Chain Management and Currency Flows.

Module-D: Multiple Objective and Dynamic Optimization Techniques
Pareto Optimality, Multiple Objective Decision Making models, Scalarization methods, weighting method, Ranking Methods, Goal Programming Formulation, Analytical Hierarchy Process, Data Envelopment Analysis, Optimal Control Problem, Stochastic Programming Problems.

Module-E: Financial Applications:
Optimization Models of Asset Liability Management with Single and Multiple Objectives, Stochastic Programming Models of Asset Liability Management using Single and Multiple Objectives, Investment decisions in Stock Markets, Single and Multiple Objective Portfolio Optimization Problems, Financial derivatives, Binomial Tree, Black Scholes Model, Financial Games.

Text Books & Reference Books:

1. An Introduction to Computational Finance, Ugur, Omer, Imperial College Press, 2009.
2. Quantitative Finance, Epps. T.W., Wiley, 2009.
3. Methods for business analysis and forecasting: text and cases, Tryfos, Peter, John Wiley & Sons, 1998.
4. Financial Engineering and Computation, Yuh-Dauh Lyuu, Cambridge University Press, 2002.
5. Quantitative Analysis for Management, Barry Render, Ralph M., Stair Jr., Michael, Pearson Education Inc., Delhi, 2003.
6. Quantitative business methods using Excel, Whigham, David, Oxford University Press, 1998.
7. Operations research: An Introduction, Taha, Hamdy A., Prentice Hall of India, New Delhi, 2001.
8. Principles of operations research with application to managerial decisions, Wagner, Harvey M., Prentice-Hall of India, New Delhi, 1996.
9. Decision Making and Information System Analysis, Krishna Chandra, Sarup & Sons Publ., New Delhi, 2002.
10. Introduction to Management Science, Prentice Hall, Taylor, B. W. , 2002.
11. Mathematical modeling: case studies from industry, Cumberbatch, Ellis; Fitt, Alistair, Cambridge University Press, 2001.
12. Valuation of Financial Assets, A.S.Ramasastri, Response Books, New Delhi, 2000.
13. Operations Research, Kanti Swaroop, P.K.Gupta and Man Mohan, Wiley, 2000.
14. Quantitative models for supply chain management, Tayur, Sridhar; Ganeshan, Ram;, Magazine, Michael, Kluwer Academic Publishers, 1999.
15. Monte Carlo Methods in Finance, Jaeckel, Peter, John Wiley & Sons, 2002.
16. Monte Carlo Methods in Financial Engineering, Glasserman, Paul, Springer-Verlag, 2003.
17. Financial Engineering, John F.Marshall and Vipul K.Bansal, Prentice Hall of India, New Delhi, 1996.

Suggested Assignments:
(i) Analysis of Banks Annual reports including balance sheet and Structural Liquidity.
(ii) Solution of Problems using MS-Excel, R and Matlab Optimization tools.
(iii) Writing Programs of computation techniques in Java
(iv) Preparing case study of various financial applications.
(v) Simulating various financial scenarios.

***BUSINESS & DATA ANALYTICS* (Credits: 3)**

Pre-requisites: Knowledge of basic linear algebra, statistics, database management systems is desirable

Course Objectives and Scope:
The main objective of the course is to provide students a good overview of the ideas, the techniques, recent developments in Analytics in all its forms viz., descriptive, predictive and prescriptive analytics. In the last one

decade, analytics has emerged as a catch-all phrase subsuming and connoting various modeling techniques for data-driven analysis such as statistical techniques/models such as multiple linear regression, logistic regression, k-means clustering, machine learning models including k-nearest neighbor technique, neural networks, decision trees, case-based reasoning, support vector machine, association rule mining, optimization, OLAP etc. Visual analytics, with ample coverage of visualization techniques shall be discussed. Feature selection and dimension reduction techniques shall also be covered. The relationship between analytics and data mining shall be discussed. Also, it aims to formulate data-driven problems as data mining or predictive analytics problems. Numerous case studies from banking, insurance, finance, manufacturing, and bioinformatics shall be discussed. This approach gives the students an ample opportunity to learn the intricate concepts in the most appropriate way and lets them develop skills to solve real-life problems using data mining. Further, the ubiquitous presence of unstructured data in many fields shall be discussed with specific reference to text mining and web mining with applications in cyber fraud detection in banking etc. This completes the whole gamut of analytics at the PG level. Concepts of data warehousing and Online Analytical Processing (OLAP), in terms of data models, conceptual design methodologies, meta data and project implementation strategies shall also be discussed. Finally, Big data analytics shall also be introduced. A salient feature of the course is students shall be tasked to work on two mini-projects on real-life problems in order to enable them to learn first and how to conduct an analytics related project using open source tools.

Contents:

Module-A: Introduction to Analytics

Introduction to Analytics; its various forms viz., descriptive, predictive and prescriptive. Introduction to Data Warehousing and its concepts, Data Mining (DM), DM concepts, DM Process; CRISP-DM Methodology, Data Preparation/Preprocessing techniques – Feature Selection methodologies, dimension reduction techniques such as PCA and Transformations. Data Visualization Techniques, Data Balancing Techniques etc.

Module-B: Descriptive and Predictive Analytical techniques

Association Rule Mining and its Algorithms & Applications; Clustering, Hierarchical and Partition clustering – Techniques and applications; Forecasting- Simple Linear Regression, Multiple Linear Regression; Classification – Logistic Regression, Decision Trees, k-NN, Neural Networks, Case Based Reasoning etc.

Module-C: Practical Considerations in Analytics Projects

Determination of best analytical/data mining technique, MSE, NRMSE, MAPE, Confusion Matrix, ROC, AUC, Lift, Comprehensibility etc.

Module-D: Applications and Case Studies

Analytical CRM applications such as bankruptcy prediction, churn prediction, default prediction, customer segmentation, market basket analysis, credit scoring, Financial Fraud detection; Manufacturing in Hardware industry; Bioinformatics applications for cancer prediction etc.

Module- E: Advanced Analytics and Case Studies

Unstructured data mining, Text Analytics, Web Mining etc., Cyber Fraud Detection including Phishing/Spam/Malware detection; Overview of prescriptive analytics and application in time series data mining with a case study from banking operations. Introduction to Big Data and applications

Suggested Assignments: Two mini projects dealing with data mining applications to finance shall be assigned to students

References:

1. Data Mining: Practical machine learning tools and techniques by IH Witten, E Frank, Morgan Kaufmann, 2005.
2. Data warehouse lifecycle toolkit: expert methods for designing, developing, and deploying data warehouses - Kimball, Ralph; Reeves, Laura et al, John Wiley & Sons, 1998.

3. Data Mining for Business Intelligence: Concepts, Techniques, and Applications in Microsoft Office Excel with XLMiner, by Galit Shmueli and Nitin R. Patel, Peter Bruce, 2010, John Wiley.
4. Practical Text Mining and Statistical Analysis for Non-structured Text Data Applications by Gary Miner, John Elder, Andrew Fast, Thomas Hill, Robert Nisbet, Dursun Delen, Andrew Fast, Academic Press, 2012.
5. Data Mining Techniques – A. K. Pujari, University Press, 2001.
6. Data mining: concepts and techniques - Han, Jiawei; Kamber, Micheline, J. Pei, Morgan Kaufmann Publishers, 2011.
7. M. N. Murty and V. S. Devi, Pattern Recognition: An Algorithmic Approach, Springer, 2013.
8. L. Bellatreche, K. Karlapalem and M. Mohania, Some Issues in Design of Data Warehousing Systems, Chapter VI, In book Developing Quality Complex Database Systems: Practices, Techniques and Technologies – Shirley A. Becker, IDEA GROUP PUBLISHING, 2001.
9. C. Bishop, Pattern Recognition and Machine Learning, Springer, 2011
10. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Springer, 2003

***SOFT COMPUTING (*Credits: 3)**

Brief Description of the Course:
Soft Computing methodologies handle imprecision, uncertainty, complexity and partial truth of information arising in real life systems, which include fuzzy logic, rough set, neural networks, and evolutionary computation (EC) as core methodologies. Soft computing methods have proved to be very useful for machine intelligence, automation and technology based Applications demanding high Computational Intelligence. This course covers fundamentals of some important methodologies of Soft computing. It also focuses on their application to Engineering, Economics, Finance and Banking Management. The course deals with Matlab and its relevant toolboxes such as Optimization toolbox, fuzzy logic toolbox, neural network toolbox and control system toolbox along with relevant problems and case studies.

Course Contents:
Module A: Fuzzy Sets and Fuzzy Logic:
Introduction, fuzzy sets versus crisp sets, fuzzy relations, extension principles, fuzzy numbers, linguistic variable, hedges, fuzzy logic, fuzzy rule base design and analysis, fuzzy control system, fuzzy segmentation and clustering, fuzzy decision making.

Module B: Artificial Neural Networks:
Basic models, single and multi layer perceptions, back propagation algorithm for MLP, support vector machine, radial basis function neural networks, general regression neural networks, Probabilistic neural networks, Kohonen's self-organizing feature map, deep learning and deep neural network.

Module C: Evolutionary Techniques:
Basics of genetic algorithm (GA), schema theorem and convergence of GA, differential evolution, ant colony optimization, particle swarm optimization.

Module D: Rough Sets
Definition, upper and lower approximations, boundary region, definability, roughness, reduct and core, decision matrices and applications.

Module E: Hybrid Systems:
Neural network based fuzzy Systems, fuzzy logic based neural networks, genetic Algorithm for neural network design and learning, fuzzy logic and genetic algorithm for optimization.

Text and Reference Books:
1. T. J. Ross, "Fuzzy logic with engineering applications", 3rd Edition, John Wiley & Sons, (2010).

2. H.-J. Zimmermann, "Fuzzy set theory and its applications", 4th edition, Kluwer Academic Publishers, (2001).
3. G. Bojadziev and M. Bojadziev, "Fuzzy sets, fuzzy logic, applications", World Scientific, (1995).
4. G. J. Klir and B. Yuan, "Fuzzy sets and fuzzy logic: theory and applications" Prentice Hall, (1995).
5. S. Haykin, "Neural networks and learning machines" 3rd edition, Prentice Hall, (2008).
6. D. W. Patterson, "Artificial neural networks: theory and applications", Prentice Hall, (1998).
7. M. H. Hassoun, "Fundamentals of artificial neural network", MIT Press, (1995).
8. D. E. Goldberg, "Genetic algorithms in search and optimization, and machine learning", Addison-Wesley, (1989)
9. K. Deb, "Multi-objective optimization using evolutionary algorithms", Wiley India Pvt Ltd, (2010).
10. C.-T. Lin and C. S. G. Lee, "Neural fuzzy systems:a neuro-fuzzy synergism to intelligent systems", Prentice Hall, (1996).
11. Z. Pawlak, "Rough sets: theoretical aspects of reasoning about data", Kluwer Academic Publishers, (1991).

*BIOMETRICS (***Credits:4)**

Brief Description of the Course:
Biometrics has emerged as mainstream use for computer authentication, identification document security, and surveillance for public safety. This emergence has been accompanied by an expansion in biometric modality from mainly fingerprints to face, iris, hand, voice, and other novel biometrics. This course concentrates on the unique advantages that biometrics brings to computer security, but also addresses challenging issues such as security strength, recognition rates, and privacy, as well as alternatives of passwords and smart cards.

Course Contents:
Module-A: Biometrics - Physiological or Behavioral, Verification, Identification and Applications, Biometric Technologies, Working of Biometrics, Benefits, Application Design, Performance measures; Fingerprinting: Fingerprint Recognition, Fingerprint Scanning, Practical Applications of Fingerprint Scanning, Accuracy and Integrity, Fingerprint Matching, Fingerprint Classification, Fingerprint Image Enhancement, Fingerprint Feature Extraction, Fingerprint Form Factors, Types of Scanners: Optical - Silicon – Ultrasound, Multispectral Fingerprint Matching.

Module-B: Hand Biometrics: Palm print, Vein pattern, Knuckle, Finger Geometry & Handwriting Recognition: Introduction, Applications, Combining Biometric Methods, Strengths and Weaknesses.

Module-C: Iris & Face Recognition: Introduction, Benefits of Using Iris Technology, Iris-Scan: How it Works, Iris-Scan Applications, Iris-Scan Issues, Introduction to Facial Recognition, How Is Facial Recognition Technology Currently Being Used?, How Well Does Facial Recognition Work, Why Face Recognition, Facial Recognition: How it Works, Image Quality, Facial Scan Process Flow, Verification vs. Identification, Primary Facial Recognition Technologies, Facial Recognition Applications.

Module-D: Voice Recognition & Keystroke Dynamics: Introduction, Working, Strengths and Weaknesses, Voice Recognition Applications, Voice Verification in Telephone Banking, Understanding Voice Recognition, Choice of Features, Speaker Modelling, Pattern Matching, Keystroke Dynamics, Active & Passive Biometrics.

Module-E: Multi-Modal Biometrics: Multi-Modal Biometric Systems, Fusion Methodology, Levels of Fusion, Feature-Extraction Level Fusion, Data Matching Level Fusion, Probabilistic-Decision level Fusion, Fusion Procedure, Modes of Operation, Integration Strategies, Design Issues, Soft Biometrics, A Biometric Vision, Securing Biometric Template: Cancellable biometrics, Authentication, Security Analysis.

Text Books & References:
1. Raud M. Bolle, Jonathan H. Connell, Sharath Panakanti, Nalini K. Ratha, Andrew W. Senior, Guide to biometrics, Springer, 2003.

2. Anil K. Jain, Patrick Flynn, Arun A. Ross, Handbook of Biometrics, Springer, 2007.
3. Davide Maltoni, Dario Maio, Anil K. Jain, Salil Prabhakar, Handbook of fingerprint recognition, Springer, 2002.
4. David D. Zhang, Palmprint Authentication, Kluwer Academic Publishers, 2004.
5. Chuck Wilson, Vein pattern recognition- a privacy enhancing biometric, CRC press, 2010.
6. Stan Z. Li, Anil K. Jain, Handbook of face recognition, Springer, 2004.
7. Arun A. Ross, Karthik Nandakumar, Anil K. Jain, Handbook of Multibiometrics, Springer, 2006.
8. Bir Bhanu, Venu Govindaraju, Multibiometrics for human identification, Cambridge University Press, 2011.
9. Hai Zhou Li, Kar Ann Toh, Liyuan Li, Advanced topics in biometrics, World Scientific, 2011.
10. Stan Z. Li, Anil K. Jain, Encyclopaedia of Biometrics, Volume 1 & 2. Springer, 2009.

***INFORMATION ASSURANCE (*Credits: 3)**

Brief Description

IA is considered as a superset of Information security. IA is an Interdisciplinary field in addition to Information Security, it covers accounting, fraud examination, forensic science, management science, systems engineering, security engineering, and criminology, corporate governance issues. It also focuses privacy, regulatory and standards compliance, auditing, business continuity, and disaster recovery

Course Contents

Module A

- Introduction to Information Assurance, Information Assurance services, Information Security, Cyber Security, Cyber Defense.
- Security Engineering - Integrated IA Governance and Metrics
- Forensic science, management science, systems engineering, security engineering, and criminology

Module B

- Analysis of Security events - Prediction, prevention and assurance
- Security Technologies; Host Infrastructure, Application;
- Network Firewalls and Web Application Firewalls

Module C

- Vulnerabilities, hardening, countermeasures and Integrated risk management
- Holistic view of various security components, synergy of threats and counter measures
- IT Laws and Critical Infrastructure protection

Module D

- Case Study and Introduction to Intrusion Detection / Prevention Systems;
- Case Studies: Compliance in Financial Services;

Module E

Recent Trends & Developments in information assurance

Text books/References

1. Information Assurance, Blyth, Andrew, Kovacich, Gerald L., Springer-Verlag London, 2006.
2. Principles of Information Security; Michael E. Whitman &Herbert J. Mattord; Publisher: Thompson Course Technology, Boston, MA;
3. Information Security: Contemporary Cases; Marie Wright and John Kakalik. Jones and Bartlett, 2007;

4. Wall Street Journal, (Required) Dow Jones, Inc. (In particular look out for the special issues on Telecommunications, Electronic Commerce etc that deal with IT)
5. Managing Information Assurance in Financial Services (eds H. R. Rao, M. Gupta, S. Upadhyaya, Idea Group, 2007)

***FINANCIAL MANAGEMENT (*Credits: 3)**

Objectives

- Familiarize the students with the financial environment of business, with special focus on financial markets
- Imparting knowledge about the decisions and decision variables in building the liability and asset sides of the balance sheet of an entity
- Developing the analytical skills by familiarizing with tools and techniques of financial analysis
- Introduce the student to fundamentals of Economics and Banking so far as they are required to understand and evaluate financial function.

On successful completion of this paper candidates should be able to:

- Discuss the role and purpose of the financial management function
- Assess and discuss the impact of the economic environment on financial management
- Carry out effective investment appraisal
- Identify and evaluate alternative sources of business finance
- Explain and calculate the cost of capital and the factors which affect it
- Explain and apply risk management techniques in business

Syllabus

Module A: **The Economic Environment of business**: Introduction to Microeconomics, -Supply and demand concepts and analysis of Markets. - Consumer behaviour. Market Power and pricing strategies. -Introduction to Macro-economics. - Growth, unemployment, inflation and role of money. -Business cycles- role of Government policy – Economic Planning, Reforms, - Indian agriculture, industry, infrastructure, tax structure and public finance.

Module B: Indian Banking System: Introduction and banking regulation. - Indian Banking structure. -Role and functions of banks, Functions and products and services - Regulatory provisions/enactments governing functioning of banks, - Regulation and Supervision of Banking and financial sector – Role, functions and working of Reserve Bank of India.- Economic and Monetary policy and its effect of economy. -Role of SEBI, IRDA, IDRBT, and other institutions. -Retail, wholesale, international banking. – Insurance companies- Bancassurance –ADRs, GDRs, PCs etc. -Banking Services –Payment and Collection systems – Financing Priority sectors – ancillary services and modern banking – Problem of NPAs -Marketing, Distribution channel management, Ancillary business (selling of MF, Insurance and other financial products.)

Module C: Financial Management:Introduction and overview of Financial management. -Financial environment of Business -Structure and components of (Indian) Financial System - Legal, regulatory and tax environment for financial management - Financial Markets: Capital Market, money market, Foreign Exchange Market

Module D: Financial Analysis and Planning: Financial Statements and analyses - Working Capital management -Capital Budgeting. -Long-term Financing. - Capital Structure and dividend policies

Module E: Financial management special areas: Corporate restructuring - Non-conventional source of finance - Inflation and financial management -Financial Management of Sick Units - Leasing, Hire purchase, Factoring and Forfaiting - International financial management

Text Books/ Reference Books:

1. Financial Management- Theory and Practice, Prasanna Chandra, Tata McGraw Hill. 2011.
2. An Introduction to Financial Management, Pandey, I M. Vikas Publishing House, New Delhi. 2010.
3. Principles and Practices Of Banking (English) 2nd Edition, Indian Institute Of Banking & Finance (IIBF) Macmillan India Limited. 2012
4. N. Gottfries; "Macroeconomics"; (2013); Macmillan.
5. O. Blanchard; "Macroeconomics"; 6th edition (2012), Pearson
6. .N.G. Mankiw; "Macroeconomics"; 8th edition (2013); WorthPublishers.
7. Goolsbee, S. Levitt and C. Syverson; "Microeconomics"; International Edition; (2013); Macmillan.
8. N.G. Mankiw and M.P. Taylor; "Microeconomics"; 2nd Edition (2011); Cengage.
9. Indian Economy. Ramesh Singh. McGraw Hill Education, 2012.

Suggested assignments

1. Analysis of financial statements of a company: Calculation of liquidity, leverage, profitability, turnover and valuation ratios.
2. Preparation of Cash flow and Funds flow statements from the company's financial statements.
3. Working out the working capital requirements of a company and preparation of financing plans.
4. Preparation of a paper on the impact of the current budget on various businesses (impact analysis) – small, medium and large industries – various types of industries (iron, coal, gas, energy, minerals, fertilizers, etc.) - on agriculture and allied industries. (Each student may be assigned one area).
5. (if possible) Assessment of a Capital project.
6. Status papers on Indian banking industry – (may be with different foci – like technology, communications, new marketing environment and competition.
7. Assessment of potential and prospects of starting a new bank. (sector specific bank? Like women's bank – postal bank rural bank?)

ORGANIZATIONAL BEHAVIOR & ENTREPRENEURSHIP **(Credits: 3)**

This course objective is

- To develop an understanding of the behavior of individuals and groups inside organizations and further enhance skills in understanding and appreciating individuals, interpersonal, and group process for increased effectiveness both within and outside of organizations.
- To develop an understanding of the nature, functioning and design of Organisation as social collectivities.
- To examine the reciprocal relationship between the organisational characteristics (for example: structure, strategies, systems etc.) and managerial behaviour.
- To develop theoretical and practical insights and problem-solving capabilities for effectively managing the organisational processes.
- To develop an understanding of the nature, functioning and design of Organisation as social collectivities.
- To examine the reciprocal relationship between the organisational characteristics (for example: structure, strategies, systems etc.) and managerial behaviour.
- To develop theoretical and practical insights and problem-solving capabilities for effectively managing the organisational processes

On successful completion of this course, candidates should have a basic understanding and appreciation of the topics outlined in the course content as well as has knowledge of things required to start up and manage a new venture or an existing one respectively.

Syllabus:

Module A: Organisational Behaviour

OB-an overview; Organisational Culture and Climate, Authority and Responsibility, Perception and Decision making., Communication, Group Dynamics and behaviour, Interpersonal Behaviour (TA), Power and Politics, Conflict management , Motivation, Stress management, Emotions and emotional intelligence, Leadership

Module B: Organisational Design and Development
Understanding organisations , Organisational structures , Organisation design Strategy and structure, Work Organisation.

Module C: Organisational Analysis, Development and Change:
Organisational Diagnosis, Organisation Development, Alternative Interventions, Transactional analysis, MBO, grid OD, Factors influencing choice of OD intervention, Organisational Change, Institution Building.

Module D : Entrepreneurship
Entrepreneurial attributes and characteristics, The business plan (Business opportunity identification, Source of assistance, Market assessment), Motivation, Leadership and Management in an entrepreneurial business, Planning, QC, Marketing, finance and production management, Developing Human Capital, Emotional intelligence in the workplace, Case studies.

Module E : Entrepreneurship Ecosystem
Entrepreneurial challenges, Entrepreneurship and Self-employment, Inclusive Entrepreneurship, Business ethics, TQM, Strategic Planning, Franchising, VC financing, Exports.

Text Books / Reference Books:

1. Principles of Management: Herald Koontz, Heinz weibrich and A. RamachandraAryasri, Tata McGraw-Hill 2004.
2. Principles and Practice of Management by L M Prasad – Sultan Chand & Sons 2010
3. Organizational Behavior by Stephen P. Robbins, Timothy A. Judge, Prentice Hall, 2014.
4. Organizational Behaviour by V G Kondalkar, New Age International Publishers, 2007
5. Organizational Behaviour by Veerabhadrappa Havinal, New Age International Publishers, 2009
6. Dynamics of Entrepreneurial Development and Management: Vasant Desai, Himalaya Publishing House.
7. Entrepreneurial Development: S.S. Kanka, S. Chand & Company 2012.
8. Entrepreneurship Development and Management: R.K. Singhal, S.K. Khataria &Sons.2012
9. Entrepreneurship Development: S. Anil Kumar, S.C. Poornima, Mini K. Abrahm,K. Jayashree, New Age International (P) Limited. 2003.
10. Hand book of Entrepreneurship Development, GR Basotia, KK Sharma, Mangal deep publications, 1999
11. Small Scale Industries and Entrepreneurship: Vasant Desai, Himalaya Publishing House. 2002
12. The One Page Business Plan for the Creative Entrepreneur. Jim Horan. PAP/COM edition. 2004

Suggested assignments:

1. Case studies of organisational changes in Indian Corporate world.
2. Case studies of successful small business entrepreneurs in Indian context.
3. Preparation of a project for starting an enterprise by a technocrat.
4. Assignment on preparation of a paper on Governmental schemes/ support for new entrepreneurs

INTRODUCTION TO DATA COMPRESSION

Prerequisite: Nil
Aim: To introduce various compression techniques

Course Content:Introduction to Lossless Compression and Lossy Compression, Mathematical Preliminaries for Lossless Compression, Test for Unique Decodability, Uniquely Decodable Codes, Prefix Codes, Kraft MacMillan Inequality, Huffman Coding, Optimality of Huffman Codes, Average Length of Huffman Codes, Extended Huffman Codes, Nonbinary Huffman Codes, Adaptive Huffman Coding, Golomb Codes, Rice Codes, Tunstall Codes

Motivation for Arithmetic Coding, Coding a Sequence, Generating a Tag, Deciphering the Tag, Generating a Binary Code, Uniqueness and Efficiency of the Arithmetic Code, Algorithm Implementation Issues, Issues related to Integer Implementation, Comparison of Huffman and Arithmetic coding.

Dictionary Techniques: Static Dictionary Techniques, Adaptive Dictionary Techniques, Universal Compression, LZ, LZW, etc. algorithms

Mathematical preliminaries for Lossy Compression, Conditional Entropy, Average Mutual Information, Differential Entropy, Rate Distortion Theory, Compression Scheme in terms of Conditional Probabilities, Rate distortion function for various sources

Scalar Quantization: Quantization Problem, Uniform Quantizer, Adaptive Quantization, Jayant Quantizer, Nonuniform Quantization, pdf Optimized Quantization, Companded Quantization, Entropy Coded Quantization

Books:

1. Khalid Sayood, Introduction to Data Compression, 2nd Edition, Morgan Kaufmann Publishers
2. David Salomon, Data Compression : The Complete Reference, 2nd Edition, Springer.
3. Mark Nelson and Jean Loup Gailly, The Data Compression Book, 2nd Edition, BPB Publications

MOBILE TRANSACTIONS

Prerequisite: Distributed computing

Aim: This course introduces the concepts, practices and methodologies required for mobile database systems

Course Content:

*Introduction***:** Mobile database system, Fully connected information space, Mobile connectivity, PCS & GSM, Location & Handoff Management, MDS architecture, objective, applications, limitations, data categorization, data management, query processing, Data caching, Database Hoarding techniques, transaction management, recovery.
M-Commerce: Models for Mobile Transaction, Kangaroo and Joey Transactions, Team Transactions, Recovery Model for Mobile Transactions, Electronic Payments and protocols for Mobile commerce, concurrency control mechanisms for mobile transactions

Data Synchronization: Synchronization in Mobile Computing system, synchronization software for Mobile devices, Synchronization protocols,
SyncML-Synchronization Language for Mobile Computing, Synch4J,

Suggested Reading:

1. Vijay Kumar, "Mobile Database Systems", Wiley-Interscience
2. Raj Kamal, "Mobile Computing", Oxford, 2009
3. "A survey of Mobile Transactions" appeared in Distributed & Parallel databases, 16, 193-230, 2004, Kluwer Academic Publishers

ROUGH COMPUTING

Objectives: The theory of rough sets has been under continuous development for over 15 years now, and a fast growing group of researchers and practitioners are interested in this methodology. The theory was originated by Zdzislaw Pawlak in 1980's as a result of a long term program of fundamental research on logical properties of information systems, carried out by him and a group of logicians from Polish Academy of Sciences and the University of Warsaw, Poland.

The methodology is concerned with the classificatory analysis of imprecise, uncertain or incomplete information or knowledge expressed in terms of data acquired from experience. The primary applications of rough sets in AI are for the purpose of knowledge analysis and discovery in data. Moreover, a considerable number of applications of rough sets in medicine, economics, drug research, process control, finance, business, environment, electrical and computer engineering, software engineering, and information science have been introduced in recent years. In addition, many rough set case studies and more than a dozen commercial, as well as, research rough set tools are currently available.

Data centric hybrid systems are needed today to meet the system requirements. As a preparatory step, this course is proposed to introduce the concept of Rough set theory and give a flavor of rough methods to budding Computer Scientists & IT developers.

Pre requisites: **(i) Discrete Mathematics (ii) Knowledge in any Programming Language**

Syllabus:

- Fundamentals of Rough sets:
    1. Rough set principles, Information system, Decision system
- Boolean Reasoning
    1. Rough Truth, Consequence, Consistency and Belief Revision
- Feature selection
    1. Reduct and Core Computation Information Systems
    2. Based on Relative Dependency between Attributes
    3. A Scalable Rough Set Knowledge Reduction Algorithm
- Formal Concept Analysis
    1. Formal Concept Analysis and Rough Set Theory
    2. Tolerance Rough Set Model
- Uncertainty Management
    1. Measuring Uncertainty, Rough Entropy Calculation, Techniques for Uncertainty Management in Databases
- Flow Graphs
    1. Representation, Certainty and coverage factors, Dependencies in flow Graphs
- Rule Discovery
    1. Decision Tree formation & Rule generation
- Hybrid Systems
    1. Rough Fuzzy Integrals for Information Fusion and Classification.
    2. Rough Bayesian Model for Distributed Decision Systems
    3. Employing Rough Sets and Artificial Neural Networks

Text Books:

1. Aboul Ella Hassanien, Zbigniew Suraj, Dominik Slezak & Pawan Lingras (2008) "Rough Commuting. Theories, Technologies and Applications" Information Science Reference, Hershey, New York
2. Zdzislaw Pawlak (1992) "Rough Sets: Theoretical Aspects of Reasoning about Data", Kluwer Academic Publishers.

References:

3. Shusaku Tsumoto, Jan Komorowski Jerzy W. Grzymala-Busse (Eds.) "Rough Sets and Current Trends in Computing" 4th International Conference, RSCTC 2004 Uppsala, Sweden, June 1-5, 2004 Proceedings. Lecture Notes in Artificial Intelligence 3066 Edited by J. G. Carbonell and J. Siekmann Subseries of Lecture Notes in Computer Science. Springer
4. Rafael Bello, Rafael Falcón, Witold Pedrycz, Janusz Kacprzyk (Eds.) Granular Computing: At the Junction of Rough Sets and Fuzzy Sets. Studies in Fuzziness and Soft Computing, Volume 224, Springer
5. Sankar Kumar Pal, Lech Polkowski and Andrzej Skowron (Eds) (2004) "Rough-Neural Computing – Techniques for Computing with Words" Springer.
6. Some articles from web, journals

ADVANCED COMPUTER NETWORKS

This course is an advanced, second-level, networks course. This course will require a large amount of participation from the students. This course is recommended ***only for those interested in computer networks*** and who wish to pursue it further.

NOTE: While the topics currently covered are listed in this syllabus, it is likely that with time, the syllabus will be changed and a new syllabus submitted for approval.

Pre-requisites: A ***very good understanding of TCP/IP stack*** and other general networking concepts. Good understanding of Operating Systems is desirable.

The course will consist of four broad areas that are some of the current trends in networking. The fifth part will be the latest papers from journals and conferences on the topics covered in the first four parts.

I. **IPv6**: The next generation internet – this is the trend of the future and many other aspects of later sections will assume understanding of IPv6. The basic IPv6 protocol with its new auto-configuration schemes will be studied. The transition technologies for moving from IPv4 to IPv6 will also be studied.

II. **Mobile IP and Mobile IPv6:** In this we study Mobile IPv4 (MIPv4) and Mobile IPv6(MIPv6). We study the basic mobile IPv4 protocol and also the triangular and optimized routing. Then, we study the way mobile IPv6 protocol and how it is different from mobile IPv4. We also study the basic handoff mechanisms that are proposed to ensure low latency.

III. **Traffic Engineering (TE)/Quality of Service(QOS) in IP**: Considering the latest trend towards VoIP, quality of service is of utmost importance in the Internet. We will study the basic concepts of QoS and the various proposals to achieve QoS in the Internet that have been standardized by the IETF such as diffserv and intserv. We will also study MPLS and how it is useful in QoS. We will also study the basic concepts of traffic engineering and how this can be achieved with MPLS.

IV. **Software Defined Networking (SDN):** In this section, motivation for introducing SDN is studied followed by understanding data plane abstraction, control plane abstraction and network virtualization concepts. This is entirely based on research papers as of now.

V. **STUDENT SEMINARS:** In this part, students will be required to do literature survey and study papers in the one of the above areas and give an in-depth seminar on the chosen topic.

TEXTBOOKS:

1. RFCs for IPv6 and Microsoft documents on IPv6.
2. *Mobile IP, Design Principles and Practices* by Charles Perkins
3. *Mobile IPv6* by Hesham Soliman
4. *MPLS and Label Switching Networks* by Uyless Black
5. *MPLS* by Bruce Davie and Yakov Rekhter
6. *QoS control in High Speed Networks* by H.Jonathan Chao, Xiaolei Guo
7. SDN Papers:

- Ethane: Taking Control of the Enterprise
- OpenFlow: Enabling Innovation in Campus Networks
- Extending Networking into the Virtualization Layer
- Virtual Switching in an Era of Advanced Edges
- NOX: Towards an Operating System for Networks
- Flowvisor: A Network Virtualization Layer
- Software-Defined Networking: The New Norm for Networks
- Scalable Network Virtualization in Software-Defined Networks(FlowN)
- Slides of Nick Mckeown's talk at COMSNETS-2014
- Scott Shenker's slides of the ONS-2011 talk

CURRENT TRENDS IN ERP (Credits: 04)

Pre-requisites

Data & File Structures, Database Management Systems, Basic Internet / Cloud Awareness

Aim: The objective of the Elective Course – *Current Trends in ERP*, is to ensure students are introduced to the latest developments in in the Enterprise Resource Planning areas to a new subject area and teach on fundamentals to set up / organization / structure / functioning of various industries in the ERP domain, are adequately prepared to take the challenges and are able to perform well in their newly acquired knowledge.

Course Content

1. Introduction to various types of organization / industry setup from Discrete / Process based industries. Talks about Industry verticals like Aerospace and Defense, High Tech and Electronics, Hospitality, Industry Machinery and Equipment, Public Sector, Food and Beverages, Fashion etc., other types along with other Micro-Vertical - Type and Structure
2. Discussion on other domains like Human Capital Management, Supply Chain Management, Customer Relationship Management, Product Lifecycle Management, etc. along with Planning models - Verticals and Horizontals and base platforms for each of them
3. History and evolution MRP / MRP-II / ERP and other key terminology and concepts that are basic to understanding the working of Industry including the necessary financial topics and other components
4. Deployment of ERP in various industries on Client / Server, Web-Based, Hosted and Cloud Architecture
5. General ERP process overview right from Materials Management, Production Planning, Purchase and Sales, Inventory Management, Services and Projects and Finance management

6. Focus on in-depth understanding on Manufacturing / Logistics and Finance that are backbone to any industry. *Full details are available in the document submitted to UoH*
7. Case Study of Infor LN Framework / Tools and Technology, Architecture and Database Setup in various deployment including latest trends in Cloud Development and Deployment methodology and key considerations

Course Format

The course will be taught through –

(i) Class-room lectures

(ii) Student seminars, presentations and group discussions during the second part

(iii) Assignments / Lab – where students implement 2-3 short projects using provided software

Typical break-up is Classroom lectures: 42 hours; Seminars / discussion: 8 hours

Suggested Reading

1. INTRODUCTION TO MATERIALS MANAGEMENT 6/E (English) 6th Edition **Authors**: Tony Arnold / Stephen Chapman **Publishers**: Pearson India
2. Manufacturing Planning and Control for Supply Chain Management (APICS / CPIM Certification Edition) **Authors**: Thomas E. Vollmann, CFPIM, William L. Berry, D. Clay Whybark, and F. Robert Jacobs **Publishers**: McGraw Hill Education
3. Accounting Handbook 6th Edition **Authors**: Shim Siegal **Publishers**: Barrons Educational Series
4. Operations Strategy 4th Edition **Authors**: Nigel Slack and Mike Lewis **Publishers**: Pearson.
5. CONCEPTS IN ENTERPRISE RESOURCE PLANNING **Authors**: Ellen F. Monk, Bret J. Wagner