

Syllabus Workshop on 04-09-2014
(Amended with CBCS course in April 2017)
University of Kalyani
Department of Computer Science & Engineering
Curriculum for M. Tech.(CSE) W. e. f. 2015-16

Semester I

Paper Code	Paper Name	Weekly Contact Period (WCP)				Cre-dit	Marks		
		Lecture	T [#]	P [#]	Total		S [#]	Exam.	Total
Theoretical									
CSE 101	Advanced Operating Systems	3	1	0	4	4	20	80	100
CSE 102	Soft Computing & Digital Image Processing	3	0	1	4	4	20	80	100
CSE 103	Advanced Mathematics	3	1	0	4	4	20	80	100
CSE 104	Advanced Computer Architecture	3	1	0	4	4	20	80	100
CSE 105	Advanced Design and Analysis of Algorithm	3	1	0	4	4	20	80	100
Practical Assignment # T – Tutorial, P – Practical, S – Sessional, ^Th – Theory, A -									
CSE 101 L	Soft Computing & Image Processing Lab.	-	-	6	6	4	20	A-20,P-50,V-30	100
Total Credit: 24						Total Marks: 600			

Semester II

Paper Code	Paper Name	Weekly Contact Period (WCP)				Cre-dit	Marks		
		Lecture	T	P	Total		S	Exam.	Total
Theoretical									
CSE 201	Advanced Network Security & TCP/IP Programming	3	0	1	4	4	20	P-20 Th-60	100
CSE 202	Mobile & Wireless Computing	3	1	0	4	4	20	80	100
CSE 203	Advanced Database Systems	3	0	1	4	4	20	P-20 Th-60	100
CSE 204 E	Elective I(CS)	3	1	0	4	4	20	80	100
CSE 205 E	Elective II (IT)	3	1	0	4	4	20	80	100
CSE 206	CBCS Course*	3	1	0	4	4	20	80	100
Practical									
CSE 201 L	Advanced Communication Lab.	0	0	6	6	4	20	A-20,P-50,V-30	100
Total Credit: 28						Total Marks: 700			

* CBCS course credits are to be earned from a course of another department of university

Semester III

Paper Code	Paper Name	Weekly Contact Period (WCP)				Cre-dit	Marks		
		Lecture	T	P	Total		S	Exam	Total
Theoretical									
CSE 301	Remote Sensing GIS, GPS	4	0	0	4	4	20	80	100
CSE 302 E	Elective III (CA)	3	0	1	4	4	20	P-20 Th-60	100
CSE 303 D	Thesis I	-	-	18	18	12	R-100, P-100, V-100*		300
Practical * R-Report, P- Presentation, V - Viva									
CSE 301 L	Satellite Image Processing & GIS Lab	-	-	6	6	4	20	A-20,P-50,V-30	100
Total Credit: 24						Total Marks: 600			

Semester IV

Paper Code	Paper Name	Weekly Contact Period (WCP)				Credit	Marks				
		Lecture	T	P	Total		Report	Presentation	Viva	Total	
Dissertation											
CSE 401D	Thesis II	-	-	24	24	16	200	100	100	400	
CSE 402S	Seminar	-	-	-	-	6	30	30	40	100	
CSE 403GV	Grand Viva	-	-	-	-	6	-	-	100	100	
Total Credit: 28										Total Marks: 600	

Total Marks for Two Year (4-Semesters) M. Tech.(CSE) Course is 2500, Total Credit is 104.
For sessional at least two intermediate exams are to be taken, average mark will be the sessional marks for each subject. Corrected paper of these intermediate exams is to be returned to the respective students. Topic must be different for each students in Seminar.

<p>Elective I(Computer Science (CS))</p> <ol style="list-style-type: none"> 1. Parallel Architecture/Processing and Grid Computing 2. Theory of Programming Languages/Computing 3. Real Time Systems 4. Pattern Recognition <p>Elective III(Computer Application (CA))</p> <ol style="list-style-type: none"> 1. Bioinformatics 2. Artificial Intelligence and Expert Systems 3. VLSI Technology 4. Speech & Natural Language Processing 5. Network Administration 6. Cloud Computing 7. Authentication & Steganography 	<p>Elective II(Information Technology (IT))</p> <ol style="list-style-type: none"> 1. Web Mining and Internet Technology 2. Data Warehousing and Data Mining 3. Management Information Systems 4. Advanced Software Engineering 5. Data Compression & Error Correction 6. Optical Networks 7. Embedded Systems
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Subject Code: CSE 101
Advance Operating Systems

Distributed Systems – Hardware and Software concepts – Design issues; Communication in Distributed systems : Layered protocols - ATM networks - Client Server model – Remote Procedure Calls.

Synchronization : Clock synchronization – Mutual exclusion – Election algorithms, - Atomic transactions – Deadlocks; Processes : Threads – System models – processor allocation – Scheduling – Fault tolerance – Real time distributed systems.

Shared memory : Consistency models – Page based distributed shared memory – Shared variables – Object based distributed shared memory; Distributed File Systems : Design and Implementation.

Case Study: Introduction to Amoeba – Object and Capabilities – memory management – Communication – Amoeba Servers.

Text Books:

1. Mukesh Singhal, Niranjana G Shivratri , “ Advanced Concepts in Operating Systems”, McGraw Hill International, 1994.
2. Silberschatz A. and Peterson J. L., “Operating System Concepts”, Wiley.

Reference Books:

1. Andrew S Tanenbaum , “ Distributed Operating Systems “ , Pearson Education India, 2001.
2. Pradeep K Sinha , “ Distributed Operating Systems Concepts and Design “ , PHI, 2002.

Subject Code: CSE 102**Soft Computing & Digital Image Processing****Soft Computing**

Fuzzy Logic and Approximate Reasoning:

Conventional and fuzzy sets: Basic concepts of fuzzy logic

Fuzzy expressions: Basic principles of fuzzy logic and fuzzy inference rules, fuzzy relations, fuzzy operators, realization of fuzzy systems using fuzzy relations

Application of fuzzy logic in vision, pattern recognition, robotics and linguistics. Approximate reasoning in Experts Systems, Fuzzy sets in approximate reasoning, Fuzzy propositions in approximate reasoning. Transition Modifier rules, Basic principles of approximate reasoning and rules of inference.

Genetic Algorithms (GAs): Introduction to GAs, Binary encodings of candidate solutions, Schema Theorem and Building Block Hypothesis, Genetic operators – crossover and mutation, parameters for GAs, Reproduction mechanism for producing Offspring, Darwinian Principle in evaluating objective function. Convergence Analysis: Simple GA schemes, Stochastic models: GA approaches to optimization problems.

Basic Concepts and Principles of Neural Networks (NNs) and Learning Systems.

Learning with GAs and Artificial NNs (ANNs); Composite use of Fuzzy Logic, ANNs and GAs.

Neurocomputing: Models of Neurocomputing: (a) Perceptron Training, (b) Back propagation learning, (c) Hopfield nets, (d) Adaptive resonance theory I & II, (e) Self-organizing feature map, (f) ADALINE. Applications in pattern classification and image understanding.

Chaos Theory, Fusion of Neuro, Fuzzy, GA & Chaos theory & Applications to simple problems.

Text Books:

1. David E. Goldberg: Genetic Algorithms in Search, Optimization and Machine Learning, Addison Wesley, MA, 1989.
2. S. Haykin: Neural Networks - A Comprehensive Foundation, Macmillan College Publishing Company, New York, 1994.
3. H. J. Zimmermann: Fuzzy set theory and its application, 2nd revised edition, Allied Publishers Ltd.
4. G. J. Klir, B. Yuan: Fuzzy sets and Fuzzy logic: Theory and Applications, PHI, 1995.
5. R. L. Devaney: An Introduction to Chaotic Dynamical Systems, 2nd Ed. Addison Wesley, 1989.
6. An Introduction to Genetic Algorithms – M. Mitchell.
7. Genetic Algorithms – K. F. Man, K. S. Tang and S. Kwong.
8. Genetic Algorithms + Data Structures = Evolution Programs – Z. Michalewicz.
9. Adaptation in Natural and Artificial Systems - J. H. Holland.
10. Genetic Algorithms : for VLSI Design, Layout & Test Automation – P. Mazumder and E. M Rudnick.

Reference Books:

1. Neuro- Fuzzy and Soft Computing : A Computational Approach to Learning and Machine Intelligence - J. S. R. Jang C. T. Sun and E. Mizutani.
2. Theory and Practice of Uncertain Programming – B. Liu.
3. Fuzzy Logic for the Applications to Complex Systems – W. Chiang and J. Lee.
4. Fuzzy Logic with Engineering Applications – T. J. Ross.
5. Neural Network and Fuzzy Systems : A Dynamical Systems Approach to Machine Intelligence – B. Kosko.

Digital Image Processing

Light, Luminance, Brightness and Contrast, Eye, Monochrome vision model, Image processing problems and applications, Vision, camera, Digital processing system, 2-D sampling theory, Aliasing, Image quantization, Lloyd Max Quantizer, Dither, Color images, Linear systems and shift invariance, Fourier Transform, Z-Transform, Matrix theory results, Block matrices and Kronecker products.

2-D orthogonal and Unitary transforms, 1-D and 2-D DFT, Cosine, Sine, Walsh Hadamard, Haar, Slant, Karhunen-loeve, Singular value decomposition transforms.

Point operations – contrast stretching, clipping and thresholding, density slicing, Histogram equalization, modification and specification, spatial operations – spatial averaging, low pass, high pass, band pass filtering, direction smoothing, medium filtering, generalized cepstrum and homomorphic filtering, edge enhancement using 2-D IIR and FIR filters, color enhancement.

Image observation models, sources of degradation, inverse and Wiener filtering, geometric mean filter, non linear filters, smoothing splines and interpolation, constrained least square restoration.

Image data rates, pixel coding, predictive techniques, transform coding and vector DPCM. Block truncation coding, Wavelet transform coding of images, color image coding, Random transform, back projection operator, inverse random transform, back projection algorithm, fan beam and algebraic restoration techniques.

Text Books:

1. Anil Jain K. “Fundamentals of Digital Image Processing”, PHI, 1999.
2. William Pratt, “Digital Image Processing”, Wiley Interscience, 2nd edition 1991

Reference books:

1. Gonzales, Rafael and Windz, “Digital Image Processing”, 2nd edition, Addison- Wesley., 1998
2. Maner Sid-Ahmed A., “Image Processing”, McGraw Hill International Edition, 1995.
3. Andriou Low-“Introductory computer Vision and Image Processing”, MCGraw Hill International Edition.

Subject Code: CSE 103

Advanced Mathematics

Combinatorics: Multinomial theorem, principle of inclusion; Recurrence relations – classification, summation method, extension to asymptotic solutions for subsequences; Linear homogeneous relations, characteristic root method, general solution for distinct and repeated roots, non-homogeneous relations and examples, generating functions and their application to linear homogeneous recurrence relations, non-linear recurrence relations, exponential generating functions, brief introduction to Polya theory of counting.

Graph Theory: Graphs and digraphs, complement, isomorphism, connectedness and reachability, adjacency matrix, Eulerian paths and circuits in graphs and digraphs, Hamiltonian paths and circuits in graphs and tournaments, trees; Minimum spanning tree, rooted trees and binary trees, planar graphs, Euler’s formula, statement of Kuratowsky’s theorem, dual of planar graph, independence number and clique number, chromatic number, statement of Four-color theorem, dominating sets and covering sets.

Logic: Propositional Calculus- propositions and consecutives, syntax; Semantics- truth assignments and truth tables, validity and satisfiability, tautology; Adequate set of consecutives; Equivalence and normal forms; Compactness and resolution; Formal reducibility – natural deduction system and axiom system; Soundness and completeness.

Introduction to Predicate Calculus: Syntax of first order language; Semantics- structures and interpretation; Formal deductibility, First Order theory, models of a first order theory (definition only), validity, soundness, completeness, compactness (statement only), outline of resolution principle.

Text Books:

1. J.L. Mott, A. Kandel and T.P. Baker: Discrete Mathematics for Computer Scientists, Reston, Virginia, 1983.
2. D.F. Stanat and D.E. McAllister: Discrete Mathematics in Computer Science, Prentice Hall, Englewood Cliffs, 1977.
3. R.A. Brualdi: Introductory Combinatorics, North-Holland, New York, 1977.
4. Reingold et al.: Combinatorial algorithms: theory and Practice, Prentice Hall, Englewood Cliffs, 1977.
5. J.A. Bondy and U.S.R. Murthy: Graph Theory with Applications, Macmillan Press, London, 1976.
6. N. Deo: Graph Theory with Applications to Engineering and Computer Science, Prentice Hall, Englewood Cliffs, 1974.
7. E. Mendelsohn: Introduction to Mathematical Logic, 2nd Ed. Van-Nostrand, London, 1979.
8. L. Zhongwan: mathematical Logic for Computer Science, World Scientific, Singapore, 1989.
9. F.S. Roberts: Applied Combinatorics, Prentice Hall, Englewood Cliffs, 1984.

Reference Books:

1. J.P Tremblay and R. Manohar: Discrete Mathematical Structures with Applications to Computers.
2. J.L. Gersting: Mathematical Structures for Computer Sciences.
3. S. Lipschutz: Finite Mathematics.
4. S. Wiitala: Discrete Mathematics – A Unified Approach.
5. C. L. Liu : Elements of Discrete Mathematics.
6. K . D. Joshi : Foundation of Discrete Mathematics.
7. S. Sahani : Concept of Discrete Mathematics.
8. L. S. Levy : Discrete Structure in computer Science.
9. J. H. Varlist and R. M. Wilson: A course in Combinatorics.

Subject Code:- CSE 104

Advanced Computer Architecture

Fundamentals of Computer design- Technology trends- cost- measuring and reporting performance quantitative principles of computer design.

Memory hierarchy design- cache performance- reducing cache misses penalty and miss rate – virtual memory- protection and examples of VM.

Instruction set principles and examples- classifying instruction set- memory addressing- type and size of operands- addressing modes for signal processing-operations in the instruction set- instructions for control flow- encoding an instruction set.-the role of compiler.

Instruction level parallelism (ILP)- over coming data hazards- reducing branch costs –high performance instruction delivery- hardware based speculation- limitation of ILP

ILP software approach- compiler techniques- static branch protection – VLIW approach – H.W support for more ILP at compile time- H.W versus S.W Solutions

Multiprocessors and thread level parallelism- symmetric shared memory architectures- distributed shared memory- Synchronization- multi threading.

Text Book:

1. Computer Architecture A quantitative approach 3rd edition John L. Hennessy & David A. Patterson Morgan Kufmann (An Imprint of Elsevier)

Reference Books:

1. Advanced Computer Architectures, Dezso Sima, Terence Fountain, Peter Kacsuk, Pearson.
2. “Computer Architecture and parallel Processing” Kai Hwang and A.Briggs International Edition McGraw-Hill.

Subject Code: CSE 105

Design and Analysis of Algorithms

Quick Review of basic concepts - complexity measures, worst-case, average case and amortized complexity functions, model of computation.

Algorithm Design Paradigm - Divide and Conquer, Recursion, Greedy method, Dynamic programming. Role of Data Structures.

Sorting and Selection Problems: Order Statistics, sorting methods, lower bounds.

Searching and Selection Problems: Order Statistics, sorting methods, lower bounds.

Searching and Set manipulation: Searching in Static table - path lengths in Binary trees and applications, optimality of Binary search in worst case and average case, construction of weighted Binary Search tree. Searching in dynamic table - randomly grown binary search trees, AVL trees, (a, b) trees; Union-find problem -tree representation of set, weighted union and path compression, analysis and application. Hashing: chaining, open addressing, universal hashing function.

Graph algorithms: Review of topological sort, connected and biconnected components, shortest paths, minimum spanning trees. Maximum matching, maximum-flow (Ford-Fulkerson).

Arithmetic and Algebraic problems: Integer multiplication, GCD, Polynomial evaluation, Matrix Multiplication, Lower Bounds. Introductory Stringology. Some geometric algorithms.

NP-completeness: Determinism and non-determinism, P, NP, NP-complete, Cook's theorem, Some NP complete problems, Approximation algorithms. Notion of Randomization and Parallelism in algorithms.

Text Books:

1. T. H. Cormen, C. E. Leiserson and R. L. Rivest: Introduction to Algorithms, MIT Press, 1990.
2. U. Manber: Introduction to Algorithms, Addison-Wesley, 1989.

Reference Books:

1. G. Brassard and P. Bentley: Algorithmics: Theory and Practice, Prentice Hall International 1996.
2. A. V. Aho, J. E. Hopcroft and J. D. Ullman: Design and Analysis of Algorithms, Addison-Wesley, 1974.

Subject Code: CSE 201

Advanced Network Security & TCP/IP Programming

Uniqueness – Number Theory concepts – Primality – Modular Arithmetic – Fermat & Euler Theorem – Euclid Algorithm – RSA – Elliptic Curve Cryptography – Diffie Hellman Key Exchange
Digests – Requirements – MAC – Hash function – Security of Hash and MAC – Birthday Attack – MD5 – SHA – RIPEMD – Digital Signature Standard – Proof of DSS Authentication applications – Kerberos – Kerberos Encryption Techniques – PGP – Radix64 – IP Security Architecture – Payload – Key management – Web security requirements – SSL – TLS – SET

Resources – Intruders and Intrusion – Viruses and Worms – OS Security – Firewalls – Design Principles – Packet Filtering – Application gateways – Trusted systems – Counter Measures

Protocols and standards – OSI model – TCP / IP protocol suite – addressing – versions – underlying technologies.

Classful addressing – other issues – subnetting – supernetting – classless addressing – routing methods – delivery – table and modules – CIDR – ARP package – RARP.

Datagram – fragmentation – options – checksum – IP package – ICMP – messages, formats – error reporting – query – checksum – ICMP package – IGMP – messages, operation – encapsulation – IGMP package – UDP – datagram – checksum – operation – uses – UDP package.

Services – flow, congestion and error control – TCP package and operation – state transition diagram – unicast routing protocols – RIP – OSPF – BGP – multicast routing – trees – protocols – MOSPF – CBT – PIM

Client server model – concurrency – processes – sockets – byte ordering – socket system calls – TCP and UDP client-server programs – BOOTP -DHCP – DNS – name space, resolution – types of records – concept – mode of operation – Rlogin.

Text Books:

1. “Network Security Essentials: Applications and Standards” by William Stallings, Pearson
2. “Network Security private communication in a public world”, C. Kaufman, R. Perlman and M. Speciner, Pearson

Reference Books:

1. “Cryptography and Network Security”, William Stallings, 2nd Edition, Pearson Education Asia
2. “Designing Network Security”, Merike Kaeo, 2nd Edition, Pearson Books
3. “Building Internet Firewalls”, Elizabeth D. Zwicky, Simon Cooper, D. Brent Chapman, 2nd Edition, Oreilly
4. “Practical Unix & Internet Security”, Simson Garfinkel, Gene Spafford, Alan Schwartz, 3rd Edition, Oreilly

Subject Code: CSE 202

Mobile & Wireless Computing

Wireless Transmission-Wired and wireless, Mobility of users and equipments, Electromagnetic Spectrum, Radio and Microwave communication, Infrared and Millimeter waves, Legthwave Transmission. Satellite Network Architecture-Satellite Orbits-GEO LEO, MEO. Inmarsat, Iridium, Odyssey, Global Star, Archimedes and other Satellite Networks.

Spread Spectrum and CDMA-Direct (pseudo-noise) and Frequency hopped Spread Spectrum. CDMA System.

Wireless LANs -MACA and MACAW protocols. Infrared LAN. Cellular Radio Systems-Paging, Cordless telephones, Analog Cellular telephones AMPS. Digital Cellular Telephone-GSM. Personal Communication service (PCS).

CDPD system.

Mobile Data Networks and their applications.

Wireless and Mobile access to the Internet.

Text Books:

1. V. K. Garg & J. E. Wilks: Wireless and Personal Communication Systems: Fundamentals and Applications IEEE Press and Prentice Hall, 1996.
2. T. S. Rappaport, B. D. Werner and J. H. Reed: Wireless Personal Communications: The Evolution of PCS, Dkyener Academic, 1996.

Reference Books:

1. G. I. Stuber: Principles of Mobile Communication, Kluener Academic, 1996.
2. U. Black: Mobile and Wireless Networks, Prentice Hall PTR, 1996.

Subject Code: CSE 203

Advanced Database Systems

Relational Database Management Issues - Transaction Processing, Concurrency, Recovery, Security and Integrity.

Distributed Databases - Storage structures for distributed data, data fragmentation, Transparency of distributed architecture, Distributed query processing, Transaction management in distributed environment, Recovery and Concurrency control, Locking protocols, Deadlock handling, Dynamic modeling of distributed databases, Client - Server Databases.

Performance Tuning, Advanced Transaction Processing.

Object-oriented Databases - Objects and Types, Specifying the behavior of objects, Implementing Relationships, Inheritance.

Sample Systems.

New Database Applications.

Multimedia Database - Multimedia and Object Oriented Databases, Basic features of Multimedia data management, Data Compression Techniques, Integrating conventional DBMSs with IR and Hierarchical Storage Systems, Graph Oriented Data Model, Management of Hypertext Data, Client Server Architectures for Multimedia Databases

Text Books:

- 1.H. F. Korth & A. Silverschatz: Database Systems Concepts, McGraw Hill.
- 2.Bindu R. Rao: Object Oriented Databases, McGraw Hill, 1994.
- 3.Gray, Kulkarni, and Paton: Object Oriented Databases, Prentice Hall International, 1992.
- 4.Khoshafian: Object Oriented Databases, John Wiley & Sons, 1993.

Reference Books:

1. S. Khoshafian & A. B. Baker, Multimedia and Imaging Databases, Morgan Kaufmann Publishers, 1996.
2. Kemper & Moerkoeette: Object-Oriented Database Management, PH, 1994.
3. Alex Berson: Client/Server Architecture, McGraw Hill.

Subject Code: CSE 301

Remote Sensing GIS, GPS

Introduction: Sun and atmosphere, Remote Sensing a historical perspective.

Electromagnetic Radiations: EM radiators, polarization, attenuation.

Thermal radiations, EM for remote sensing.

Fundamental of Radiometry.

Physical Basics of Signatures: Signature OIR, TIR & Microwave Region

Remote Sensor: Classifications of Sensors, Sensor parameters.

Resolution- Spatial & Spectral

Optical, Microwave Sensors

Platform: Principle of Sattelite Motion, Types of orbit, Orbit perturbations.

GPS – Data Products: Dataformats, data product generation output media

Date analysis: Visual analysis, Digital Classifications

Application of Remote Sensing: Agriculture, Forestry, Land Cover Studies

Water Resource, Earth System Science

Geographical Interaction System Application.

Text Books:

1. “Principles of geographical information systems”, P. A. Burrough and R. A. Mcdonnel, Oxford.
2. “Remote sensing of the environment” , J. R. Jensen, Pearson

References Books:

1. “Exploring Geographic Information Systems”, Nicholas Christmas, John Wiley & Sons.
2. “Getting Started with Geographic Information Systems”,Keith Clarke, PHI.
3. “An Introduction to Geographical Information Systems”, Ian Heywood, Sarah Cornelius, and Steve Carver. Addison-Wesley Longman.

Subject Code: Elective I (CS - I)

Parallel Architecture/Processing and Grid Computing

Parallel computer models: Multiprocessors and Multicomputer – Multifactor and SIMD computer PRAM & VLSI models, conditions of parallelism. System interconnect architectures performance. Metrics and Measures.

Advanced processor technology – Super scalar and vector processors – Memory hierarchy technology, virtual memory technology – cache memory organization – shared – memory organization.

Linear pipeline processors – Nonlinear pipeline processors – Instruction pipeline design, Arithmetic pipeline design – Superscalar pipeline design.

Multiprocessor system interconnects – Cache coherence, Vector processing principle
Compound Vector processing, SIMD computer organization, multiprocessor operating system, multiprocessor examples
Grid Computing values and risks – History of Grid computing – Grid computing model and protocols – overview of types of Grids
Desktop Grids : Background – Definition – Challenges – Technology – Suitability – Grid server and practical uses; Clusters and Cluster Grids; HPC Grids; Scientific in sight – application and Architecture – HPC application development environment and HPC Grids; Data Grids; Alternatives to Data Grid – Data Grid architecture.
The open Grid services Architecture – Analogy – Evolution – Overview – Building on the OGSA platform – implementing OGSA based Grids – Creating and Managing services – Services and the Grid – Service Discovery – Tools and Toolkits – Universal Description Discovery and Integration (UDDI)
Desktop supercomputing – parallel computing – parallel programming paradigms – problems of current parallel programming paradigms – Desktop supercomputing programming paradigms – parallelizing existing applications – Grid enabling software applications – Needs of the Grid users – methods of Grid deployment – Requirements for Grid enabling software – Grid enabling software applications.

Text Books:

1. Kai Hwang, “Advanced Computer Architecture”, Parallelism, Scalability, Programmability, McGraw Hill, 1993.
2. Ahmar Abbas, “Grid Computing, A Practical Guide to Technology and Applications”, Firewall media, 2004.

Reference Books:

1. Hwang Briggs, “Computer Architecture and parallel processing”, McGraw hill.
2. William Stallings, “Computer Organization and Architecture- Designing for Performance”, PHI, 2000.
3. Joshy Joseph, Craig Fellenstein, “Grid Computing”, Pearson Education, 2004.
4. Foster, “Grid Blue print foe new computing”.

Subject Code: Elective I (CS - II)

Theory of Programming Languages/Computing

Concepts of structural program development; concept of data types; precedence and associativity of operators; conditional transfer; deterministic and in-deterministic loops; recursions; functions and procedures - call by value, call by reference and their differences; programming for numerical methods; records.
Data-type handling and various constructs (conditional, loop, functions etc); pointers: concept of pointers and passing parameters using pointers, non-numeric processing, concept of arrays of pointers and pointers to pointers; Structures and unions – advantage of using structures, concept of information hiding, pointers to structures; Files - basic concept of various types of file access methods: sequential, indexed sequential, random, various statements for file handling
Advanced Programming Languages like C++, ADA, LISP, PROLOG, and PASCAL. Comparison of various languages

Text Books:

1. Tennence W.Pratt, "Programming languages design and implementation", Prentice Hall of India.
2. Allen B. Tucker, "Programming Languages", Tata McGraw Hill.

Reference Books:

1. Gottfried BS – Programming with C, TMH pub.
2. Balagurusamy:ANSI C TMH

Subject Code: - Elective I (CS - III)**Real Time Systems**

Real Time Systems, Specification, Analysis, Design. Definition, Types and Evolution; State Diagram, Finite Automata, Timed Petri Net, Formal Methods for Analysis & Design. Algorithm Development, Implementation of Real Time Algorithms Debugging and Verification Real Time Distributed Computing Clock Synchronization, Real Time constraint satisfaction Reliability & Safety. Case Studies Computer Control Systems Real Time Simulation Systems Mission Control Systems Safety Critical Systems.

Text Books:

1. Real-time Systems, Jane W. S. Liu
2. Real-Time Systems Design and Analysis, Philip A. Laplante
3. Real-time Systems, Hermann Kopetz

Reference Books:

1. Real-time Systems: Theory and practice, Rajib Mall
2. Real-Time Concepts for Embedded Systems, Caroline Yao, Li Zhang

Subject Code: Elective I (CS - IV)**Pattern Recognition**

Bayes' Decision Theory, Discriminant functions and decision procedures, Relaxation procedures, Non-separable behavior. Parameter estimation and supervised learning, Maximum likelihood estimation, Sufficient statistics, Problems of dimensionality, Nom [Ara, etroc techniques, density estimates, Parzen Windows, k-nearest neighbour estimation, Fisher's linear discriminate. Clustering and unsupervised learning, Cluster validity, hierarchical and graph theoretic methods, Sealing. Feature Selection-Karhunen Loeve, Stochastic approximation, kernel approximation, divergence measures. Syntactic Pattern Recognition, Inductive Learning, Grammatical Inference, Error correcting Parsing, Vapnik - Chorvononkis result.

Text Books:

1. Tou & Gonzalez: Principles of Pattern Recognition, Addison Wesley.
2. B. D. Ripley: Pattern Recognition & Neural Networks, Cambridge University Press.

Reference Books:

1. Tou & Gonzalez: Syntactic Pattern Recognition, Addison Wesley.
2. Bishop, C. M. Neural Networks for Pattern Recognition. Oxford University Press. 1995.

Subject Code: Elective II (IT - I)**Web Mining and Internet Technology**

Data integration for e-commerce, Web personalization and recommender systems, Web content and structure mining, Web data warehousing, Review of tools, applications, and systems, Data collection and sources of

data, Data preparation for usage mining, Mining navigational patterns, Integrating e-commerce data, Leveraging site content and structure, User tracking and profiling, E-Metrics: measuring success in e-commerce, Privacy issues, Evolution of the Internet, Growth of the World Wide Web and Big Data, Client-server model, Architecture of the Intranet/Internet/Extranet, Access method: dialup, ISDN, ADSL/2+, cable, LAN, WiFi, Mobile and Satellite, Proxy Servers, Application areas: E-commerce, Education, Entertainment such as Games and Gambling
Internet of Things (IoT) Search Engines, Webbots, integrity of information, database online.

Text Books:

1. Presten Gralla and Michael Troller., How the Internet Works, Que, (8th Edition), 2006
2. Perry J. et al, The Internet – Illustrated Introductory, Course Technology (3rd Ed)
3. Bates, C., Web Programming: Building Internet Applications, John Wiley and Sons (3rd Ed), 2006.
4. Berners-Lee, T. et al, Weaving the Web, Harper Business, 2000

Reference Books:

1. Hofstetter, F.T., Internet Literacy, McGraw Hill (4th Ed), 2005
2. McGloughlin, S., Multimedia: Concepts and Practice, Prentice Hall, 2001.
3. Anderson, P., Web 2.0 and Beyond: Principles and Technologies, Chapman & Hall/CRC Textbooks in Computing, 2012
4. Bahga, A and Madiseti, V., Internet of Things: A Hands-On Approach, VPT, 2014

Subject Code: Elective II (IT - II)

Data Warehousing and Data Mining

Introduction: Fundamentals of data mining, Data Mining Functionalities, Classification of Data Mining systems, Major issues in Data Mining, Data Warehouse and OLAP Technology for Data Mining Data Warehouse, Multidimensional Data Model, Data Warehouse Architecture, Data Warehouse Implementation, Further Development of Data Cube Technology, From Data Warehousing to Data Mining, Data Preprocessing: Needs Preprocessing the Data, Data Cleaning, Data Integration and Transformation, Data Reduction, Discretization and Concept Hierarchy Generation, Online Data Storage. Data Mining Primitives, Languages, and System Architectures: Data Mining Primitives, Data Mining Query Languages, Designing Graphical User Interfaces Based on a Data Mining Query Language Architectures of Data Mining Systems, Concepts Description: Characterization and Comparison: Data Generalization and Summarization- Based Characterization, Analytical Characterization: Analysis of Attribute Relevance, Mining Class Comparisons: Discriminating between Different Classes, Mining Descriptive Statistical Measures in Large Databases.

Mining Association Rules in Large Databases: Association Rule Mining, Mining Single-Dimensional Boolean Association Rules from Transactional Databases, Mining Multilevel Association Rules from Transaction Databases, Mining Multidimensional Association Rules from Relational Databases and Data Warehouses, From Association Mining to Correlation Analysis, Constraint-Based Association Mining.

Classification and Prediction: Issues Regarding Classification and Prediction, Classification by Decision Tree Induction, Bayesian Classification, Classification by Back propagation, Classification Based on Concepts from Association Rule Mining, Other Classification Methods, Prediction, Classifier Accuracy.

Cluster Analysis Introduction :Types of Data in Cluster Analysis, A Categorization of Major Clustering Methods, Partitioning Methods, Density-Based Methods, Grid-Based Methods, Model-Based Clustering Methods, Outlier Analysis.

Mining Complex Types of Data: Multidimensional Analysis and Descriptive Mining of Complex, Data Objects, Mining Spatial Databases, Mining Multimedia Databases, Mining Time-Series and Sequence Data, Mining Text Databases, Mining the World Wide Web.

Text Books:

1. Data Mining – Concepts and Techniques - JIAWEI HAN & MICHELINE KAMBER Harcourt India.
2. Data Mining Techniques – ARUN K PUJARI, University Press
3. Building the Data Warehouse- W. H. Inmon, Wiley Dreamtech India Pvt. Ltd.

Reference Books:

1. Data Warehousing in the Real World – SAM ANAHORY & DENNIS MURRAY. Pearson Edn Asia.
2. Data Warehousing Fundamentals – PAULRAJ PONNAIAH WILEY STUDENT EDITION
3. The Data Warehouse Life cycle Tool kit – RALPH KIMBALL WILEY STUDENT EDITION
4. Data Mining Introductory and advanced topics –MARGARET H DUNHAM, PEARSON EDUCATION

Subject Code: - Elective II (IT – III)
Management Information Systems

Management activities, roles and levels
 Management Planning and Control: how planning and control systems interrelate
 Strategic Planning within an organization: activities, techniques and results
 The nature of decision-making: decision-making models and classification of decision-making situations
 Management as the direct user of an MIS vs Intermediary usage
 Measurement of MIS performance and capabilities
 Reporting Systems (MRS)
 Decision Support Systems (DSS)
 Office Information Systems (OIS) – including video conferencing and email
 Knowledge based systems that support management such as Expert Systems (ES) and Neural Network (NN) Systems
 The application of Online-Analytical Processing (OLAP)/Data Mining/Business Intelligence (BI) tools in supporting management decision making
 The relationships of MIS to other enterprise applications, such as Transaction Processing Systems (TPS) and Enterprise Resource Planning (ERP) systems
 IS within functional areas such as Human Resources, Marketing and Sales, Production, Accounting and Finance, Customer Relationship Management (CRM), Product Supply Chain Management Systems
 The Internet and MIS provisions: Internet and the linkages to legacy MIS, Internet customer interfaces, security issues.
 MIS and mobile computing
 MIS and social media

Text Books:

1. Kenneth C. Laudon & Jane P. Laudon, Essentials of Management Information Systems, Tenth Edition, Pearson Prentice-Hall, 2012
2. Terry Lucy, Management Information Systems, Ninth Edition, 2005, Thompson

Reference Books:

1. McNurlin, Sprague & Bui, Information Systems Management in Practice, Prentice-Hall (8th Ed), 2013
2. Efraim Turban, Jay Aronson & Tin-Peng Liang, Decision Support Systems and Intelligent Systems, Ninth Internal Edition, Pearson Prentice Hall, 2010.

Subject Code: Elective II (IT - IV)
Advanced Software Engineering

System Engineering - Analysis & Design
 Software Architectures & Design.
 Software Metrics.
 Software Testing Strategies: Analytical models (e.g. Markov Chain Model, Probabilistic Models)
 Software Reliability: Analytical Models
 Formal Methods in Software Engineering (e.g. Formal Specification Language)
 Software Re-use
 Re-engineering - reverse engineering.
 Real-time Software Engineering.
 Client/Server Software Engineering.
 CASE tool design & implementation.
 Verification & Validation.

Object-oriented Software Engineering: OO-Analysis, OO-Design, OO-Testing, metrics for OO systems.
System Modeling and Simulation.
Software Engineering Economics.

Text Books:

1. Pressman: Software Engineering, McGraw Hill.
2. Shoeman: Software Engineering, McGraw Hill.
3. Ghezzi, Software Engineering, PHI

Reference Books:

1. Fundamentals of Software Engineering by Rajib Mall, PHI.
2. Sommerville, Ian – Software Engineering, Pearson Education

Subject Code: - Elective II (IT -V)

Data Compression & Error Correction

Data Compressions

Introduction, Brief history, minimum redundancy codes, Shannon – Fanno code, Huffman code, Adaptive Huffman code,

Arithmetic coding, Statistical Modelling, Dictionary based compression, Sliding window compression, Lz78 Compression, Speech compression, Lossy Graphics compression.

Error Corrections

Mathematical background, Linear codes, codes for high-speed memories, - bit error correcting, byte error correcting. Codes for mass memories. Asymmetric and unidirectional error codes, codes for logic design.

Recent development of error correcting codes.

Text Books:

1. Error control coding for Computer system by T.R.N Rao & E. Fujiwara, PHI Inc.
2. B. Forouzan , “Cryptography and Network Security”, Tata McGraw-Hill.

Reference Books:

1. Nelson, “The Data Compression Book”, BPB.
2. AtulKahate , “Cryptography & Network Security”, TMH.

Subject Code: Elective II (IT- VI)

Optical Networks

Introduction to Optical Networks

Components

Transmitters

Transmission System Engineering

First Generation Networks

Wavelength Routing Networks

Virtual Topology Design

Access Networks

Text Books:

1. Optical networks: A practical perspective, Kumar Sivarajan and Rajiv Ramaswamy: Morgan Kauffman 1998.
2. Gigabit-capable Passive Optical Networks-D. Hood, Wiley

Reference Books:

1. Optical Communication Networks: Biswajit Mukherjee: TMG,1998.
2. Optical Networks, Ulysees Black: Pearson education 2007.

Subject Code: Elective II (IT- VII)**Embedded Systems**

Software Technology: - Software Architectures, Software development Tools, Software Development Process Life Cycle and its Model, Software Analysis, Design and Maintenance Introduction To Data Representation:- Data representation ,Two's complement, Fixed point and Floating Point Number Formats ,Manipulating Bits in -Memory, I/O Ports, Low level programming in C ,Primitive data types , Arrays, Functions ,Recursive Functions, Pointers, Structures & Unions ,Dynamic Memory Allocation ,File handling ,Linked lists, Queues, Stacks Mixing C and Assembly:- C and assembly, Programming in assembly ,Register Usage Conventions ,Typical use of Addressing Options, Instruction Sequencing , Procedure Call and Return , Parameter passing ,Retrieving Parameters , Everything in pass by value ,Temporary variables. Input/Output Programming:- I/O Instructions, Synchronization, Transfer Rate & Latency, Polled Waiting Loops, Interrupt – Driven I/O, Writing ISR in Assembly and C, Non Maskable and Software Interrupts Memory Management: - Direct Memory Access, Local and Global Scope, Automatic and Static Allocation, Distinguishing Static from Automatic Object Creation, Initialization and Destruction, Dynamic Allocation Unified Modeling Language:- UML basics, Object state behavior - UML state charts - Role of scenarios in the definition of behavior - Timing diagrams - Sequence diagrams - Event hierarchies - types and strategies of operations - Architectural design in UML concurrency design - threads in UML Software Tools: - DJGPP C/C++ compiler, linker, loader and utilities, The ASM assembler, µCOS-II Preemptive Kernel, Multi C Non-Preemptive Kernel

Text Books:

1. Daniel W. Lewis, “Fundamentals of embedded software where C and Assembly meet”, Pearson Education
2. Bruce Powel Douglas, “Real time UML, second edition (The Addison Wesley Object technology series)”, 2nd edition 1999, Addison Wesley

Reference Books:

1. Hassan Gomma, “Designing concurrent, distributed, and real time application with UML”, Pearson Education, 2000
2. Albert M. K. Cheng, “Real-time systems: scheduling, analysis and verification”, Wiley

Subject Code: Elective III (CA -I)**Bioinformatics**

Machine learning foundations – probabilistic framework, algorithms
Neural Networks and applications
Hidden Markov Models – theory & Applications
Probabilistic Graphical Models & Applications
Phylogenetic trees
Stochastic grammars & linguistics
Microarrays & Gene Expressions
Internet resources & public databases
Information theory & statistics in bioinformatics
HMM Techniques
Gaussian Process, Kernel Methods and support.

Text Book:

1. Phillip Compeau, Pavel Pevzner, Bioinformatics Algorithms: an Active Learning Approach
2. Neil C. Jones, Pavel Pevzner, Introduction to Bioinformatics Algorithms, ANE Books, 1st Edition edition

Books/References:

1. Molecular Cell Biology by Daid Baltimar
2. Aurther M. Lesk, Introduction to Bioinformatics, Oxford University Press, 4th edition
3. Dan E. Krane and Michael L. Raymer, Fundamental Concepts of Bioinformatics Krane and Raymer, DORLING KINDERSLEY (RS); First edition
4. David Mount : Bioinformatics: Sequence and Genome Analysis, CBS; 2 edition

Subject Code: Elective III (CA -II)**Artificial Intelligence and Expert Systems**

Introduction: AI problem; AI techniques, problem as a state space search, Production Systems, Issues in design of search programs. Heuristic Search Techniques : Generate and test, Hill Climbing, Best-First Search, Problem reduction, Means- Ends analysis. Knowledge representation & Reasoning: Knowledge representation issues, Ontological commitments. Predicate logic, knowledge representation using rules, weak slot-and-Filler structure. Natural Language Processing : Syntactic processing, semantic analysis, Discourse and pragmatic processing. Expert Systems : Representation using domain knowledge, Expert System shell, knowledge acquisition.

Text Books:

1. George F. Luger, 'Artificial Intelligence – Structures and Strategies for Complex Problem Solving', Fourth Edition, Pearson Education, 2002.
2. Kevin Knight, Elaine Rich, B. Nair, Artificial Intelligence ,McGraw Hill Education (India) Private Limited; 3 edition

Reference Books:

1. Nils J. Nilsson, Principles of Artificial Intelligence (Symbolic Computation / Artificial Intelligence), Springer; Softcover reprint of the original 1st ed. 1982 edition
2. George F. Luger, Artificial Intelligence, Pearson Education; Fifth edition
3. Stuart Russell and Peter Norvig: Artificial Intelligence: A Modern Approach, Pearson; Third edition

Subject Code: Elective III (CA -III)**VLSI Technology**

Introduction on VLSI Design
Bipolar Junction Transistor Fabrication
MOSFET Fabrication for IC
Crystal Structure of Si
Crystal Structure contd
Defects in Crystal + Crystal growth
Crystal growth Contd + Epitaxy I
Epitaxy II - Vapour phase Epitaxy
Epitaxy III - Doping during Epitaxy
Molecular beam Epitaxy
Oxidation I - Kinetics of Oxidation
Oxidation II Oxidation rate constants
Oxidation III - Dopant Redistribution
Oxidation IV - Oxide Charges
Diffusion I - Theory of Diffusion
Diffusion II - Infinite Source
Diffusion III - Actual Doping Profiles
Diffusion IV Diffusion Systems

Ion - Implantation Process
Ion - Implantation Process
Annealing of Damages
Masking during Implantation
Lithography - I
Lithography - II
Wet Chemical Etching
Dry Etching
Plasma Etching Systems
Etching of Si, SiO₂, Si₃N₄ and other materials
Plasma Deposition Process
Metallization - I
Problems in Aluminum Metal contacts
IC BJT - From junction isolation to LOCOS
Problems in LOCOS + Trench isolation
More about BJT Fabrication and Realization
Circuits + Transistors in ECL Circuits
MOSFET I - Metal gate vs. Self-aligned Poly-gate
MOSFET II Tailoring of Device Parameters
CMOS Technology
Latch - up in CMOS
BICMOS Technology

Text Books:

1. "Silicon VLSI Technology: Fundamentals, Practice and Modeling" by James D. Plummer, Michael D. Deal, Peter B. Griffin
2. "The Science and Engineering of Microelectronic Fabrication" by Stephen A. Campbell
3. "VLSI Technology" by C.Y. Chang and S.M. Sze

Reference Books:

1. "Digital Integrated Circuits" Demassa & Ciccone, Willey Pub.
2. "Modern VLSI Design: system on silicon" Wayne Wolf; Addison Wesley Longman Publisher
3. "Basic VLSI Design" Douglas A. Pucknell & Kamran Eshraghian; PHI
4. "CMOS Circuit Design, Layout & Simulation", R.J. Baker, H.W. Lee, D.E. Boyee, PHI

Subject Code: Elective III (CA -IV)

Speech & Natural Language Processing

Introduction:

NLP tasks in syntax, semantics, and pragmatics. Applications such as information extraction, question answering, and machine translation. The problem of ambiguity. The role of machine learning. Brief history of the field.

N-gram Language Models:

the role of language models. Simple N-gram models. Estimating parameters and smoothing. Evaluating language models.

Part of Speech Tagging and Sequence Labeling:

Lexical syntax. Hidden Markov Models. Maximum Entropy Models. Conditional Random

Syntactic parsing:

Grammar formalisms and treebanks. Efficient parsing for context-free grammars (CFGs). Statistical parsing and probabilistic CFGs (PCFGs). Lexicalized PCFGs.

Semantic Analysis:

Lexical semantics and word-sense disambiguation. Compositional semantics. Semantic Role Labeling and Semantic Parsing.

Information Extraction (IE):

Named entity recognition and relation extraction. IE using sequence labeling.

Machine Translation (MT):

Basic issues in MT. Statistical translation, word alignment, phrase-based translation, and synchronous grammars.

Text Books:

1. D. Jurafsky & J. H. Martin – “Speech and Language Processing – An introduction to Language processing, Computational Linguistics, and Speech Recognition”, Pearson Education
2. Manning, Christopher and Heinrich Schütze. 1999. “Foundations of Statistical Natural Language Processing”. MIT Press.

Reference Books:

1. Allen, James. 1995. – “Natural Language Understanding”. Benjamin/Cummings, 2ed.
2. Bharathi, A., Vineet Chaitanya and Rajeev Sangal. 1995. Natural Language Processing- “A Pananian Perspective”. Prentice Hill India, Eastern Economy Edition.
3. Eugene Charniak: “Statistical Language Learning”, MIT Press, 1993.

Subject Code: Elective III (CA -V)

Network Administration

History – TCP/IP, UUCP network, Network through Linux & Maintenance TCP/IP Networking: interfaces, IP Address, Address resolutions of tcp/ip. Configuring Serial devices Configuring Network Hardware Names services, P-P Protocols, Firewall, IP Accounting, Network Information Systems IP Masquerade, IPX and NCP file systems, managing UUCP, E-Mail, Senfd Mail, Networks and configurations, E-news

Text Book:

1. Linux Network Administrators guide by Olaf Kierch & Terry Dawson shroff.
2. Limoncelli –“The Practice of System & Network Administration”-Pearson.

Reference Books:

1. Kirch – “ Linux network Administrator’s guide (2nd Ed.)” – O’Rielly
2. Maxwell – “Unix system administration” - TMH

Subject Code: Elective III (CA -VI)

Cloud Computing

Enabling Technologies and System Models for Cloud Computing
Introduction to Cloud Computing including benefits, challenges, and risks
Cloud Computing Models including Infrastructure/Platform/Software – as a service
Public cloud, private cloud and hybrid clouds
Cloud OS
Cloud Architectures including Federated Clouds
Scalability, Performance, QoS
Data centers for Cloud Computing
Principles of Virtualization platforms
Security and Privacy issues in the Cloud
VMWare ESX Memory Management
Capacity Planning and Disaster Recovery in Cloud Computing

Text Books:

1. Cloud Computing: From Beginning to End, Ray J. Rafaels
2. Cloud Computing: A hands-on Approach, Arshdeep Bhaga and Vijay Madiseti
3. Cloud Computing: Concepts, Technology & Architecture and Cloud Computing Design Patterns, Thomas Erl and others

Reference Books:

1. Cloudnomics: The Business Value of Cloud Computing
2. Amazon web Services for Dummies, Bernard Golden

Subject Code: Elective III (CA -VII)
Authentication and Steganography

Introduction to Biometrics: Introduction, Physiological or Behavioral, Verification vs. Identification, Applications, Biometrics Technologies, Working of Biometrics, Benefits, Application Design.

Fingerprint Recognition: What Is Fingerprint Scanning? Practical Applications for Fingerprint Scanning, Accuracy and Integrity, Fingerprint Matching, Fingerprint Classification, Fingerprint Image Enhancement, Fingerprint Feature Extraction, Fingerprint Form Factors, Types of Scanners: Optical - Silicon – Ultrasound, Fingerprint Matching.

Speaker Recognition: Algorithms for training, recognition and adaptation to speaker and transmission channel, mainly based on Hidden Markov Models (HMM), methods for reducing the sensitivity to external noise and distortion, acoustic modeling of static and time-varying spectral properties of speech, statistic modeling of language in spontaneous speech and written text, specific analysis and decision techniques for speaker recognition.

Face Recognition: Introduction to Face Recognition, How is Face Recognition Technology Currently Being Used? How Well Does Face Recognition Work, Why Face Recognition, Face Recognition: How it Works, Image Quality, Facial Scan Process Flow, Verification vs. Identification, Primary Facial Recognition Technologies, Facial Recognition Applications. Multi-Modal Biometrics: Introduction to 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, Issues, Soft Biometrics, A Biometric Vision.

Text Books:

1. Guide to Biometrics (Springer Professional Computing) by R. Bolle, J. Connell, S. Pankanti, N. Ratha, Springer Press, 2003, ISBN0387400893
2. Biometrics Personal Identification in Networked Society, Jain, Bolle, Pankanti 1999
3. Handbook of Fingerprint Recognition, Maltoni, Maio, Jain, Prabhakar, 2005
4. Biometric Systems, Wayman, Jain, Maltoni and Maio 2004

Reference Books:

1. Fundamentals of Speech Recognition, L. Rabiner and B. Juang, , Pearson Education.
2. Speech and Audio Signal Processing, B. Gold and N. Morgan, John Wiley.
3. Spoken Language Processing, Huang, Acero & Hon, Prentice Hall, 2001.
4. Speech and Language Processing: An Intro to NLP, CL, and Speech Recognition (2nd Edition) Jurafsky & Martin, Prentice Hall, 2000.
5. Statistical Methods for Speech Recognition. Jelinek. MIT Press,
6. Fundamentals of Speech Recognition, Rabiner & Juang, Prentice-Hall,