

**Syllabus of Ph.D. Preparatory Course Work (PCW) and M.Phil**

**in**

**Computer Science and Application**



**Enlightenment to Perfection**

Department of Computer Science and Application,

University of North Bengal (N.B.U.)

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## List of Electives

- E01: Adhoc and Sensor Networks
- E02: Algorithms Analysis and Design
- E03: ANN and Pattern Recognition
- E04: Artificial Intelligence & Expert Systems
- E05: Augmentative and Alternative Communication Technology
- E06: Big Data and Large-Scale Computing
- E07: Biocomputing and Health Informatics
- E08: Biometrics Systems
- E09: Computer Networks
- E10: Cloud and Grid Computing
- E11: Data Warehousing and Mining
- E12: Digital Image Processing
- E13: Digital Watermarking and Steganography
- E14: Education Technology
- E15: GIS and Remote Sensing
- E16: High Performance and Scientific Computing
- E17: Human-Computer Interaction (HCI)
- E18: Information Security and Cyber Forensics
- E19: Natural Language Processing
- E20: Network Security and Cryptography
- E21: Soft Computing
- E22: System Software and Compiler Optimization

## 1. Scheme of the Program and Examination

Semester	Paper Code	Papers Title	Type of Paper	Credit	Term End Examination	Sessional	Total Marks	Teaching/Laboratory/Period
Semester-I (Ph.D. Preparatory Coursework & M.Phil.)	IT-11	<a href="#">Research Methodology 1: Research Foundation</a>	Theory	2	40	10	50	2 hr lecture / week
	IT- 12	<a href="#">Research Methodology 2: Computer Applications in Research</a>	Theory	2	40	10	50	2 hr lecture / week
	IT- 13	Elective: Any one paper to be chosen from the <a href="#">list of electives</a> based on the research interest of the scholar and availability of suitable supervisor	Theory	4	80	20	100	4 hr lecture /week
	End Semester / Ph.D. preparatory coursework Total				8	160	40	200
Semester-II (M.Phil.)	IT-21	Elective: Any one paper (except the one chosen for IT-13) to be chosen from the <a href="#">list of electives</a> based on the research interest of the scholar and availability of teacher.	Theory	4	80	20	100	4 hr lecture /week
	IT-21L	Corresponding Lab for the paper chosen for IT-21	Lab	2	80	20	100	4 hr lab /week
	IT-22	One distinct MOOCs course from SWYAM or NPTEL of minimum 2 credits relevant to the discipline or interdisciplinary / Tutorial-1	Theory	2			100	4 hr lecture /week
	End Semester Total				8			300
Semester-III (M.Phil.)	IT-31	Elective: Any one paper (except the one chosen for IT-13, IT-23) to be chosen from the <a href="#">list of electives</a> based on the research interest of the scholar and availability of suitable supervisor	Theory	4	80	20	100	4 hr lecture /week
	IT-31L	Corresponding Lab for the paper chosen for IT-31	Lab	2	80	20	100	4 hr lab /week
	IT-32	One distinct MOOCs course from SWYAM or NPTEL of minimum 2 credits relevant to the discipline or interdisciplinary / Tutorial-2	Theory	2			100	4 hr lecture /week

	End Semester Total			8			300	
<b>Semester-IV</b>  <b>(M.Phil.)</b>	<b>IT-41D</b>	Dissertation	Dissertation Work	6			200	
	<b>IT-42S</b>	Seminar	Presen tation	2			100	
	End Semester Total			8			300	
<b>M.Phil. Total</b>				32			1200	

- **General Instruction:**

- Ph.D. coursework candidates required to complete only the Semester-I of the program consisting total 8 credits.
- M.Phil. candidates required to complete all the semesters i.e. Semester-I, Semester-II, Semester-III and Semester-IV of the program.
- One MOOCs course from SWYAM or NPTEL of minimum 2 or more credits relevant to the discipline or interdisciplinary shall contribute 2 credits in this course.
- Choice of elective papers shall depend on the availability of teachers in that concerned subject.
- One credit shall mean one teaching period of 1(one) hour per week for one semester (of 15 weeks) for theory courses and 2(two) practical / laboratory / field / demonstration hours / week for one semester.

## 2. Programme Syllabus

### 2.1. IT 11: Research Methodology 1: Research Foundation [Credit Assign: 2, FM: 40+10, Teaching Period: 2hr/week]

**Introduction-** Meaning, purpose, objectives, characteristics, motivation, significance, types of research; approaches, process, methods and methodology used in research; criteria of good research; difference among research in social science, scientific and engineering domains; research methods in general and computer science, engineering, applications and IT in particular.

**The Research Problem** – Research problems and sub-problems identification, stating, defining, techniques involved in defining problem

**Research Planning and Design** - Research plan and its components, developing a research plan, meaning, importance and types of research design, characteristics of a good research design

**Development of working hypothesis** – Concepts, formulation and types of hypotheses, hypotheses testing methods/techniques, correlation and regression, chi-square test, analysis of variance and covariance etc.

**Interpretation and Report Writing-** Techniques of interpretation - significance, types, steps, checklist/precautions and characteristics of research documentation i.e. reviews, treatise, monographs, abstracts, articles, technical reports, white papers, research papers, thesis etc. - issues and techniques of writing project proposals, paper presentation and soft skills

**Ethical issues and Professional Conduct** Ethics in general, Professional Ethics, Ethical Issues and their significance those arise from Computer Technology, General Moral Imperatives, Concepts and issues related to plagiarism and Intellectual Property Rights

**Quantitative Methods:** Data collection and analysis techniques and tools; Sampling – concepts, types, steps and characteristics of sample, measurement and scaling techniques, types of data with sources; Statistics - Probability & Sampling distribution; Estimation, Hypothesis testing & application; Correlation & regression analysis

**Literature Review** - Importance of literature review in defining a problem, including literature in research proposal, critique, survey & peer review process, identifying gap areas from literature review; Major Research areas, Journals, Publication, Conferences and Status of Research in the field of Computer Science, engineering, Application and IT

#### References:

1. Research Methodology Methods and Techniques by C. R. Kothari, Wishwa Prakashan Publishers.
2. An introduction to Research Methodology by Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., RBSA Publishers.
3. Research Methodology Sinha, S.C. and Dhiman, A.K., Ess Publications. 2 volumes.
4. Research Methods: the concise knowledge base by Trochim, W.M.K., Atomic Dog Publishing.
5. How to Write and Publish a Scientific Paper by Day, R.A., Cambridge University Press.
6. Conducting Research Literature Reviews: From the Internet to Paper by Fink, A., Sage Publications
7. Proposal Writing by Coley, S.M. and Scheinberg, C. A., Sage Publications, 1990.
8. Handbook on Intellectual Property Law and Practice by Subbarau NR, S Viswanathan, Printers and Publishing Private Limited

9. Research Methodology by Dalip Kumar Bhattacharyya
10. Research Methodology by C.H. Chaudhary, RBSA Publication
11. Statistical Techniques by S.P. Gupta, Sultan Chand & Sons
12. An Introduction to Multivariate Statistical Analysis by Anderson T. W., Wiley Eastern Pvt., Ltd., New Delhi.
13. WWW(Web Sources)

**2.2. IT 12: Research Methodology 2: Computer Applications in Research** [Credit Assign: 2, FM: 40+10, Teaching Period: 2hr/week]

**Introduction:** Use of computer in research as a tool; introduction and use of internet and search engines with advanced search tools for data and information collection and repository; getting familiar and using e-resources i.e. open courseware, online tutorials, eBooks, eJournals etc., Libraries, INFLIBNET, Shodhganga, ShodhGangotri, N-LIST, UGC-INFONET Digital Library Consortium etc., different academic and research forums, bodies, societies etc.; concept of free and open source software (FOOS)

**Spreadsheets and Statistical tools:** Introduction to spread-sheet applications i.e. MS Excel, Open office and similar or other advanced tools, features & functions, using formulae & functions, data storing, features for statistical data analysis, generating charts/graphs & other features, GNU octave, ploticus, PSPP, R etc.

**Presentation tool:** Introduction to presentation tools i.e. MS Powerpoint, Open Office or any other tool, features & functions, creating presentations, customizing presentation.

**Thesis writing & Scientific editing tools:** Using different text editing and formatting tools i.e. LaTeX, MS Office, Scientific Office, LibreOffice Writer, MS-Publisher, Idea Rover, Wunderlis, Mendely, Zotero, Docear, endnote, Evernote, Dropbox, Spotify, Citavi, Docear, ActiveScholar, FocusWriter, WriteMonkey, Celtx, Sigil, Scribus and others alike.

**References:**

1. LaTeX Beginner's Guide by Stefan Kottwitz
2. Getting Started with LaTeX by David R. Wilkins
3. Making TeX Work by Norman Walsh
4. A Gentle Introduction to TeX by Michael Doob
5. The Computer Science of TeX and LaTeX by Victor Eijkhout
6. LATEX for Beginners: Workbook [Available at <http://www.docs.is.ed.ac.uk/skills/documents/3722/3722-2014.pdf> ]
7. LATEX Tutorials A PRIMER Indian TEX Users Group Trivandrum, India 2003 September Edited by E. Krishnan [Available at <https://www.tug.org/twg/mactex/tutorials/ltxprimer-1.0.pdf> ]
8. LaTeX Wikibook [ available at <https://en.wikibooks.org/wiki/LaTeX> ]
9. WWW

**2.3. IT 13: Elective – 1:** Any one paper to be chosen from the list of following electives based on the research interest of the scholar and availability of suitable supervisor:

**3. Elective Papers**

**List of Electives:**

E01: Adhoc and Sensor Networks

- E02: Algorithms Analysis and Design
- E03: ANN and Pattern Recognition
- E04: Artificial Intelligence & Expert Systems
- E05: Augmentative and Alternative Communication Technology
- E06: Big Data and Large-Scale Computing
- E07: Biocomputing and Health Informatics
- E08: Biometrics Systems
- E09: Computer Networks
- E10: Cloud and Grid Computing
- E11: Data Warehousing and Mining
- E12: Digital Image Processing
- E13: Digital Watermarking and Steganography
- E14: Education Technology
- E15: GIS and Remote Sensing
- E16: High Performance and Scientific Computing
- E17: Human-Computer Interaction (HCI)
- E18: Information Security and Cyber Forensics
- E19: Natural Language Processing
- E20: Network Security and Cryptography
- E21: Soft Computing
- E22: System Software and Compiler Optimization

The syllabus of the Lab corresponding to the above electives shall be dynamic and relevant to the subject covered in the theory. The concerned teacher shall be responsible to provide relevant assignments over the time.

**E01: Adhoc and Sensor Networks**

**Introduction to mobile and ad-hoc/sensor networks:** Concepts; advantages, unique constraints and challenges; Driving Applications, Wireless Communications/Radio Characteristics, Ad-Hoc wireless networks, network simulators (OPNET, NS2, etc.)

**Wireless LAN (WiFi):** 802.11 specifications, Medium Access Control Protocol issues; power control, spatial reusability, and QoS.

**Bluetooth:** specifications, Piconet synchronization and master-slave switch, scatternet formations, interference issues, interoperability with WiFi.

**Architecture:** typical network architectures, data relaying strategies, aggregation, role of energy in routing decisions, single node architecture: hardware and software components of a sensor node, TinyOS operating system, nesC language.

**Media Access Control (MAC) Protocols:** MAC layer protocols, classifications of MAC protocols, MAC protocols, issues in designing MAC protocols, contention-based protocols, schedule-based protocols, 802.15.4 standard.

**Routing:** Cellular and Ad hoc wireless networks, Issues in designing routing protocols, Classification of routing protocols, Issues of MAC layer and Routing, Proactive, Reactive and Hybrid Routing protocols, Multicast Routing, Tree based and Mesh based protocols, Multicast with Quality of Service Provision, Routing protocols, Agent-based routing, random walk, trace routing; TCP over mobile ad hoc networks- IP address acquisition, effects of partitions on TCP, provisions for mobility and fairness.

**Quality of Service:** Real-time traffic support, Issues and challenges in providing QoS, Classification of QoS Solutions, MAC layer classifications, QoS Aware Routing Protocols, Ticket based and Predictive location based QoS Routing Protocols

**Energy Management Ad Hoc Networks:** Need for Energy Management, Classification of Energy Management Schemes, Battery Management and Transmission Power Management Schemes, Network Layer and Data Link Layer Solutions, System power Management schemes

**Mesh Networks:** Necessity for Mesh Networks, MAC enhancements, IEEE 802.11s Architecture, Opportunistic Routing, Self Configuration and Auto Configuration, Capacity Models, Fairness, Heterogeneous Mesh Networks, Vehicular Mesh Networks

**Sensor Networks:** Introduction, Unique features, Sensor Network architecture, Clock Synchronization-clustering for synchronization, sender-receiver and receiver-receiver synchronization, Error analysis, Node Localization- absolute and relative localization, triangulation, multi-hop localization and error analysis, anchoring, geographic localization, naming and addressing- addressing services, publish-subscribe topologies ; Data Dissemination, Data Gathering, MAC Protocols for sensor Networks, Deployment of ad-hoc/sensor network, Sensor tasking and control, Transport layer and security protocols, Location discovery, Quality of Sensor Networks, Evolving Standards, Other Issues, Recent trends in Infrastructure less Networks

**Sensor Network Platforms and Tools:** Berkley Motes, Sensor network programming challenges, Embedded Operating System, Simulators

**Applications of Ad-Hoc/Sensor Network and Future Directions:** Ultra wide band radio communication, Wireless fidelity systems

**References:**

1. C. Siva Ram Murthy And B.S.Manoj, Ad Hoc Wireless Networks – Architectures And Protocols, Pearson Education, 2004
2. Feng Zhao And Leonidas Guibas, Wireless Sensor Networks, Morgan Kaufman Publishers, 2004.
3. C. K. Toh, Adhoc Mobile Wireless Networks, Pearson Education, 2002.
4. Thomas Krag And Sebastin Buettrich, Wireless Mesh Networking,, O,,Reilly Publishers, 2007
5. Holger Karl and Andreas Willig, Protocols and Architectures for Wireless Sensor Networks, WILEY
6. Carlos de Moraes Cordeiro and Dharma Prakash Agrawal, “Ad Hoc and Sensor Networks : Theory and Applications”, Second Edition, World Scientific Publishers, 2011
7. Prasant Mohapatra and Sriramamurthy, “Ad Hoc Networks: Technologies and Protocols”, Springer International Edition, 2009



8. Kazem Sohraby, Daniel Minoli, Taieb Znati, "Wireless Sensor Networks", A John Wiley & Sons Inc. Publication, 2007

## E02: Algorithms Analysis and Design

**Complexity Theory:** Time and Space complexity, linear speedup theorem

**Algorithm design techniques:** Divide and conquer, Dynamic programming, Greedy method

**Algorithm analysis:** Recurrences, Expected-case analysis, Amortized analysis

**Sorting and merging algorithms:** Lower bounds for sorting and merging, Straight insertion sort, Quicksort, Heapsort, Merging and mergesort, Linear-time methods

**Selection algorithms:** Selection in linear time (expected case), Selection in linear time (worst case)

**Searching algorithms:** Priority queues, Binary heaps, Binomial heaps, Dictionaries, Hash tables (open address and chained), General dynamic lists, Binary search trees, Red-black trees, B-trees, Skip lists, Splay trees

**Data compression algorithms:** Huffman compression, Lempel-Ziv compression

**Number-theoretic algorithms:** RSA data encryption, Primality testing

**String matching algorithms:** String matching with finite automata, The Knuth-Morris-Pratt algorithm, The Boyer-Moore algorithm

**The FFT and applications:** The FFT, Polynomial multiplication

Approximation Algorithms and Randomised Algorithms

**NP completeness:** P and NP, NP-Completeness, NP complete problems, Polynomial-time reductions, Cooke's theorem and other relevant emerging topics.

### References:

1. Thomas H. Cormen, Charles E. Leiserson, and Ronald Rivest, "Introduction to Algorithms", The MIT Press, 1990.
2. Sara Baase, "Computer Algorithms: Introduction to Design and Analysis, Second Edition", Addison-Wesley, 1988.
3. C.H. Papadimitriou: Computational Complexity, Addison-Wesley, 1994.
4. Jon Kleinberg and Eva Tardos, "Algorithm Design", Addison-Wesley, 2006

## E03: ANN and Pattern Recognition

**Fundamentals of AI:** Definitions, foundations of AI, Brief History of Artificial Intelligence, solving Problems by Searching, Informed Search and Exploration, constraint Satisfaction Problems, Adversarial Search, Knowledge Representation, different branches and application domains of AI

**Introduction to ANN : Introduction-** Features, structure and working of Biological Neural Network, Trends in Computing Comparison of BNN and ANN; **Basics of Artificial Neural Networks-** History of neural network research, characteristics of neural networks terminology, models of neuron Mc Culloch – Pitts model, Perceptron, Adaline model, Basic learning laws, Topology of neural network architecture;

**Backpropagation networks (BPN) -** Architecture of feed forward network, single layer ANN, multilayer perceptron, back propagation learning, input - hidden and output layer computation, backpropagation algorithm, applications, selection of tuning parameters in BPN, Numbers of hidden nodes, learning;

**Activation & Synaptic Dynamics -** Introduction, Activation Dynamics models, synaptic Dynamics models, stability and convergence, recall in neural networks; **Neural Network Classifier -** Single and Multilayer Perceptron, Back Propagation Learning, Hopfield Network, Fuzzy Neural Network;

**Unsupervised Classification-** Clustering, Hierarchical, clustering, Graph Based Method, Sum of Squared Error Technique, Iterative Optimization

**Pattern Recognition:** Feature extraction and Pattern Representation, Concept of Supervised and Unsupervised Classification, Application Areas; **Statistical Pattern Recognition -** Bayes Decision Theory, Minimum Error and Minimum Risk Classifiers; Discriminant Function and Decision Boundary, Normal Density, Discriminant Function for Discrete Features, Parameter Estimation; **Dimensionality Problem-**

Dimension and accuracy, Computational Complexity, Dimensionality Reduction, Fisher Linear Discriminant, Multiple Discriminant Analysis; **Nonparametric Pattern Classification** - Density Estimation, Nearest Neighbour Rule, Fuzzy Classification; **Linear Discriminant Functions:** Separability, Two Category and Multi Category Classification, Linear Discriminators, Perceptron Criterion, Relaxation Procedure, Minimum Square Error Criterion, Widrow-Hoff Procedure, Ho-Kashyap Procedure, Kesler's Construction; **Time Varying Pattern Recognition** - First Order Hidden Markov Model, Evaluation, Decoding, Learning

**Basic functional units of ANN for pattern recognition tasks:** Basic feed forward, Basic feedback and basic competitive learning neural network, Pattern association, pattern classification and pattern mapping tasks; Feedforward neural networks – Linear responsibility X-OR problem and solution. - Analysis of pattern mapping networks summary of basic gradient search methods; Feed back neural networks Pattern storage networks, stochastic networks and simulated annealing, Boltzmann machine and Boltzmann learning

**Competitive learning neural networks:** Components of CL network pattern clustering and feature mapping network, ART networks, Features of ART models, character recognition using ART network.

**Applications of ANN:** Pattern classification – Recognition of Olympic games symbols, Recognition of printed Characters. Neocognitron – Recognition of handwritten characters. NET Talk: to convert English text to speech. Recognition of consonant vowel (CV) segments, texture classification and segmentation

#### References:

1. Artificial Intelligence A Modern Approach, Second Edition By Stuart Russell, Peter Norving., Prentice Hall of India Private Limited New Delhi-110001,( 2003).
2. Artificial Intelligence (second edition) by E. Rich & K. Knight, (McGraw Hill, 1991)
3. Introduction to Artificial Intelligence by D. W. Patterson, ( Prentice Hall, 1990)
4. B. Yegnanarayana - Artificial neural network PHI Publication
5. S. Raj sekaran, Vijayalakshmi Pari - Neural networks, Fuzzy logic and Genetic Algorithms
6. Kevin L. Priddy, Paul E. Keller – Artificial neural networks: An Introduction - SPIE Press, 2005
7. Mohammad H. Hassoun – Fundamentals of artificial neural networks - MIT Press ,1995
8. Nelson Morgan – Artificial neural network: Electronic Implementations – IEEE Press, 1990

### E04: Artificial Intelligence & Expert Systems

**Scope of AI:** Games, theorem proving, natural language processing, vision and speech processing, robotics, expert systems, AI techniques-search knowledge, abstraction.

**Problem solving:** State space search- Production systems; Search space control-Depth first search, breadth first search, heuristic search – Hill climbing, best first search, branch and bound; Minimax search- Alpha-Beta cutoffs.

**Knowledge Representation:** Predicate Logic- Skolemizing queries, Unification, Modus ponens. Resolution, dependency directed backtracking.

**Rule Based Systems-** Forward reasoning, Conflict resolution, Backward reasoning- Use of no backtrack.

**Structured Knowledge Representations:** Semantic Net: slots, Frames.

**Handling uncertainty:** Probabilistic reasoning, Use of certainty factors, Fuzzy logic.

**Learning:** Concept of learning, learning automation, genetic algorithm, learning by induction, neural nets-back propagation.

**Expert Systems:** Need and justification for expert systems, Knowledge acquisition

**Case studies:** MYCIN, RI.

#### References:

1. Nilsson, N. J., Principles of AI, Narosa publishing House, 1990
2. Patterson, D. W., Introduction to AI and Expert Systems, PHI, 1992
3. Peter Jackson, Introduction to Expert Systems, Addison Wesley Publishing Company, M.A., 1992

4. Rich. E., and knight, K., Artificial Intelligence, 2nd Ed., TMH, 1992
5. Schalkoff, R.J., Artificial Intelligence – An Engineering Approach, McGraw Hill International Edition, Singapore, 1992
6. Sasikumar, M. Ramani, S., Rule Based Expert System, Narosa Publishing House, 1994

### **E05: Augmentative and Alternative Communication Technology**

**Overview of augmentative and alternative communication: Introduction and terms:** Definition of augmentative and alternative communication, who relies on augmentative an alternative communication, what it is like to rely on AAC strategies, what is the goal of AAC systems, and competencies needed to use an AAC system; **Message management:** This is the formulation, storage, and retrieval of messages in AAC systems. What factors influence message selection, messages for conversation, vocabulary needs for different communication modes and contexts, vocabulary needs of people with different communication capabilities, and vocabulary resources and functions; **Symbols and rate enhancement:** Symbol characteristics: iconicity, transparent, translucent, opaque, symbols, aided and unaided systems, combined symbol systems and use of rate enhancement techniques; **Alternative access:** Types of selection, direct and scanning. Types of displays, fixed, dynamic, hybrid and visual scene displays. Physical characteristics such as number of items, spacing orientation (position of the display relative to the floor.) size, selection techniques, feedback, and message output and input.

**Assessment: Principals of Assessment:** Personnel involved in augmentative and alternative communication assessment, intervention teams, assessment models (candidacy model vs participation model) phases of assessment (referral, initial assessment, assessment for tomorrow, and follow up), and process for completing the participation model; **Assessment of specific capabilities:** Assessment strategies of seating and positioning, assessment strategies for motor access and visual considerations, assessment of cognitive /linguistic capabilities, speech assessment, symbol assessment and literacy considerations.

**Therapy Strategies and Scheduling:** Decision making for intervention and evaluation. Barrier interventions, naturalability interventions environmental adaptation interventions, augmentative and alternative communication and interventions and measuring outcomes; Augmentative and alternative communication issues for people with developmental disabilities; Supporting participation and communication for beginning communicators; Language development and intervention; Linguistic and social competency; Literacy intervention, Educational inclusion

#### **References:**

1. Beukelman, David R., & Mirenda, P. (2013) “Augmentative and Alternative Communication: Supporting Children and Adults With complex Communication Needs”, Baltimore, MD; Brookes Publishers.
2. Beukelman, David., Garrett, Kathryn., and Yorkston, Kathryn (2007), “Augmentative Communication Strategies for Adults with Acute or Chronic Medical Conditions”, Baltimore, MD: Brookes Publishers.

### **E06: Big Data and Large-Scale Computing**

**Introduction:** Introduction to Big Data with applications, Technologies for handling big data, Hadoop overview- MapReduce and HDFS, Hadoop ecosystem- Mahout, Giraph, Pig, Hive, HBase, Sqoop, Spark; Apache Spark overview

**Hadoop Fundamentals:** Hadoop architecture and HDFS – Hadoop Distributed File System, The MapReduce paradigm, Anatomy of a MapReduce program, Working with (key, value) pairs, Streaming in Hadoop

**Data Storage, Importing and Exporting Data:** Ingress and egress, Understanding HDFS and HBase, Sqoop to import/export from/to MySQL; Importing/Exporting data between HDFS and MongoDB; Ingress/Egress between HBase and HDFS; Data serialization

**Working with Hive and Pig:** Hive basics and Hive query language (HiveQL), Data analytics with Hive, Working with user-defined functions (UDFs), Combining Pig with scripts, Combining (sorted and skewed) data with Pig, Sorting data with Pig

**Hadoop Use Cases:** How Hadoop is used in the real world, Recognizing Hadoop problems, Example use-cases in search, ad targeting, churn analysis, etc.

**Big Data ML with Mahout – Classification:** Mahout's machine learning themes, Classification, Data as vector, Choosing an algorithm, Classifier evaluation API, Deploying a classifier in large systems, Case study I: Click prediction, Case study II: Spam classifier

**Big Data ML with Mahout- Clustering and Recommenders:** Clustering algorithms in Mahout o k-means, fuzzy k-means, Topic modeling by LDA, Clustering on a Hadoop cluster, Case studies, Recommenders, User, item, and content-based recommendations, Recommendations with Hadoop

**Apache Spark Fundamentals:** Stack: Spark Core, SQL, Streaming, GraphX, MLlib, Programming with Resilient Distributed Datasets (RDDs), Spark SQL, Introduction to data analysis with Scala and Spark

**Temporal, Geospatial, Text Data Analysis with Spark:** Spark Streaming, Working with temporal and geospatial data in Spark, Parsing text, TF-IDF, SVD, querying and scoring, relevance

**Analyzing Networks with GraphX:** Constructing co-occurrence network, Understanding network structure, Computing graph statistics

**Big Data ML with MLlib:** k-means Clustering, Decision Trees and Random Forests, Recommenders

**Spark MLlib Use Cases:** Recommending music, Predicting forest cover, Network traffic anomaly detection

## References:

1. Hadoop in Practice, Manning Publications Co. Alex Holmes
2. Hadoop in Action, Manning Publications Co. Chuck Lam
3. Mahout in Action, Manning Publications Co. Sean Owen, Robin Anil, Ted Dunning, Ellen Friedman
4. Learning Spark, O'Reilly Holden Karau, Andy Konwinski, Patrick Wendell, and Matei Zaharia
5. Advanced Analytics with Spark, O'Reilly Sandy Ryza, Uri Laserson, Sean Owen & Josh Wills

## E07: Biocomputing and Health Informatics

**Health Data, Information, and Knowledge:** Overview of field and problems with motivation, Describe the data, information, and knowledge environment of health informatics, from cells and genes to people to health systems, Introduction to health informatics, bioinformatics and its relation to health informatics, Introduction to drug discovery

**Introduction to Structural biology:** Nucleic acid structures, RNA folding, RNA loops, conformational study; various ribose ring conformations, ribose-ring puckering; protein-protein interactions, protein ligand

interactions; DNA-binding proteins, RNA-binding proteins; biophysical aspects of proteins and nucleic acids;

**Biological Data Acquisition:** The form of biological information. Retrieval methods for DNA sequence, protein sequence and protein structure information;

**Databases – Format and Annotation:** Conventions for database indexing and specification of search terms, Common sequence file formats; Annotated sequence databases - primary sequence databases, protein sequence and structure databases; Organism specific databases; **Data Access, Retrieval and Submission:** Standard search engines; **Data retrieval tools:** Entrez, DBGET and SRS; Submission of (new and revised) data; **Structural databases:** Protein Data bank (PDB), Nucleic Acid Data Bank (NDB),Molecular modeling Data Bank (MMDB); Secondary structure, three-dimensional structure prediction, protein folding and functional sites, protein folding classes.

**Sequence Similarity Searches:** Local versus global. Distance metrics; Similarity and homology; Scoring matrices; Dynamic programming algorithms, Needleman-wunsch and Smith-waterman. Heuristic Methods of sequence alignment, FASTA, BLAST and PSI BLAST; Multiple Sequence Alignment and software tools for pairwise and multiple sequence alignment;

**Genome Analysis:** Whole genome analysis, existing software tools; Genome Annotation and Gene Prediction; ORF finding;

**Phylogenetic Analysis:** Comparative genomics, orthologs, paralogs. Methods of phylogenetic analysis: UPGMA, WPGMA, neighbour joining method, Fitch/Margoliash method, Character Based Methods.

**Protein structure prediction:** Homology modeling, prediction of protein structure from sequences, functional sites; Protein folding problem and classes; protein identification and characterization-AACompIdent, TagIdent, PepIdent and MultiIdent, PROSEARCH, PepSea, PepMAPPER, FindPept; Predicting transmembrane helices, Primary structure analysis and prediction,Secondary structure analysis and prediction, motifs, profiles, patterns and fingerprints search. Methods of sequence based protein prediction.

**Electronic Health Records:** Describe and demonstrate the electronic health record (EHR) and its derivatives, and the functions for which it is used, Collection and flow of health data, including clinical decision support and re-use of clinical data

**Personal Health Records and Decision Aids:** Describe and demonstrate the personal health record (PHR) and decision aids, and the functions for which they are used to inform personal health decision-making

**Information Retrieval (Search):** Discuss the discovery and dissemination of health-related knowledge and demonstrate the ability to retrieve and appraise it

**Informatics Applications in Public Health:** Describe the applications of informatics to public health

**Data Science, Analytics, and Visualization:** Apply analytical and visualization skills to data sets, Managing and using EMR data for research, methods for evaluation

**Ethical Issues in Health Informatics:** Discuss the ethical challenges for the use of data and information in health-related areas, EMRs, PHRs, and data standards (narrative vs. structured data, ontologies)

**References:**

1. Hoyt, RE and Yoshihashi, A, Eds. (2014). Health Informatics: Practical Guide for Healthcare and Information Technology Professionals, Sixth Edition. Pensacola, FL, Lulu.com.
2. Guide to Health Informatics Second Edition, Enrico Coiera, Hodder Arnold, 2003
3. Health Informatics: Practical Guide For Healthcare And Information Technology Professionals Robert E Hoyt (Editor), Nora Bailey (Editor), Ann Yoshihashi (6th Edition) <http://informaticseducation.org/>
4. Shortliffe, E.H., Cimino, J.J. (2014). Biomedical Informatics: Computer Applications in Health Care and Biomedicine (4th ed.). Springer. ISBN: 1447144732 <http://www.amazon.com/gp/product/1447144732>
5. Stanley I. Letovsky, "Bioinformatics: Databases and Systems"
6. SorinDraghici, "Bioinformatics Databases: Design, Implementation, and Usage"
7. Arthur M.Lesk, "Data base annotation in molecular biology, principles and practices"
8. Tao, Jiang, Ying Xu, Michael Q.Zang, "Current topics in computational molecular biology"

## **E08: Biometrics Systems**

**Notion of biometrics (3 lectures):** Introduction of biometric traits and its aim, Image processing/pattern recognition/statistics, Error types, Development of biometric authentication; Basic terms, biometric data, biometric characteristics, biometric features, biometric templates and references; Expected properties of biometric identifiers; Basics in biometric errors estimation; Enrollment, verification and identification.

**Fingerprint recognition (5 lectures):** Fingerprint capture, sensor types, latent fingerprints. Fingerprint image preprocessing, segmentation, binary and skeletal images. Fingerprint singularities, detection of loops, deltas, whorls and cores, using singularities in fingerprints classification; Galton's details, base and complex minutiae, detection of minutiae; Fingerprint recognition, minutiae- and correlation-based methods; Fingerprints in forensics and biometrics, similarities and differences.

**Iris recognition (5 lectures):** Eye and iris morphogenesis, genetic penetrance; Principles of iris image capture, iris sensors; Iris image preprocessing, segmentation, formatting and filtering; Daugman's method, iris code, statistical properties of the iris code; Other iris coding methods, wavelet analysis.

**Face recognition (2 lectures):** Face detection in still images and sequences; Face features. Face space, principal component analysis and its application, eigenfaces, linear discriminant analysis and its application, Fisherfaces; Face recognition methods.

**Other, selected physical biometric methods (2 lectures):** Use of vein patterns of a hand, finger and retina; Thermal imaging and geometry of a hand.

**Recognition of handwritten signatures (2 lectures):** Signature capture, off-line (scanned) and on-line (captured by tablets) signatures; Signature as a multidimensional curve, two- and multi-dimensional analyses. Signature features, hidden and visible features; Use of dynamic time warping in signature recognition

**Other, selected behavioral biometric methods (3 lectures):** Speaker recognition, formants, speaker features in time, frequency and cepstrum domains, homomorphic deconvolution of voice signals; Use of electroencephalogram (EEG) in biometrics.

**Security of biometrics: presentation attack detection (3 lectures):** Static and dynamic liveness features. What we want to detect (subversive actions) vs. what we can detect (suspicious actions); Liveness detection in finger- and eye-based biometrics; Selected liveness detection techniques, frequency analysis for paper



printouts detection, pupil dynamics and blood pulse analyses for detection of sophisticated eye and finger spoofing trials.

**From biometric methods to biometric systems (3 lectures):** Multiple biometrics, merging biometric information and decisions. System level issues, template aging, user perspective, interoperability of devices and methods; Development of a biometric system, programming interfaces, biometric data exchange, biometric standards

**Security of biometrics: system perspective (3 lectures):** Secure transfer of biometric data; Merging biometrics and cryptography, template protection; Merging biometrics and steganography, embedding steganographic signatures in biometric data; Secure storage, use of smart cards, principles of match-off-card and match-on-card techniques; Use of biometric data intrinsic properties in security enhancements, dynamic coding, information quantization.

**Statistical evaluation of biometrics (3 hours):** Technology, scenario and operational evaluations. Errors of biometric systems, false non-match vs. false rejection, false match vs. false acceptance. Error curves, ROC, DET, CMC. Statistical error estimation, hypothesis testing; Principles of biometric database collection and usage

**Biometric passports (2 hours):** Structure of biometric passports. Capturing and formatting of passport-compliant biometric data. Security of biometric passports, basic access control, passive and active authentication, extended access control; Public key infrastructure in a biometric passport system.

#### References:

1. Digital Image Processing using MATLAB, By: Rafael C. Gonzalez, Richard Eugene Woods, 2nd Edition, Tata McGraw-Hill Education 2010
2. Guide to Biometrics, By: Ruud M. Bolle, Sharath Pankanti, Nalini K. Ratha, Andrew W. Senior, Jonathan H. Connell, Springer 2009
3. Pattern Classification, By: Richard O. Duda, David G. Stork, Peter E. Hart, Wiley 2007

### E09: Computer Networks

**Computer Networks and the Internet:** What is the Internet, The Network edge, The Network core, Access Networks and Physical media, ISPs and Internet Backbones, Delay and Loss in Packet-Switched Networks, History of Computer Networking and the Internet? Foundation of Networking Protocols: 5-layer TCP/IP Model, 7-Layer OSI Model, Internet Protocols and Addressing, Equal-Sized Packets Model: **ATM - Networking Devices:** Multiplexers, Modems and Internet Access Devices, Switching and Routing Devices, Router Structure.

**The Link Layer and Local Area Networks:** Link Layer: Introduction and Services, Error-Detection and Error-Correction techniques, Multiple Access Protocols, Link Layer Addressing, Ethernet, Interconnections: Hubs and Switches, PPP: The Point-to-Point Protocol, Link Virtualization. Routing and Internetworking: Network-Layer Routing, Least-Cost-Path algorithms, Non-Least-Cost-Path algorithms, Intradomain Routing Protocols, Interdomain Routing Protocols, Congestion Control at Network Layer

**Logical Addressing:** IPv4 Addresses, IPv6 Addresses. Internet Protocol: Internetworking, IPv4, IPv6, Transition from IPv4 to IPv6 – Multicasting Techniques and Protocols: Basic Definitions and Techniques, Intradomain Multicast Protocols, Interdomain Multicast Protocols, Node-Level Multicast algorithms - Transport and End-to-End Protocols: Transport Layer, Transmission Control Protocol (TCP), User Datagram Protocol (UDP), Mobile Transport Protocols, TCP Congestion Control – Application Layer: Principles of Network Applications, The Web and HTTP, File Transfer: FTP, Electronic Mail in the Internet, Domain Name System (DNS), P2P File Sharing, Socket Programming with TCP and UDP, Building a Simple Web Server

**Wireless Networks and Mobile IP:** Infrastructure of Wireless Networks, Wireless LAN Technologies, IEEE 802.11 Wireless Standard, Cellular Networks, Mobile IP, Wireless Mesh Networks (WMNs). Optical Networks and WDM Systems: Overview of Optical Networks, Basic Optical Networking Devices, Large-Scale Optical Switches, Optical Routers, Wavelength Allocation in Networks, Case Study: An All-Optical Switch VPNs, Tunneling and Overlay Networks: Virtual Private Networks (VPNs), Multiprotocol Label Switching (MPLS), Overlay Networks – VoIP and Multimedia Networking: Overview of IP Telephony, VoIP Signaling Protocols, Real-Time Media Transport Protocols, Distributed Multimedia Networking, Stream Control Transmission Protocol - Mobile Ad-Hoc Networks: Overview of Wireless Ad-Hoc Networks, Routing in Ad-Hoc Networks, Routing Protocols for Ad-Hoc Networks – Wireless Sensor Networks: Sensor Networks and Protocol Structures, Communication Energy Model, Clustering Protocols, Routing Protocols

## References:

1. Computer Networking: A Top-Down Approach Featuring the Internet, *James F. Kurose, Keith 2. W. Ross*, Third Edition, Pearson Education, 2007
2. Computer and Communication Networks, *Nader F. Mir*, Pearson Education, 2007
3. Data Communications and Networking, *Behrouz A. Forouzan*, Fourth Edition, Tata McGraw Hill, 2007
4. Guide to Networking Essentials, *Greg Tomsho, Ed Tittel, David Johnson*, Fifth Edition, Thomson.
5. An Engineering Approach to Computer Networking, *S. Keshav*, Pearson Education.
6. Campus Network Design Fundamentals, *Diane Teare, Catherine Paquet*, Pearson Education (CISCO Press)
7. Computer Networks, *Andrew S. Tanenbaum*, Fourth Edition, Prentice Hall.
8. The Internet and Its Protocols, *A. Farrel*, Elsevier.

## E10: Cloud and Grid Computing

**Introduction to Grid Computing:** What is a grid? Infrastructure of hardware and software, Main Projects and Applications, The Open Grid Forum, International Grid Trust Federation; Grid Architecture, Overview of Resource Managers, Overview of Grid Systems; Application Management: Grid Application Description Languages, Application Partitioning, Meta-scheduling, Mapping, Monitoring; Web Services, Grid Portals,

**Cloud Computing Overview:** What is a cloud, Definition of cloud, Characteristics of cloud, Why use clouds, How clouds are changing, Driving factors towards cloud, Comparing grid with cloud, Public clouds (commercial), Cloud Computing and SOA, Enterprise Cloud drivers and adoption trends, Typical Cloud Enterprise workloads, Cloud service models/types, Cloud deployment models, Cloud ROI models, Cloud reference architectures, Cloud standards, Technology providers vs. Cloud providers vs. Cloud vendors, Planning Cloud transformations

**Cloud service delivery:** Cloud service, Cloud service model architectures, Infrastructure as a service (IaaS) architecture, Platform as a service (PaaS) architecture, Platform as a service (PaaS), Software as a service (SaaS) architecture, Examples of SaaS applications, Business Process as a Service (BPaaS) Architecture, Trade-off in cost to install versus, Common cloud management platform reference architecture: Architecture overview diagram, Common cloud management platform.

**Cloud deployment scenarios:** Cloud deployment models, Public clouds, Hybrid clouds, Community, Virtual private clouds, Vertical and special purpose, Migration paths for cloud, Selection criteria for cloud deployment, Case study example: IBM Smart Cloud

**Security in cloud computing:** Cloud security, Cloud security reference model, How security gets integrated, Cloud security challenges, Understanding security risks, Cloud security approaches: encryption, Digital signature, tokenization/ obfuscation, cloud security alliance standards, cloud security models and related patterns; Virtualization and multitenancy, Internal security breaches, Data corruption or loss, User account and service hijacking, Steps to reduce cloud security breaches, Steps to reduce cloud security breaches; Identity detection, forensics and management, What is SSL? Cloud security in mainstream vendor solutions; Mainstream Cloud security offerings: security assessment, secure Cloud architecture design; Design a secure Cloud architecture to support the deployment of a secure version of the course project application.

## References:



1. Barrie Sosinsky, Cloud Computing Bible, Wiley-India, 2010
2. Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Cloud Computing: Principles and Paradigms, Wiley, 2011
3. Nikos Antonopoulos, Lee Gillam, Cloud Computing: Principles, Systems and Applications, Springer, 2012
4. Ronald L. Krutz, Russell Dean Vines, Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Wiley-India, 2010
5. M. N. Rao, Cloud Computing, PHI

## **E11: Data Warehousing and Mining**

**Introduction to Data Mining:** Definition of data mining, Data Mining functionalities, Classification of data mining systems, Data Mining Applications, Architectures of data mining systems, Data mining class comparison.

**Data Mining Algorithms:** Concept Description: Definition, Data Generalization and Summarization – Based Characterization, Mining Descriptive Statistical Measures in Large Databases; Mining Association Rules: Association Rule Mining, Market Basket Analysis, Association Rule Classification, The Apriori Algorithm, Mining Multilevel Association Rules, Constraint-Based Association Mining, Sequential mining

**Classification and Prediction:** What is Classification and Prediction? Data Classification Process, Issues Regarding Classification and Prediction, Classification by Decision Tree Induction, Bayesian Classification, Classification Based on Association Rule Mining, Other Classification Methods Cluster Analysis: What is Cluster Analysis? Types of Data in Cluster Analysis, Categorization of Clustering Methods, Partitioning methods

**Introduction to Data Warehousing:** Introduction to Decision Support System: DSS Definition, History of DSS, Ingredients of DSS, Data and Model Management, DSS Knowledge base, User Interfaces, The DSS Users, Categories and Classes of DSSs Need for data warehousing, Operational & informational data, Data Warehouse Definition and characteristics, Operational Data Stores

**Data warehouse Components:** Architectural components, Data Preprocessing: Why Preprocess Data? Data Cleaning Techniques, Data Integration and Transformation, Data Reduction Techniques, Discretization and Concept Hierarchy, Generation for numeric and categorical data, Significant role of metadata, Building a Data warehouse, Benefits of Data Warehousing.

**OLAP in the Data Warehouse:** A Multidimensional Data Model, Schemas for Multidimensional Databases: Stars, Snowflakes, Star join and Fact Constellations Measures, Concept Hierarchies, OLAP Operations in the Multidimensional Data Model, Need for OLAP, OLAP tools, Mining Multimedia Databases, Mining Text Databases, Mining the World Wide Web.

### **References:**

1. Data Mining – Concepts and Techniques - Jiawei Han & Micheline Kamber, Morgan Kaufmann Publishers, 2nd Edition, 2006.
2. Introduction to Data Mining – Pang-Ning Tan, Michael Steinbach and Vipin Kumar, Pearson education.
3. Data Warehousing in the Real World – Sam Aanhory & Dennis Murray Pearson Edn Asia.
4. Data Warehousing Fundamentals – Paulraj Ponnaiah Wiley student Edition
5. The Data Warehouse Life cycle Tool kit – Ralph Kimball Wiley student edition
6. Building the Data Warehouse By William H Inmon, John Wiley & Sons Inc, 2005.
7. Data Mining Introductory and advanced topics –Margaret H Dunham, Pearson education
8. Data Mining Techniques – Arun K Pujari, University Press.

## **E12: Digital Image Processing**

**Fundamentals of Image Processing:** Image Acquisition, Image Model, Sampling, Quantization, Relationship between pixels and distance measurement, connectivity, Image Geometry, Photographic film, Light, Brightness adaption and discrimination, Perspective Projection, Spatial Domain Filtering, Grayscale and Color fundamentals, color models (RGB, CMY, HIS), formulation, color complements, color slicing, tone and color corrections, image file formats

**Image Filtering:** *Spatial Domain Filtering*- Intensity transformations, contrast stretching, histogram equalization, Correlation and convolution, Smoothing filters, sharpening filters, gradient and Laplacian; *Frequency domain Filtering*- Hotelling Transform, Fourier Transforms and properties, FFT, Convolution, Correlation, 2-D sampling, Discrete Cosine Transform, Frequency domain filtering, Inverse filtering, Least squares filtering. Recursive filtering

**Image Compression:** Encoder-Decoder model, Types of redundancies, Lossy and Lossless compression, Entropy of an information source, Shannon's 1st Theorem, Huffman Coding, Arithmetic Coding, Golomb Coding, LZW coding, Transform Coding, Sub-image size selection, blocking artifacts, DCT implementation using FFT, Run length coding, FAX compression (CCITT Group-3 and Group-4), Symbol-based coding, JBIG-2, Bit-plane encoding, Bit-allocation, Zonal Coding, Threshold Coding, JPEG, Lossless predictive coding, Lossy predictive coding, Motion Compensation; Wavelet based Image Compression- Expansion of functions, Multi-resolution analysis, Scaling functions, MRA refinement equation, Wavelet series expansion, Discrete Wavelet Transform (DWT), Continuous Wavelet Transform, Fast Wavelet Transform, 2-D wavelet Transform, JPEG-2000 encoding, Digital Image Watermarking; Fidelity criterion- MSE, PSNR, Compression ratio,

**Image Restoration:** Basic Framework and models, Interactive Restoration, Image deformation and geometric transformations, image morphing, Restoration techniques, Noise characterization, Noise restoration filters, Adaptive filters, Linear, Position invariant degradations, Estimation of Degradation functions, Restoration from projections.

**Morphological Image Processing:** Basics, SE, Erosion, Dilation, Opening, Closing, Hit-or-Miss Transform, Boundary Detection, Hole filling, Connected components, convex hull, thinning, thickening, skeletons, pruning, Geodesic Dilation, Erosion, Reconstruction by dilation and erosion.

**Image Segmentation:** Definition, Detection of Discontinuities, Point, line detection, Edge detection, Edge linking, local processing, regional processing, Hough transform, Iterative and Multivariable thresholding, Otsu's method, Moving averages, Boundary detection based techniques; Characteristics of segmentation, Pixel based, Region based and histogram based segmentation methods, segmentation by sub region aggregation, split and merge technique, Watershed segmentation, Use of motion in segmentation (spatial domain technique only),

**Image Enhancement:** *Spatial Domain Methods*- Arithmetic and Analytical operations, pixel or point operations, size operations) Smoothing filters Mean, Median, Mode filters. Low pass filters, high pass filters, sharpening filters; *Frequency Domain Method*- Design of Low Pass, High Pass, Edge enhancement, Sharpening filters in frequency domain, Butterworth Filter, Homomorphic filters in frequency domain and spatial domain.

**Application:** Different application domains of digital image processing i.e. steganography, medical image processing, GIS etc.

## References:

1. Gonslaez, et.al, "Digital Image Processing", Addison Wesley, Reading, M.A., 1990
2. Anil K Jain; Fundamentals of Digital Image Processing
3. Rafael C Gonzalez, Richard E Woods; Digital Image Processing, Pearson Education
4. Rafael C Gonzalez, Richard E Woods, Eddins; Digital Image Processing using MATLAB, Pearson Education
5. B Chanda & D Dutta Majumder; Digital Image Processing and Analysis, PHI

## E13: Digital Watermarking and Steganography

**Fundamentals of Image Processing:** Basics of image Acquisition and Model, Sampling and Quantization, Image Geometry; Light, Brightness adaption and discrimination, Perspective Projection, Grayscale and Color fundamentals, models and formulation, color issues, image file formats; Image Filtering-Spatial Domain and Frequency domain Filtering; Image Compression- Encoder-Decoder model, Types of redundancies, Lossy and Lossless compression, different types of Image Compression techniques; Image Restoration- Basic Framework , models and techniques; Morphological Image Processing- Introduction, different morphological operations on image; Image Segmentation- Introduction, detection of discontinuities; point, line, edge and boundary detection; Edge linking, characteristics of segmentation, different segmentation approaches; Image Enhancement- Spatial and Frequency Domain Methods

**Digital Watermarking Fundamentals:** Spatial-Domain Watermarking, Substitution Watermarking in the Spatial Domain, Additive Watermarking in the Spatial Domain, Frequency-Domain Watermarking, Substitution Watermarking in the Frequency Domain, Multiplicative Watermarking in the Frequency Domain, Watermarking Based on Vector Quantization, The Rounding Error Problem, The Fragile Watermark, The Block-Based Fragile Watermark, Weaknesses of the Block-Based Fragile Watermark, The Hierarchical Block-Based Fragile Watermark, The Robust Watermark, The Redundant Embedding Approach, The Spread Spectrum Approach;

**Watermarking Attacks and Tools** - Image Processing Attacks, Attacks by Filtering, Attack by Remodulation, Attack by JPEG Coding Distortion, Attack by JPEG 2000 Compression, Geometric Transformation, Attack by Image Scaling, Attack by Rotation, Attack by Image Clipping, Attack by Linear Transformation, Attack by Bending, Attack by Warping, Attack by Perspective Projection, Attack by Collage, Attack by Template, Cryptographic Attack, Protocol Attacks, Watermarking Tools;

**Combinational Digital Watermarking** - An Overview of Combinational Watermarking, Watermarking in the Spatial Domain, Watermarking in the Frequency Domain, Experimental Results, Further Encryption of Combination Watermarking, Genetic Algorithm-Based Digital Watermarking, Adjusted-Purpose Digital Watermarking, Robust High-Capacity Digital Watermarking

**Introduction to Digital Steganography:** Types of Steganography, Technical Steganography, Linguistic Steganography, Digital Steganography, Applications of Steganography, Cover Communication, One-Time Pad Communication, Embedding Security and Imperceptibility, Examples of Steganographic Software, S-Tools, StegoDos, EzStego, Jsteg-Jpeg; **Steganalysis** -An Overview, The Statistical Properties of Images, The Visual Steganalytic System, IQM-Based Steganalytic System, Learning Strategies, Introduction of the Support Vector Machine, Neural Networks, Principle Component Analysis, Frequency-Domain Steganalytic System;

**Genetic Algorithm-Based Steganography-** An Overview of the GA-Based Breaking Methodology, The Fitness Function, Reproduction, Crossover, Mutation, The GA-based Breaking Algorithm on the SDSS, Generating the Stego-Image on the Visual Steganalytic System, Generating the Stego-Image on the Image Quality, Measure-Based Steganalytic System, The GA-Based Breaking Algorithm on the FDSS, Experimental Results, The GA-Based Breaking Algorithm on the VSS, The GA-Based Breaking Algorithm on the IQM-SDSS, The GA-Based Breaking Algorithm on the JFDSS, Complexity Analysis.

## References:

1. Rafael C Gonzalez, Richard E Woods, Eddins; Digital Image Processing using MATLAB, Pearson Education
2. Ingemar Cox, Matthew Miller, Jeffrey Bloom, and Jessica Fridrich . Digital Watermarking and Steganography, 2nd Ed, (The Morgan Kaufmann Series in Multimedia Information and Systems).
3. Frank Y. Shih. Digital Watermarking and Steganography: Fundamentals and Techniques, CRC Press.g
4. Stefan Katzenbeisser, Fabien, and A.P. Petitcolas. Information Hiding Techniques for Steganography and Digital Watermarking, Artech House.
5. Neil F. Johnson; Zoran Duric; Sushil Jajodia. Information Hiding: Steganography and Watermarking – Attacks and Countermeasures, Springer. 5. Gregory Kipper. Investigator’s Guide to Steganography, Auerbach Publications.

## E14: Education Technology

**Technology in Education:** Meaning, Evolution, issues and development

**E-Learning:** Conceptual Frame Work- Pedagogy, Managerial Perspectives, Online Learning, Media Interactivity, E-Learning Framework; Technologies and Applications - Social Networking, Really Simple Syndication, Concept Maps in e-Learning, Learning Management Systems

**Traditional Educational Technology/Materials:** Cone of Experiences: Direct and Purposeful ( Games & Experiments), Contrived Experiences (Three Dimensional, Mock up, Diorama), Dramatized Experiences(Pageant, Socio-Drama), Demonstration Boards (chalkboard, peg board etc.), Field Trips, Exhibits, Still Pictures(drawings, graphs, cartoon, etc.)

**Trends in Educational Technology:** Projected materials, Audio Materials, Interactive Materials

**ICT in Education:** Computer, Internet, Multimedia/Hypermedia

**Educational Technology in Instructional Planning:** Multiple Intelligence, Learning Styles, Blooms Taxonomy

**Technology and Student Assessment:** Rubrics, Checklist, Blogs, Miscellaneous Special Topics related to topics of Research

#### **References:**

1. Teachers Discovering Computers, Integrating Technology in the Classroom, Second Edition by Shelly Cashman Gunter, (ISBN: 0-7895-6492-0).
2. Integrating Educational Technology into Teaching, Student Value Edition (6th Edition), M. D. Roblyer, Aaron H. Doering, Publisher: Pearson; 6 edition (February 25, 2012) ISBN-10: 013289680X, ISBN-13: 978-0132896801.

### **E15: GIS and Remote Sensing**

**Introduction to GIS:** GIS definition, key components, scope and functions of GIS, benefits, relationship with other disciplines, issues, application areas.

**Functional requirements of GIS:** GIS components; Cartography –GIS interface; Recent trends and applications of GIS; Open source GIS;

**Geographic data:** Spatial and non spatial; Data models: Raster and vector; Database Management System (DBMS); Data Structures: Relational, hierarchical and network; Data input: Digitization of maps and imageries; Coordinate transformation; Attribute data generation; Spatial Data Structures - Quad-tree, R-tree-searching, insertions, deletion algorithms, Topology and topological models- 9 Intersection model

**Spatial data base fundamentals:** Extended ER diagram for spatial entities. Spatial data model, object relational mode, ex. Oracle spatial data model

**Spatial data models:** ISO 19101 data model, geometry classes, basic element types, SDO-GEOMETRY structure and operations

**Spatial Indexing and analysis:** Spatial indexing - principles, benefits, index types, implementation in Oracle; Spatial overlay operations, network analysis and proximity analysis; 3D models; TIN, DEM, DTM Query in GIS;

**Spatial SQL:** (operators and functions) terminology, principles, set based operations, topological operations. Spatial joins. Spatial functions.

**Network modelling:** motivation, general network concepts, Network data model and metadata, spatial indexes on NM, shortest path and other functions. Directed and undirected networks, Traveling salesperson problem, reachability analysis, spanning tree spatial data infrastructure and

**OpenGIS:** introduction, components of SDI, Standards

**Principles of Remote Sensing:** Definition, types and scope of remote sensing; Stages in remote sensing data acquisition; Electromagnetic radiation and electromagnetic spectrum; Black body radiation and radiation laws; Interaction of EMR with atmosphere and Earth's surface features.

**Platforms, Sensors and Data Products:** Remote sensing platforms; Types & characteristics of sensors: IRS, LANDSAT, SPOT, IKONOS, Quick Bird; Remote sensing data products.

**Thermal & Microwave Remote Sensing:** Thermal Remote Sensing; Thermal properties of materials: emissivity of materials; thermal inertia of Earth surface features; Thermal data sets: LANDSAT and ASTER; Concept and Principles of microwave remote sensing; Microwave data sets SLAR. LIDAR and SAR; Application of Thermal and Microwave data

**Remote Sensing Applications:** Remote Sensing Applications in Human Settlement and Urban Analysis, Geosciences, Agriculture, Forestry and Soil, Hydrology & Water Resources Management

#### **References:**

1. Geographic Information Systems and Science, Longley, Goodchild, Rhind, Wiley & Sons



2. The Design and Analysis of Spatial Data Structures by Hanan Samet, Addison Wesley
3. Maguire, D.J.; Goodchild, M.F.; Rhind, D.W. 1991. Geographical information System, Longman, London, UK
4. Siddiqui, M.A.; 2006, Introduction to Geographical Information System, Sharda Pustak Bhavan, Allahabad.
5. Fotheringham, S.; Rogerson, P. (ed.), 1994. Spatial analysis and GIS. Taylor and Francis, London, UK
6. Spatial Databases- A Tour by Shekhar Chawla, Upper Saddle River, NJ, USA, Prentice Hall. 4. Pro Oracle Spatial, R. Kothuri & Beinat, E, APRESS, USA
7. Curran, Paul J; 1985, Principles of Remote Sensing, Longman, London.
8. Estes, J.E. and LW Senger, 1974, Remote Sensing techniques for environmental Analysis, Hamilton, Santa Barbara, California.
9. Lillesand, Thomas M. and RW Kiefer, 1987, Remote sensing and Image Interpretation, John Wiley & Sons, New York.
10. Sabins, floyd F, 1986, Remote Sensing: Principles and Interpretation, Freeman, New York.
11. Slater, PN, 1980, Remote Sensing: Optics and Optical System, Addison-Wesley, Reading

## E16: High Performance and Scientific Computing

**Introduction:** An overview of high performance and scientific computing ; Review of Sequential Computing: *Uniprocessor Architecture*- The CPU, Memory, I/O and Networking, Design Tradeoffs, Single-processor performance, memory hierarchy, and pipelines; *Enhancing Uniprocessor Performance*- Increasing Processor Clock Frequency, Parallelizing ALU Structure, Using Memory Hierarchy, Pipelining, Very Long Instruction Word (VLIW) Processors, Instruction-Level Parallelism (ILP) and Superscalar Processors, Multithreaded Processor, Performance bottlenecks of sequential computing,

**Introduction to Parallel Computing:** Motivation, What is Parallel Computing and Why to Use? Concurrent, Parallel, Distributed computing, interacting with hardware- Composite Capabilities, How Do Languages and Environments Assist with These Tasks? Applications of Parallel Computing, RAM and PRAM model, PRAM pseudo code, Data vs. Task parallelism,

**Parallel Computers Architectures:** Overview of parallel system organization, Modifications to the Von-Neumann Model, Memory Barriers, Memory Hierarchy and organization, Different types of memory access-UMA and NUMA, Shared memory, distributed memory and distributed shared memory architectures, Cache Coherence and Memory Consistency, classification of parallel computers, Flynn's Classical Taxonomy, ILP, Multi-threaded architectures and TLP, Pipeline Parallelism, I/O Operations; Overheads- Hardware System Architecture, Costs of Operations; Parallel Architecture Design Tradeoffs and Future Directions, SIMD Processors, Systolic Processors, Cluster Computing, Grid and Cloud Computing, Multicore Systems, GPU computing, Synchronization and Mutual Exclusion; Scalability and Load Balance,

**Interconnection Networks:** Introduction, Communication between Parallel Processors, Classification of Interconnection Networks by Logical Topologies, Interconnection Network Switch Architecture, Routing Mechanisms for Interconnection Networks,

**Performance Analysis and Tuning:** Measuring Benefits of Parallel Computing, Performance, Performance Metrics, Scalability and Scalability Metrics, Speed up, Amdahl's law, Gustafson-Barsis's Law, efficiency, Scalability, Granularity, Latency, Bandwidth, Throughput, Cache, false sharing, Performance Analysis Tools- Tau.

**Principles of Parallel Algorithm Design:** Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models, templates, Basic parallel programming techniques-loop splitting, spin locks, contention barriers and row conditions, Variations in splitting, self and indirect scheduling. Data dependency-forward and backward, block scheduling.

**Coding and scripting for HPC:** Embarrassingly parallel problems, introduction to \*nix, shells, make, C/C++, Fortran, to message passing and MPI programming , A brief history of HPC & Numerical and HPC libraries,

## References:

1. B. Wilkinson and M. Allen, Parallel Programming: Techniques and Applications Using Networked Workstations and Parallel Computers, 2nd Ed., PHI, 2005
2. Michael J. Quinn. Parallel Programming in C with MPI and OpenMP. TMH, 2004
3. Ananth Grama, Anshul Gupta, George Karypis, and Vipin Kumar, Introduction to Parallel Computing, 2nd Ed., Pearson Education, 2003
4. M. Sasi Kumar, Dinesh Shikhare P. Raviprakash, Introduction to Parallel Processing, PHI
5. V. Rajaraman And C. Siva Ram Murthy, Parallel Computers – Architecture and Programming
6. Peter S. Panchao, An Introduction to Parallel Programming, 2011
7. Brawer, S., Introduction to parallel programming, Academic Press, New York, 1989
8. Bruce P. Lester. The Art of Parallel Programming, 2nd Ed., 1st World Publishing, 2006
9. Kenneth A. Berman and Jerome L. Paul. Algorithms: Sequential, Parallel, and Distributed, Thomson Course Technology, 2005
10. Introduction to High Performance Computing for Scientists and Engineers, G. Hager and G. Wellein, 2010, CRC Press
11. J. L. Hennessy and D. A. Patterson, Computer Architecture: A Quantitative Approach, Morgan Kaufmann.
12. A. Silberschatz, P. B. Galvin, G. Gagne, Operating System Concepts, John Wiley.
13. R. E. Bryant and D. R. O'Hallaron, Computer Systems: A Programmer's Perspective, Prentice Hall.

## E17: Human-Computer Interaction

**Introduction:** Introduction to HCI, Humans, Information Process, Computer, Information Process, Differences and Similarities, Need for Interaction, Models, Ergonomics, Style, Context, Paradigms

**Design Process:** Designing of Interactive Systems, Usability, Paradigm shift, Interaction Design Basics, Design Process, Scenarios, Users Need, Complexity of Design

**Design of Interactive Systems:** Software Process, Usability Engineering, Issue based Information Systems, Iterative Design, Practices, Design Rules, Maximum Usability, Principles, Standards and Guidelines, Design Patterns, Programming Tools, Windowing Systems, Interaction Tool Kit, User Interface Management System,

**Models:** Universal Design Principles, Multimodal Systems, User Support, Presentation and Implementation Issues, Types, Requirements, Approaches, Cognitive Model, Hierarchical Model, Linguistic Model, Physical and Device Models, Socio technical Models, Communication and Collaboration Models, Task Models, Task Analysis And Design.

**Theories:** Dialogue Notations and Design, Dialogue Need, Dialogue Design Notations, Graphical, Textual, Representing Dialogue, Formal Descriptions, Dialogue Analysis, System Models, Interaction Models, Relationship with Dialogue, Formalisms, Formal Notations, Interstitial Behavior, Virtual Reality, Modeling Rich Interaction, Status Event Analysis, Properties, Rich Contexts, Sensor-based Systems, Groupware, Applications, Ubiquitous Computing, Virtual Reality

**Experimental Design and Statistical Analysis of HCI:** Basic Design Structure, Single Independent Variable, Multiple Independent Variable, Factorial Design, Split-Plot Design, Random Errors, Experimental Procedure, Statistical Analysis, T Tests, Analysis of Variance Test, Regression, Chi-Square Test, Survey, Probabilistic Sampling, Non-Probabilistic Sampling, Developing Survey Questions, Evaluation Techniques, Evaluation Design, Evaluating Implementations, Observational Methods.

## References:

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, Human Computer Interaction, 3rd Ed., PHI, 2004
2. Jonathan Lazar Jinjuan Heidi Feng, Harry Hochheiser, Research Methods in Human Computer Interaction, Wiley, 2010
3. Ben Shneiderman and Catherine Plaisant, Designing the User Interface: Strategies for Effective Human-Computer Interaction, 5th Ed., Addison-Wesley Publishing Co, 2009

## E18: Information Security and Cyber Forensics

**Information Security Concepts:** Introduction, History, Critical Characteristics of Information, Information System and its components, Security Vs. Protection, Need for Security, Information Security Overview, Goals for Security, Securing the Components, Information Security Services, The Security SDLC, Business Needs, Security Threats and Vulnerabilities , Attacks and Types of Attacks, Legal, Ethical and Professional Issues, Balancing Security and Access, NSTISSC Security Model, E-commerce Security, Computer Forensics, Steganography, Security Engineering

**Security Threats, vulnerabilities and Scanning:** Overview of Security threats, Hacking Techniques, Password Cracking, Insecure Network connections, Malicious Code, Programming Bugs, Cyber crime and Cyber terrorism, Information Warfare and Surveillance, Overview of vulnerability scanning, Open Port / Service Identification, Banner / Version Check, Traffic Probe, Vulnerability Probe, Vulnerability Examples, OpenVAS, Metasploit. Networks Vulnerability Scanning - Netcat, Socat, understanding Port and Services tools - Datapipe, Fpipe, WinRelay, Network Reconnaissance – Nmap, THC-Amap and System tools. Network Sniffers and Injection tools – Tcpdump and Windump, Wireshark, Ettercap, Hping Kismet

**Network Defense tools:** Firewalls and Packet Filters: Firewall Basics, Packet Filter Vs Firewall, How a Firewall Protects a Network, Packet Characteristic to Filter, Stateless Vs Stateful Firewalls, Network Address Translation (NAT) and Port Forwarding, the basic of Virtual Private Networks, Linux Firewall, Windows Firewall, Snort: Introduction Detection System

**Web Application Tools:** Scanning for web vulnerabilities tools: Nikto, W3af, HTTP utilities, Curl, OpenSSL and Stunnel, Application Inspection tools, Zed Attack Proxy, Sqlmap. DVWA, Webgoat, Password Cracking and Brute-Force Tools, John the Ripper, LOhtcrack, Pwdump, HTC-Hydra

**Network and Computer Security:** Cryptography, Access Control and Intrusion Detection, Access Control Devices, Physical Security, Security and Personnel, Security issues in wireless

**Cyber Security:** Introduction, Weak / Strong Passwords and Password Cracking, Web Browsers Security, Email Security: PGP and SMIME, Web Security: web authentication, SSL and SET, Firewall And Utm,

**Cyber Forensics:** Firewalls and Packet Filters, password Cracking, Keyloggers and Spyware, Virus and Worms, Trojan and backdoors, Steganography, DOS and DDOS attack, SQL injection, Buffer Overflow, Attack on wireless Networks

**Cyber Crimes and Law:** Cyber Crimes, Types of Cybercrime, Hacking, Attack vectors, Cyberspace and Criminal Behavior, Clarification of Terms, Traditional Problems Associated with Computer Crime, Introduction to Incident Response, Digital Forensics, Realms of the Cyber world, Recognizing and Defining Computer Crime, Contemporary Crimes, Computers as Targets, Contaminants and Destruction of Data, Cyber Law, Indian IT Act, 2000, Information Security Policy, Standards and Practices, NIST Models, VISA International Security Model, Design of Security Architecture, Planning for Continuity, SSE-CMM / COBIT, ISO 17799/BS 7799, ISO 27001, Basics of Indian Evidence ACT IPC and CrPC , Electronic Communication Privacy ACT, Legal Policies.

## References:

1. Michael E Whitman and Herbert J Mattord, Principles of Information Security, Vikas Publishing House, 2003
2. Matt Bishop, Computer Security Art and Science, Pearson Education, 2002
3. Ron Weber, Information Systems Control and Audit, Pearson Education, 2004
4. Stuart Mc Clure, Joel Scrambray, George Kurtz, Hacking Exposed, TMH, 2003
5. Mike Shema, Anti-Hacker Tool Kit (Indian Edition), TMH
6. Nina Godbole and Sunit Belpure, Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Publication Wiley
7. Garms, Jess and Daniel Somerfield, Professional Java Security, Wrox. 2001
8. Nelson Phillips and Enfinger Steuart, Computer Forensics and Investigations, Cengage Learning, New Delhi, 2009
9. Kevin Mandia, Chris Prosis, Matt Pepe, Incident Response and Computer Forensics, TMH, 2006
10. Bernadette H Schell, Clemens Martin, Cybercrime, ABC – CLIO Inc, California, 2004
11. Understanding Forensics in IT, NIIT Ltd, 2005

## E19: Natural Language Processing

**Introduction:** Introduction, Machine Learning and NLP, ArgMax Computation,

**Tree Adjoining Grammars:** Dependency Grammars-Statistical Parsing-Introduction to Semantic Processing Semantic Knowledge Representation, Deep Structure and Logical Form-Compositional Semantic Interpretation-Semantic Grammars-Case Frames and Case Frame based Parsing.

**Natural Language Generation:** Problems in NL Generation-Basic Generation Techniques Hard Problems in NLP-Speech Understanding and Translation-Discourse Processing.

**Lexical Functional Grammar:** Active-Passive and Dative Constructions-Wh-movement in Questions-Overview of LFG-LFG Formalism-Well-formedness Conditions-Handling Wh movement in Questions-Computational Aspects.

**Morphology and Finite State Transducers:** Inflectional Morphology-Derivational Morphology-Finite State Morphological Parsing-The Lexicon and Morphotactics Morphological Parsing with Finite State Transducers-Orthographic Rules and Finite-State Transducers-Combining an FST Lexicon and Rules-Lexicon-Free FSTs.

**Word Sense Disambiguation:** WordNet, Wordnet; Application in Query Expansion, Measures of WordNet Similarity, Resnick's work on WordNet Similarity, Parsing Algorithms, Evidence for Deeper Structure; Top Down Parsing Algorithms, Noun Structure; Top Down Parsing Algorithms, Non-noun Structure and Parsing Algorithms. Probabilistic parsing; Sequence labelling, PCFG,

**Probabilistic parsing:** Training issues, Arguments and Adjuncts, Probabilistic parsing; inside-outside probabilities.

**Speech :** Phonetics, Hidden Markov Model, Morphology, Graphical Models for Sequence Labelling in NLP, Consonants (place and manner of articulation) and Vowels.

**Forward Backward probability:** Viterbi Algorithm, Phonology, Sentiment Analysis and Opinions on the Web, Machine Translation and MT Tools - GIZA++ and Moses, Text Alignment, POS Tagging.

**Phonology:** ASR, Speech Synthesis, Hidden Markov Model and Viterbi, Precision, Recall , F-score, Map, Semantic Relations; UNL; Towards Dependency Parsing.

**Universal Networking Language:** Introduction, Semantic Role Extraction, Baum Welch Algorithm; HMM training.

## References:

1. Alexander Clark, Chris Fox, and Shalom Lappin (Editors):The Handbook of Computational Linguistics and Natural Language Processing (Blackwell Handbooks in Linguistics).
2. Akshar Bharathi, Vineet Chaitanya, and Rajeev Sangal: Natural Language Processing: A Paninian Perspective. Prentice Hall of India.
3. Allen, James, Natural Language Understanding, Second Edition, Benjamin/Cumming, 1995.
4. Charniack, Eugene, Statistical Language Learning, MIT Press, 1993.
5. Jurafsky, Dan and Martin, James, Speech and Language Processing, Second Edition, Prentice Hall, 2008.
6. Manning, Christopher and Heinrich, Schutze, Foundations of Statistical
7. Natural Language Processing, MIT Press, 1999.
8. Radford, Andrew et. al, Linguistics, An Introduction, Cambridge University Press, 1999.

## E20: Network Security and Cryptography

**Introduction to Classical Cryptosystems:** Introduction, Need and importance of Cryptography, Classical Cryptosystems, Introduction to symmetric and asymmetric cryptography, Cryptanalysis of Classical Cryptosystems, Shannons Theory

**Mathematical Foundations:** Number Theory, Number Theoretic Results, Factorization- Factoring Algorithms, Quadratic Sieve Factoring Algorithm, Pollard-Rho Method; Modular Arithmetic- Groups, Solving Modular Linear Equations, Chinese Remainder Theorem, Modular Exponentiation, Discrete Logarithm Problem; GCD Computation- Euclids Algorithm, Extended Euclids Algorithm, Probability and Information Theory, The Discrete Logarithm Problem (DLP), Computation of Generators of Primes; Stream Ciphers, Pseudorandom functions.

**Symmetric Key Ciphers and Cryptanalysis:** Introduction, Symmetric Key Ciphers, Modern Block Ciphers- DES, AES; Linear Cryptanalysis, Differential Cryptanalysis, Other Cryptanalytic Techniques, Overview on S-Box Design Principles, Modes of operation of Block Ciphers, NIST recommendations.

**Hash Functions and MACs:** Hash functions, The Merkle Damgard Construction, Message Authentication Codes (MACs)



**Asymmetric Key Ciphers and Cryptanalysis:** Construction and Cryptanalysis, RSA Cryptosystem, Different Attacks & Remedies on RSA, Semantic Security of RSA, The Discrete Logarithm Problem (DLP), Diffie Hellman Key Exchange algorithm, The ElGamal Encryption Algorithm, Massey-Omura; Construction and Cryptanalysis, Cryptanalysis of DLP

**Modern Trends in Asymmetric Key Cryptography:** Overview of Modern Cryptography, Elliptic curve theory and Elliptic Curves based cryptography, Security of Elliptic Curves Cryptography, Elliptic Curve Factorization.

**Digital Signatures:** Introduction, Signature schemes, Authentication Protocols, Digital Signature Standards (DSS), Proxy Signatures

**Network Security:** Secret Sharing Schemes, Network Protocols, Kerberos, Pretty Good Privacy (PGP), Secure Socket Layer (SSL), Intruders and Viruses, Firewalls

**Primality Testing:** Primality Testing, Quadratic Residues, Randomized Primality Test & Deterministic Polynomial Time Algorithm

## References:

1. Neal Koblitz, A Course in Number Theory and Cryptography, Springer Verlag, New York Inc, 2001
2. William Stallings, Cryptography and Network security: Principles and Practice, Pearson Education, 2002
3. W. Trappe and L. C. Washington, Introduction to Cryptography with Coding Theory, 2nd Ed., Pearson Education 2007
4. R. Motwani and P. Raghavan, Randomized Algorithms, Cambridge University Press, 1995
5. Douglas Stinson, Cryptography Theory and Practice, 2nd Ed., Chapman & Hall/CRC
6. B. A. Forouzan, Cryptography & Network Security, TMH
7. Wenbo Mao, Modern Cryptography, Theory & Practice, Pearson Education.
8. Hofstein, Piper, Silverman, An Introduction to Mathematical Cryptography, Springer
9. J. Daemen, V. Rijmen, The Design of Rijndael, Springer.
10. A. Joux, Algorithmic Cryptanalysis, CRC Press
11. S. G. Telang, Number Theory, TMH
12. C. Boyd, A. Mathuria, Protocols for Authentication and Key Establishment, Springer
13. Matt Bishop, Computer Security, Pearson Education

## E21: Soft Computing

**Soft Computing:** Introduction of soft computing, soft computing vs. hard computing, various types of soft computing techniques, applications of soft computing; Artificial Intelligence : Introduction, Various types of production systems, characteristics of production systems, breadth first search, depth first search techniques, other Search Techniques like hill Climbing, Best first Search, A\* algorithm, AO\* Algorithms and various types of control strategies; Knowledge representation issues, Propositional and predicate logic, monotonic and non monotonic reasoning, forward Reasoning, backward reasoning, Weak & Strong Slot & filler structures, NLP.

**Optimization:** Derivative-based Optimization, Descent Methods, The Method of Steepest Descent, Classical Newton's Method, Step Size Determination, Derivative-free Optimization, Genetic Algorithms, Simulated Annealing, Random Search, Downhill Simplex Search.

**Artificial Neural Networks:** Neuron, Nerve structure and synapse, Artificial Neuron and its model, activation functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks. Various learning techniques; perception and convergence rule, Auto-associative and hetro-associative memory; Propagation Networks- introduction, Counter propagation network, architecture, functioning & its characteristics, Back Propagation Networks -Architecture: perceptron model, solution, single layer artificial neural network, multilayer perceptron model; back propagation learning methods, effect of learning rule co-efficient ;back propagation algorithm, factors affecting backpropagation training, applications; Hopfield/ Recurrent network, configuration, stability constraints, associative memory, and characteristics, limitations and applications; Hopfield v/s Boltzman machine; Adaptive Resonance Theory: Architecture, classifications, Implementation and training; Associative Memory.

**Fuzzy Logic:** Basic concepts of crisp and fuzzy logic, Fuzzy sets and Crisp sets, Fuzzy set theory and operations, Properties of fuzzy sets, Fuzzy and Crisp relations, Fuzzy to Crisp conversion; Fuzzy rule base

system-Membership functions, features of membership functions, fuzzy reasoning, interference in fuzzy logic, fuzzy decision making, fuzzy propositions, formation, decomposition & aggregation of fuzzy rules, fuzzy if-then rules, Fuzzy implications and Fuzzy algorithms, Fuzzyfications & Defuzzificataions, Fuzzy Controller, Applications of fuzzy logic, Industrial applications,

**Genetic Algorithm(GA):** Basic concepts, working principle, procedures of GA, flow chart of GA, Genetic representations, (encoding) Initialization and selection, fitness function, reproduction, Genetic modeling: Genetic operators, Inheritance operator, cross over, inversion & deletion, mutation operator, Bitwise operator; Generational Cycle, Convergence of GA, Applications & advances in GA, Differences & similarities between GA & other traditional method

**Hybrid Systems:** Integration of neural networks, fuzzy logic and genetic algorithms.

## References:

1. S. Rajsekaran & G.A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications, PHI.
2. Siman Haykin, Neural Netowrks, PHI
3. Timothy J.Ross, Fuzzy Logic with Engineering Applications, McGraw-Hill, 1997
4. Kumar Satish, Neural Networks, TMH
5. J. Yen and R. Langari., Fuzzy Logic, Intelligence, Control and Information, Pearson Education
6. J. S. R. Jang, C. T. Sun and E. Mizutani, Neuro-Fuzzy and Soft Computing, PHI, 2004

## E22: System Software and Compiler Optimization

**System Software:** Introduction, Definition, Role and Functions, characteristics, types

**Assembler:** Introduction, functions, features, design of one pass and two pass assemblers;

**Macroprocessors:** Introduction, functions, features and design;

**Loader and Linkers:** Basic Concepts of Linkers and Loader Functions, Boot Loaders, Linking Loaders, Linkage Editors, Dynamic Linking

**Compiler:** Introduction to Compiler, Diferent phases and passes of compiler, Compiler Structure, Analysis-synthesis model of compilation, various phases of a compiler, tool based approach to compiler construction.

**Lexical Analysis:** Role of Lexical Analyzer, Interface with input, parser and symbol table, Input Buffering, Specification of Tokens, lexeme and patterns; difficulties in lexical analysis; error reporting; Finite state machines and regular expressions and their applications to lexical analysis, regular definition, transition diagrams, Lex., Review of regular languages, design and implementation of a lexical analyzer,

**Syntax Analysis:** Role of the parser, Formal and context free grammars(CFGs) and their application to syntax analysis, ambiguity, associatively, precedence, Derivation and parse trees, Top Down parsing, LL(1) grammars, recursive descent parsing, transformation on the grammars, predictive parsing, bottom up parsing, Shift Reduce Parsing, LR(0) grammars, operator precedence grammars, LR parsing algorithms and LR parsers, Yacc.

**Syntax directed translation and Definitions:** Syntax directed definitions, Construction of syntax trees, Top down and bottom up approaches, dependency graph, data types, mixed mode expression; subscripted variables, evaluation order and sequencing statement, Inherited and synthesized attributes, bottom up and top down evaluation of attributes, L- and S-attributed definitions.

**Type Checking:** Type system, type expressions, structural and name equivalence of types, type conversion.

**Run Time System Environments:** Source Language issues, Storage organization, Storage Allocation strategies, activation tree, activation record, parameter passing, symbol table, dynamic storage allocation, Access to non-local names, Parameter passing mechanism

**Intermediate Code Generation:** Intermediate languages, Intermediate Graphical representations, Three address code, Implementation of three address statements (Quadruples, Triples, Indirect triples), translation of declarations, assignments, control flow, Boolean expressions and procedure calls, implementational issues.

**Code Optimization and generation:** Introduction and Issues, Basic blocks and flow graphs, Transformation of basic blocks, DAG representation of basic blocks, code generation from dags, Loops in flow graph, Principle sources of optimization, Peephole optimization, machine dependent and machine independent optimization techniques, Issues in the design of code generator, Register allocation and assignment, code generation, specifications of machine.

**Subroutines and functions:** parameters called by address, by name and by value, subroutines with side effects.

**References:**

1. A. V. Aho, R. Sethi and J. D. Ullman, Compilers: Principles, Techniques, and Tools (US edition), Addison Wesley, 1986
2. R. Mak, Writing Compilers and Interpreters, 2nd Ed., John Wiley & Sons, 1996
3. D. Galles, Modern Compiler Design, Pearson Education, 2007
4. S. Chattopadhyay, Compiler Design, PHI, 2005
5. Alfred Aho, Monica S. Lam, Ravi Sethi, Jeffrey D Ullman, Compilers Principles, Techniques and Tools, 2nd Ed., Pearson Education Asia, 2009
6. Leland L. Beck, System Software: An Introduction to Systems Programming, 3rd Ed., Addison-Wesley, 1997
7. Allen I. Holub Compiler Design in C, PHI, 2006
8. C. N. Fischer and R. J. LeBlanc, Crafting a compiler with C, Pearson Education.
9. J. P. Bennet, Introduction to Compiler Techniques, Second Edition, TMH, 2003
10. Henk Alblas and Albert Nymeyer, Practice and Principles of Compiler Building with C, PHI, 2001
11. Kenneth C. Loudon, Compiler Construction: Principles and Practice, Thomson Learning
12. D. M. Dhamdhare, Systems Programming and Operating Systems, TMH
13. John J. Donovan, Systems Programming, 3rd Ed., 1997, Addison Wesley

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