

**Pre Ph.D. Course in Computer Science Engineering  
Schematic and Syllabus**

Sr. no.	Nature of Course	Name of course	Credits	Remarks
1.	Core	Research Methodology	4	The syllabus of RM should be formulated faculty wise
		Discipline Specific subjects	4	1.Cloud Computing 2. Advanced Concepts in Image Processing 3. Advanced Information Security 4. Modelling and Simulation 5. Data Warehousing and Data Mining 6. Mobile Computing Technologies 7. Network Security and Cryptography 8. Advanced Software Engineering 9. Advanced Computer Architecture 10. Advanced Database systems 11. Advanced Data structure & Algorithms 12. Soft Computing 13. Advanced Operating Systems 14. Big Data Analytics
		Presentation	3	Discipline specific
2.	Interdisciplinary	Elective	4	From list of subjects from allied fields 1. Advanced Data Communication 2. Internetworking 3. Optimization Techniques 4. Adhoc Wireless and Sensor Networks 5. Neural Networks and Fuzzy Logic 6. Mathematical Foundations of Computer Networks
<b>Total Minimum credits</b>			<b>15</b>	

*Prin. Dr.*

*Sanjay Malik*

*Dr. S. K. Singh*

### **Paper Title: Research Presentation**

L	T	P
0	0	3

Research Scholar will have to present a seminar based upon his/her research area. Performance of the scholar and participation in seminar will be taken into consideration.

### **Pre Ph.D. Course in Computer Science and Engineering Research Methodology**

L	T	P
4	0	0

1. Introduction Research Methodology: Definition of Research, Need of Research, Concept and steps of Research Methodology, Uses of Research Methodology, Research Techniques. Reviewing Literature: Need, Sources-Primary and Secondary, Purposes of Review, Scope of Review, Steps in conducting review.
2. Identifying and defining research problem: Locating. Analyzing stating and evaluating problem, Generating different types of hypotheses and evaluating them. Method of Research: Descriptive research design-survey, case study, content analysis, Ex-post Facto Research, Correlational and Experimental Research.
3. Sampling Techniques : Concept of population and sample' sampling techniques-simple random sampling, stratified random sampling, systematic sampling and cluster sampling, quota sampling techniques determining size of sample. Procedure of data collection: Aspects of data collection, Techniques of data Collection
4. Statistical Methods of Analysis: Descriptive statistics: Meaning, graphical representations, mean, range and standard deviation, characteristics and uses of normal curve. Inferential statistics: t-test. Chi-square tests. Correlation (rank difference and product moment), ANOVA (one way).
5. Procedure for writing a research proposal and report: Purpose, types and components of research proposal, Audiences and types of research reports, Format of Research report and journal.

Case Studies on s/w tools used for research work.

Books:

1. C.R. Kothari, "Research Methodology – Methods and Techniques", Wiley Eastern Ltd 2009
2. Richard I. Levin, David S. Rubin, Statistics for Management (7th Edition), Pearson Education India.
3. K. N. Krishnaswamy, Appa Iyer Sivakumar, M. Mathirajan," Management Research Methodology: Integration of Methods and Techniques, Pearson, 2006
4. S.P Gupta, "Statistical Methods", Sultan Chand & Sons, 2006



**Pre Ph.D. Course in Computer Science and Engineering**  
**Cloud Computing**

L	T	P
4	0	0

1. Cloud Computing Basics: Cloud Computing Overview; Characteristics; Applications; Internet and Cloud; Benefits; Limitations; Challenges.
2. Cloud Computing Services and Deployment Models: Infrastructure as a Service; Platform as a Service; Software as a Service; Private Cloud; Public Cloud; Community Cloud; Hybrid Cloud.
3. Cloud Computing vs Other Computing Technologies: Overview of Grid, Peer-to-Peer, Pervasive and Utility Computing technologies; their characteristics and comparison between them.
4. Accessing the Cloud: Hardware and Infrastructure requirements; Access Mechanisms: Web Applications, Web APIs, Web Browsers. Cloud Storage and Cloud Standards: Overview; Storage as a Service; Cloud Storage Issues; Challenges; Standards.
5. Security Issues: Securing the Cloud, Securing Data, Establishing identity and presence. Developing Applications: Major Players in Cloud Business; Overview of Service Oriented Architecture; Tools for developing cloud services and applications.
6. Introduction to Google App Engine, Azure Services Platform, Amazon EC2, Amazon S3. Migrating to the Cloud: Overview; Issues; Approaches.

**Books**

1. Anthony T. Velte, Toby J. Velte, and Robert Elsenpeter, Cloud Computing: A Practical Approach, McGraw Hill, 2010.
2. Rajkumar Buyys, James Broberg, Andrzej Goscinski (Editors), Cloud Computing: Principles and Paradigms, Wiley, 2011.
3. Barrie Sosinsky, Cloud Computing Bible, Wiley, 2011.
4. Judith Hurwitz, Robin Bloor, Marcia Kaufman, Fern Halper, Cloud Computing for Dummies, Wiley, 2010.
5. Borko Furht, Armando Escalante (Editors), Handbook of Cloud Computing, Springer, 2010.
6. Dimitris N. Chorafas, CRC Press, Taylor and Francis Group, 2011.

*Prasad*

*Dan Mair*

*Halper*

## Pre Ph.D. Course in Computer Science and Engineering

### Advanced Concepts in Image Processing

L	T	P
4	0	0

1. Introduction to Image Processing: Introduction to Digital Image Processing, Examples and Components of Digital Image Processing, Digital Image fundamentals: Elements of Visual Perception, Light and the Electromagnetic Spectrum, Image Sensing and Acquisition, Image Sampling and Quantization, Basic Relationships Between Pixels, Linear And Nonlinear Operations, Color Models.

2. Image Enhancements and Restoration: Gray Level Transformations, Histogram Processing, Enhancement Using Spatial Filtering: Smoothing Filters, Sharpening Filters, Image Enhancement in the frequency domain: Introduction to the Fourier Transform , Smoothing filters, Sharpening Filters, Homomorphic Filtering, Image Restoration : Image Degradation/ Restoration Process, Noise Models, Periodic Noise Reduction by Frequency Domain filtering, Linear, Position-Invariant Degradations, Estimating the degradation Function, Inverse Filtering, Minimum Mean Square Error(Wiener)Filtering, Constrained Least Squares Filtering, Morphological Image Processing.

3. Image Compression and wavelets: fundamentals, image compression models, elements of information theory, error free compression lossy compression, image compression standards, Color Fundamentals, Wavelets and multiresolution processing: multiresolution expansions, wavelets transforms in one dimension, the fast wavelet transform, wavelets transforms in two dimensions, wavelet packets.

Image Segmentation, Recognition and Analysis: Image Segmentation : Detection of 4. Discontinuities, Edge Linking and Boundary Detection, Thresholding, Region- Based Segmentation, Representation and Description :Boundary descriptors, Regional Descriptors, Use of Principal Components for Description , Relational Descriptors, Object Recognition : Patterns and Pattern Classes, Recognition Based on Decision- Theoretic Methods, Structural Methods. Case studies on research areas related to image processing.

#### Books:

1. Gonzalez and Woods, "Digital Image Processing" ISDN 0-201-600-781, Addison Wesley 1992.
2. Trucco & Verri, "Introductory techniques for 3-D Computer Vision", Prentice Hall.
3. Jain, A.K. Kasturi and Scunk, "Fundamental of Digital Image Processing", Tata McGraw-Hill 1995.
4. Sonka, Hlavac, Boyle. "Image Processing, Analysis and Machine Vision" 2nd ed. PWS Publishing, 1999.
5. Madhuri A. Joshi, "Digital Image Processing: An Algorithmic Approach ", PHI learning private limited.
6. S. Jayaraman, S.Esakkirajan, T. Veerakumar, " Digital Image Processing", Tata McGraw Hill, 2010

*[Signature]*

*[Signature]*

*[Signature]*



**Pre Ph.D. Course in Computer Science and Engineering**  
**Advanced Information Security**

L	T	P
4	0	0

1. Introduction to Security/Security Models: Introduction to Computer Security, Threats , Security Policy , Formal Model and Mechanism ,Security Trends , Security Attacks, Trust and assurance , Confidentiality and Integrity Model, Lattice Model ,Bell-LaPadulla Model , Access Control Matrix Model ,HRU Model, Integrity Model , Biba Integrity Model , Clark Wilson Model , Originator Controlled Access Control, Role based Access Control, Study of Emerging Access Control Models.
2. Cryptography and Cryptosystem: Cryptography, Classical Cryptosystems, DES , AES, Computational vs. Unconditional (or Information-Theoretic) Security; One-Way Functions and Hash Functions; Design Principles; Examples: MD5, Secure Hash Algorithm (SHA-1), etc.; Hashing with Block Ciphers; MACs from Hash Functions , Public-Key Cryptography , Trapdoor Functions; Fast Exponentiation; Square-and-Multiply Algorithm; Diffie-Hellman Key Agreement Protocol, Status of Security; Rivest-Shamir-Adleman (RSA) System , Elliptic Curve Cryptosystems , Discrete Logarithm Algorithms , Digital Signatures; Digital Signatures Based on Discrete Logarithms, Public-Key Certificates; Key Management Protocol, X.509, PGP, Study of Emerging Cryptography Techniques .
3. Intrusion detection and prevention models for network security: Intrusion Detection, Models, Architecture, NIDS, HIDS, Network Security , Network Security Attacks, Applications of Cryptography in Network Security; Encryption at Different OSI-Layers; Code Based Vulnerabilities, Policy Deployment in Network
4. Study of Emerging Intrusion Detection and Prevention Techniques , Protection in general purpose operating systems , Data base protection and security. Assurance and Trust. Building Secure and Trusted Systems, Software Design Assurance, Formal Methods, Formal Specification and Verification , Formal Specification Languages, Evaluation System Criteria , TCSEC , ITSEC , Common Criteria, Disaster Recovery and Business Continuity, Organisational Policies , Risk Management.

**Book**

1. Bishop, Matt: Introduction to Computer Security. Addison-Wesley, Pearson Education, Inc.
2. William Stallings," Cryptography and Network Security Principles and Practice", 2/e, Pearson Education.
3. Michael. E. Whitman and Herbert J. Mattord , " Principles of Information Security" .
4. William Stallings,"Network Security Essentials, Applications and Standards", Pearson Education.
5. J Pieprzyk, Thomas and Jennifer, "Fundamental of Computer Security", Springer.
6. Arthur and White, "Principles of Computer Security", Tata Mcgraw Hill.

*Principles*  
*Principles of Information Security*  
*Principles of Computer Security*

**Pre Ph.D. Computer Science and Engineering  
Modelling and Simulation**

L	T	P
4	0	0

1. Introduction: What is modeling and simulation? Application areas, definition and types of system, model and simulation, introduction to discrete-event and continuous simulation.
2. Simulation Methods: Discrete-event Simulation, Time advance Mechanisms, Components and organization of Discrete-event simulation, Flowchart of next-event time advance approach, Continuous Simulation, Random Number generation methods.
3. Queuing Models: Single server queuing system, introduction to arrival and departure time, flowcharts for arrival and departure routine. Event graphs of queuing model. Determining the events and variables.
4. Distribution Functions: Stochastic activities, Discrete probability functions, Cumulative distribution function, Continuous probability functions. Generation of random numbers following binomial distribution, poisson distribution, continuous distribution, normal distribution, exponential distribution, uniform distribution.
5. Programming in MATLAB: Introduction, Branching statements, loops, functions, additional data types, plots, arrays, inputs/outputs etc.
6. Programming in GPSS and C/C++: Basic Introduction to Special Simulation Languages: GPSS and Implementation of Queuing Models using C/C++.
7. Introduction to Simulators: Introduction regarding features and usage of any Network simulator.

Books:

1. Averill M. Law and W. David Kelton, "Simulation Modeling and Analysis", Tata McGraw-Hill Publication.
2. Geoffrey Gordon, "System Simulation", Prentice-Hall of India.
3. D.S. Hira, "System Simulation", S. Chand Publications
4. Stephen J. Chapman, "MATLAB Programming for Engineers", Thomson learning inc.
5. Jerry Banks, John S. Carson, Barry L. Nelson and David M. Nicol, "Discrete-Event System Simulation", Prentice-Hall of India.

*Prakash*      *Daman Main*      *Prakash*



**Pre Ph.D. Course in Computer Science and Engineering**  
**Data Warehousing and Data Mining**

L	T	P
4	0	0

1. Introduction: Introduction to RDBMS, Data Warehouse, Transactional Databases, Data Mining Functionalities, Interestingness of pattern, classification of data mining system, major issues.
2. Data Warehouse and OLAP: Difference from traditional databases, Multidimensional data model, Schema for Multi dimensional model, measures, concept hierarchies, OLAP operations, star query model, Data Warehouse architecture, ROLAP, MOLAP, HOLAP, Data Warehouse Implementation, Data Cube, Metadata Repositories, OLAP.
3. Data Processing: Data Cleaning, Data Integration and Transformation, Data Reduction, Discretization and concept hierarchy generation.
4. Data Mining Architecture: Data Mining primitives, Task relevant data, interestingness measures, presentation and visualization of patterns, Data Mining Architecture, Concept Description, Data Generalization and Summarization, Attributed oriented induction, Analytical characterization, Mining class comparisons.
5. Association Rules: Association rules mining, Mining Association rules from single level, multilevel transaction databases, multi dimensional relational databases and data warehouses, Correlational analysis, Constraint based association mining.
6. Classification and Clustering: Classification and prediction, Decision tree induction, Bayesian classification, k-nearest neighbour classification, Cluster analysis, Types of data in clustering, categorization of clustering methods.

Books:

1. Data Mining: Concepts and Techniques By J.Han and M. Kamber, Morgan Kaufman publishers, Harcourt India pvt. Ltd. Latest Edition
2. Data Mining Introductory and Advance Topics By Dunham, Pearson Education, Latest Edition

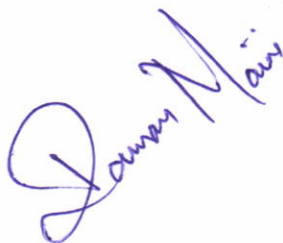
*Handwritten signatures:*  
Jinshu  
Damon Mair  
Daher

**Pre Ph.D. Course in Computer Science and Engineering  
Mobile Computing Technologies**

L	T	P
4	0	0

1. Introduction to Mobile Computing Architecture Mobile Computing – Middleware and Gateways – Application and Services – Developing Mobile Computing Applications – Security in Mobile Computing – Architecture for Mobile Computing – Three Tier Architecture – Design considerations for Mobile Computing – Mobile Computing through Internet – Making existing Applications Mobile Enabled. Cellular Technologies: GSM, GPS, GPRS, CDMA and 3G Bluetooth – Radio Frequency Identification – Wireless Broadband – Mobile IP – Internet Protocol Version 6 (IPv6) – Java Card – GSM Architecture – GSM Entities – Call Routing in GSM – PLMN Interfaces – GSM addresses and Identifiers – Network aspects in GSM – Authentication and Security – Mobile computing over SMS – GPRS and Packet Data Network – GPRS Network Architecture – GPRS Network Operations – Data Services in GPRS – Applications for GPRS – Limitations of GPRS.
2. Wireless Application Protocol (WAP) and Wireless LAN WAP – MMS – Wireless LAN Advantages – IEEE 802.11 Standards – Wireless LAN Architecture – Mobility in wireless LAN Intelligent Networks and Interworking Introduction – Fundamentals of Call processing – Intelligence in the Networks – SS#7 Signaling.
3. Client Programming, Palm OS, Symbian OS, Win CE Architecture Introduction – Moving beyond the Desktop – A Peek under the Hood: Hardware Overview – Mobile phones – PDA – Design Constraints in Applications for Handheld Devices – Palm OS architecture – Application Development – Multimedia – Symbian OS Architecture – Applications for Symbian, Different flavors of Windows CE -Windows CE Architecture J2ME JAVA in the Handset – The Three-prong approach to JAVA Everywhere – JAVA 2 Micro Edition (J2ME) technology – Programming for CLDC – GUI in MIDP – UI Design Issues.
4. Voice over Internet Protocol and Convergence Voice over IP- H.323 Framework for Voice over IP – Session Initiation Protocol – Comparison between H.323 and SIP – Real Time protocols – Convergence Technologies – Call Routing – Voice over IP Applications – IP multimedia subsystem (IMS) – Mobile VoIP Security Issues in Mobile Computing.

- BOOKS: 1. Mobile Computing – Technology, Applications and Service Creation – Asoke K Talukder, Roopa R Yavagal, 2009, TATA McGraw Hill
2. Mobile Communications – Jochen Schiller – 2nd Edition – Pearson Education
  3. The CDMA 2000 System for Mobile Communications – Vieri Vaughni, Alexander Damn Jaonvic – Pearson
  4. ADALESTEIN : Fundamentals of Mobile & Parvasive Computing, 2008, TMH.





**Pre Ph.D. Course in Computer Science and Engineering**  
**Network Security and Cryptography**

L	T	P
4	0	0

1. Introduction: Attacks, Services and Mechanisms, Security attacks, Security services, A Model for Internetwork security. Classical Techniques: Conventional Encryption model, Steganography, Classical Encryption Techniques.
2. Modern Techniques: Simplified DES, Block Cipher Principles, Data Encryption standard, Strength of DES, Differential and Linear Cryptanalysis, Block Cipher Design Principles and Modes of operations. Algorithms: Triple DES, International Data Encryption algorithm, Blowfish, RC5, CAST-128, RC2, Characteristics of Advanced Symmetric block ciphers. Conventional Encryption: Placement of Encryption function, Traffic confidentiality, Key distribution, Random Number Generation. Public Key Cryptography: Principles, RSA Algorithm, Key Management, Diffie-Hellman Key exchange, Elliptic Curve Cryptography.
3. Number theory: Prime and Relatively prime numbers, Modular arithmetic, Fermat's and Euler's theorems, Testing for primality, Euclid's Algorithm, the Chinese remainder theorem, Discrete logarithms. Message authentication and Hash functions: Authentication requirements and functions, Message Authentication, Hash functions, Security of Hash functions and MACs.
4. Hash and Mac Algorithms: MD File, Message digest Algorithm, Secure Hash Algorithm, RIPEMD-160, HMAC. Digital signatures and Authentication protocols: Digital signatures, Authentication Protocols, Digital signature standards. Authentication Applications: Kerberos, X.509 directory Authentication service. Electronic Mail Security: Pretty Good Privacy, S/MIME.
5. IP Security: Overview, Architecture, Authentication, Encapsulating Security Payload, Combining security Associations, Key Management. Web Security: Web Security requirements, Secure sockets layer and Transport layer security, Secure Electronic Transaction. Intruders, Viruses and Worms : Intruders, Viruses and Related threats. Fire Walls : Fire wall Design Principles, Trusted systems.

**BOOK:**

1. Cryptography and Network Security: Principles and Practice - William Stallings, 2000, PE.
2. Principles of Network and Systems Administration, Mark Burgess, John Wielly.

*Principles of Network and Systems Administration*  
*Daman Maini* *Kahur*

**Pre Ph.D. Course in Computer Science and Engineering**  
**Advanced Software Engineering**

L	T	P
4	0	0

1. Software Project Management: Software Project Planning and its characteristics, Types of metrics, Effort Estimation- FP, LOC, FP vs. LOC, Schedule & Cost Estimation Models- Activity Networks-PERT/CPM, COCOMO-I, COCOMO-II, Risk Assessment- Probability Matrix, Risk Management. Agile Methodology- Scrum and XP. Formal Methods: Basic concepts, mathematical preliminaries, Applying mathematical notions for formal specification, Formal specification languages, using Z to represent an example software component, the ten commandments Of formal methods, Formal methods- the road ahead.
2. Component-Based Software Engineering: CBSE process, Domain engineering, Componentbased development, Classifying and retrieving components and economics of CBSE. Client/Server Software Engineering: Structure of client/server systems, Software engineering for Client/Server systems, Analysis modeling issues, Design for Client/Server systems, Testing issues
3. Web Engineering: Attributes Of web-based applications, the Web E process, a framework for Web E. Formulating, Analysing web-based systems, design and testing for web-based applications, Management issues. Reengineering: Business process reengineering, Software reengineering, Reverse reengineering, Restructuring, Forward reengineering, economics of reengineering.
4. Software Quality: CASE tools, metrics, Standards, Certification and Assessment. TQM. Bootstrap methodology, The SPICE project, ISO-IEC 15504, Six Sigma Concept for Software Quality. Computer-Aided Software Engineering: Building Blocks for CASE, taxonomy Of CASE tools, integrated CASE environments, Integration architecture, and CASE repository.

**Books**

1. Software Engineering a Practitioners Approach, Roger S. Pressman, McGraw-Hill 8<sup>th</sup> Edition, 2014
2. Formal Specification and Documentation testing - A Case Study Approach, J.Bowan . International Thomson Computer Press, 2003
3. Software Engineering for Embedded Systems: Methods, Practical and Applications, Robert Oshana, Mark Kraeling, Newnes Publisher, 2013
4. Software engineering an engineering approach, James S. Peters, WitoldPedrycz, Wiley India, 2011.
5. Software Engineering Principles and Practice, Hans Van Vliet, Yded (WILEY), 2015.

*Prakash*

*Danav Main*

*Kalra*



**Pre Ph.D. Course in Computer Science and Engineering**  
**Advanced Computer Architecture**

L	T	P
4	0	0

1. Fundamentals of Processors: Instruction set architecture; single cycle processors, hardwired and micro-coded FSM processors; pipelined processors, multi-core processors; resolving structural, data, control and name hazards; analyzing processor performance.

2. Fundamentals of Memories: memory technology; direct-mapped, associative cache; write-through and write-back caches; single-cycle, FSM, pipe-lined cache; Analyzing memory performance.

3. Advanced Processors: Superscalar execution, out-of-order execution, register renaming, memory disambiguation, dynamic instruction scheduling, branch prediction, speculative execution; multithreaded, VLIW and SIMD processors.

4. Advanced Memories: non-blocking cache memories; memory protection, translation and virtualization; memory synchronization, consistency and coherence.

Books:

1. Computer Architecture: A Quantitative Approach, by J.L Hennessy and D.A Patterson.
2. Digital Design and Computer Architecture, by D.M Harris and S.L Harris.

*Prakash*

*Daman Maini*

*Kalish*

**Pre Ph.D. Course in Computer Science and Engineering**  
**Advanced Database Systems**

L	T	P
4	0	0

1. Data Base Analysis and Design Techniques: Review of basic Database Concepts, Database Design Methodologies. ER Modeling: Specialization, Generalization, Aggregation, Normalization Theory. Database Implementation using UML: Introduction to UML, Structure diagrams, behavioral diagrams, object oriented analysis, class diagram. Advanced Transaction Processing and Concurrency Control: Transaction Concepts, Concurrency Control: Locking Methods, Timestamping Methods, Optimistic Methods for Concurrency Control, Concurrency Control in Distributed Systems.
2. Query Compiler: Introduction, parsing, generating logical query plan from parse tree. Query Processing: Physical-Query-plan Operators. Operations: selection, sorting, join, project, set. Query Evaluation: Introduction, Approaches to Query Evaluation, Transformation of relational expressions in Query optimization, heuristic optimization, cost estimation for various operations, transformation rule.
3. Distributed Database Centralized DBMS and Distributed DBMS, functions and architecture of a DDBMS, Distributed Data Storage, Transparency issues in DDBMS, Query Processing DDBMS, Distributed transaction Management and Protocols, Distributed Concurrency Control and Deadlock Management. Object Oriented Database: Limitations of RDBMS, Need of Complex Datatype, Data Definition, ODBMS Fundamentals, issues in OODBMS, Object-oriented database design. Comparison of ORDBMS and OODBMS.
4. Emerging Database Models, Technologies and Applications Multimedia database-Emergence, Temporal Databases, difference from other data types, structure, deductive databases, GIS and spatial databases, Knowledge database, Information Visualization, Wireless Networks and databases, Personal database, Digital libraries, web databases, case studies of the emerging databases.

**Books:**

1. Distributed Databases by Ozsu and Valduriez, Pearson Education.
2. Fundamentals of Database Systems by RamezElmasri, ShamkantNavathe, Pearson Education
3. Database System Concepts by Abraham Silberschatz, Henry F. Korth, S. Sudarshan, Tata McGraw-Hill.
4. Advanced database management system by RiniChkrabarti and ShibhadraDasgupta, Dreamtech.
5. An Introduction to Database Systems, C J Date, Addison Wesley Publishing Company.
6. An Introduction to Data Systems, Bipin C. Desai, West Publishing Company.





**Pre Ph.D. Course in Computer Science and Engineering**  
**Advanced Data Structures & Algorithms**

L	T	P
4	0	0

1. Algorithms Complexity and Analysis: Recurrence Relations, Probabilistic Analysis, Amortized Analysis, Competitive Analysis, Internal and External Sorting algorithms: Quick Sort, Heap Sort, Merge Sort, Counting Sort, Bin Sort, Multi-way merge sort, Polyphase merging, Search: Linear, Binary, Hashing. Advanced Data Structures: AVL Trees, Red-Black Trees, Splay Trees, B-trees, Fibonacci heaps,
2. Data Structures for Disjoint Sets, Augmented Data Structures.
3. Graphs & Algorithms: Representation, Type of Graphs, Paths and Circuits: Euler Graphs, Hamiltonian Paths & Circuits; Cut-sets, Connectivity and Separability, Planar Graphs, Isomorphism, Graph Coloring, Covering and Partitioning, Depth- and breadth-first traversals.
4. Minimum Spanning Tree: Prim's and Kruskal's algorithms, Shortest-path Algorithms: Dijkstra's and Floyd's algorithm, Topological sort, Max flow: Ford-Fulkerson algorithm, max flow – min cut problem.
5. String Matching Algorithms: Suffix arrays, Suffix trees, Rabin-Karp, Knuth-Morris-Pratt, Boyer-Moore.
6. Approximation algorithms: Need of approximation algorithms: Introduction to P, NP, NP-Hard and NP-Complete; Deterministic, non-Deterministic Polynomial time algorithms; Knapsack, TSP, Set Cover, Open Problems.
7. Randomized Algorithms: Introduction, Type of Randomized Algorithms, Quick Sort, Min-Cut, 2-SAT; Game Theoretic Techniques, Random Walks.

Books:

1. Thomas Cormen, "Introduction to Algorithms", Third edition, Prentice Hall of India (2009).
2. Kleinberg J., Tardos E., "Algorithm Design", 1st Edition, Pearson, 2012.
3. Motwani R., Raghavan P., "Randomized Algorithms", Cambridge University Press, 1995.
4. Vazirani, Vijay V., "Approximation Algorithms", Springer, 2001.



**Pre Ph.D. Course in Computer Science and Engineering  
Soft Computing**

L	T	P
4	0	0

1. Soft Computing: An introduction. Artificial Neural Network: An introduction, Supervised Learning Network: Perceptron Networks, Adaptive Linear Neuron, Multiple Adaptive Linear Neuron, Back Propagation Network and other networks, Associative memory networks, Unsupervised Learning Networks.

2. Fuzzy Logic: Introduction to Fuzzy logic, Classical Sets and Fuzzy Sets, Classical Relations and Fuzzy Relations, Membership functions, Defuzzification, Fuzzy Arithmetic and Fuzzy measures, Fuzzy Rule base and approximate reasoning, Fuzzy decision making

3. Genetic Algorithm: An introduction, Traditional Optimization and Search Techniques, GA and Search Space, General GA, Operators in GA, Stopping Condition and GA flow, Constraints in GA, Classification of GA, Genetic Programming.

4. Hybrid Soft Computing Techniques: An Introduction, Neuro-Fuzzy Hybrid Systems, Genetic Neuro-Hybrid systems, Genetic fuzzy Hybrid and fuzzy genetic hybrid systems.

Books:

1. Principals of Soft Computing by Sivanandam and S. N. Deepa, Wiley Publication.
2. NEURAL NETWORKS, FUZZY LOGIC AND GENETIC ALGORITHM: SYNTHESIS AND APPLICATIONS By S. RAJASEKARAN, G. A. VIJAYALAKSHMI, PHI.
3. Introduction to Soft Computing By Samir Roy and Udit Chakraborty, Pearson.

*[Handwritten signatures in blue ink]*



**Pre Ph.D. Course in Computer Science and Engineering**  
**Advanced Operating Systems**

L	T	P
4	0	0

1. Distributed operating system: Architectures, Issues in Distributed operating systems, Limitations of Distributed Systems, Lamport's logical clock, Global states, Chandy-Lamport's global state recording algorithm, Basic concepts of Distributed Mutual Exclusion, Lamport's Algorithm, RicartAgrawala Algorithm; Basic concepts of Distributed deadlock detection, Distributed File system, Architecture, Design issues, SUN Network File system
2. Basic concepts of Distributed shared memory, Basic concepts of Distributed Scheduling, Load balancing, Load sharing. Distributed Resource Management: Distributed File systems, Architecture, Mechanisms, Design Issues, Distributed Shared Memory, Architecture, Algorithm, Protocols - Design Issues. Distributed Scheduling, Issues, Components, Algorithms. Distributed OS Implementation: Models, Naming, Process migration, Remote Procedure Calls.
3. Failure Recovery and Fault Tolerance: Basic Concepts-Classification of Failures, Basic Approaches to Recovery; Recovery in Concurrent System; Synchronous and Asynchronous Checkpointing and Recovery; Check pointing in Distributed Database Systems; Fault Tolerance; Issues - Two-phase and Nonblocking Commit Protocols; Voting Protocols; Dynamic Voting Protocols
4. Multiprocessor System: Definition, Classification, Multiprocessor Interconnections, Types, Multiprocessor OS functions & requirements; Design & Implementation Issue; Introduction to parallel programming; Multiprocessor Synchronization. Real Time Operating systems: Fundamentals of real time operating systems, real time multitasking, embedded application, preemptive task scheduling, inter-task communication and synchronization. Analytic Modeling: Introductions, Queuing Theory, Markov Process.

**Books:**

1. Operating Systems Concepts & design-Milan Milenkovic, TMH
2. Operating System- H.M. Deitel, Pearsons.
3. Advanced Concepts in operating Systems-Mukesh Singhal and Niranjan G. Shivaratri, TMH
4. Mukesh Singhal and N. G. Shivaratri, "Advanced Concepts in Operating Systems", McGraw-Hill, 2000
5. Abraham Silberschatz, Peter B. Galvin, G. Gagne, "Operating System Concepts", Sixth Addison Wesley Publishing Co., 2003.

*[Signature]*

*Daman Mani*

*[Signature]*

**Pre Ph.D. Course in Computer Science and Engineering  
Big Data Analytics**

L	T	P
4	0	0

1. An Overview of Big Data and Big Data Analytics. Understanding Hadoop Ecosystem (Hadoop Distributed File System, MapReduce, Hadoop YARN, HBase, Combining HBase and HDFS, Hive, Pig, Sqoop, ZooKeeper, Flume, Oozie). MapReduce Framework. Techniques to Optimize MapReduce Jobs, Role of HBase in Big Data Processing
2. Developing Simple MapReduce Application, Points to Consider while Designing MapReduce. Controlling MapReduce Execution with InputFormat, Reading Data with Custom RecordReader, Organizing Output Data with OutputFormats, Customizing Data with RecordWriter, Optimizing MapReduce Execution with Combiner, Controlling Reducer Execution with Partitioners.
3. YARN Architecture, Working of YARN, YARN Schedulers, Backward Compatibility with YARN, YARN Configurations, Commands, Containers. Introduction to NoSQL. Types of NoSQL Data Models, Schema-Less Databases, Materialized Views, Distribution Models.
4. Analytical Approaches, Introducing to various Analytical Tools, Installing R, Handling Basic Expressions in R, Variables in R, Working with Vectors, Storing and Calculating Values in R, Creating and Using Objects, Interacting with Users, Handling Data in R Workspace, Executing Scripts, Reading Datasets and Exporting Data from R, Manipulating and Processing Data in R, Working with Functions and Packages in R, Performing Graphical Analysis in R, Techniques Used for Visual Data Representation, Types of Data Visualization

Books:

1. Big Data, Black Book by DT Editorial Services, Dreamtech Press.
2. Big Data Computing and Communications edited by Yu Wang, Hui Xiong, Shlomo Argamon, XiangYang Li, JianZhong Li, Springer
3. Big Data Analytics Beyond Hadoop by Vijay Srinivas Agneeswaran, FT Press.

*[Handwritten signatures in blue ink]*



## Inter Disciplinary course


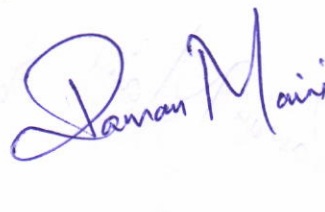
### Pre Ph.D. Course in Computer Science and Engineering Advanced Data Communication


L	T	P
4	0	0

1. Digital Modulation: Introduction, Information Capacity Bits, Bit Rate, Baud, and M-ARY Coding, ASK, FSK, PSK, QAM, BPSK, QPSK, 8PSK, 16PSK, 8QAM, 16QAM, DPSK – Methods, Band Width Efficiency, Carrier Recovery, Clock Recovery.
2. Basic Concepts of Data Communications, Interfaces and Modems: Data Communication Components, Networks, Distributed Processing, Network Criteria- Applications, Protocols and Standards, Standards Organizations- Regulatory Agencies, Line Configuration- Point-to-point Multipoint, Topology- Mesh- Star- Tree- Bus- Ring- Hybrid Topologies, Transmission Modes Simplex- Half duplex- Full Duplex, Categories of Networks- LAN, MAN, WAN and Internetworking, Digital Data Transmission- Parallel and Serial, DTE- DCE Interface- Data Terminal Equipment, Data Circuit- Terminating Equipment, Standards EIA 232 Interface, Other Interface Standards, Modems- Transmission Rates.
3. Error Detection and Correction: Types of Errors- Single- Bit Error, CRC (Cyclic Redundancy Check)- Performance, Checksum, Error Correction- Single-Bit Error Correction, Hamming Code. Data link Control: Stop and Wait, Sliding Window Protocols. Data Link Protocols: Asynchronous Protocols, Synchronous Protocols, Character Oriented Protocol- Binary Synchronous Communication (BSC) - BSC Frames- Data Transparency, Bit Oriented Protocols – HDLC, Link Access Protocols.
4. Switching: Circuit Switching- Space Division Switches- Time Division Switches- TDM Bus Space and Time Division Switching Combinations- Public Switched Telephone Network, Packet Switching, Circuit Switched Versus Virtual Circuit Connection, Message Switching.
5. Multiplexing: Time Division Multiplexing (TDM), Synchronous Time Division Multiplexing, Digital Hierarchy, Statistical Time Division Multiplexing. Multiple Access: Random Access, Aloha- Carrier Sense Multiple Access (CSMA)- Carrier Sense Multiple Access with Collision Detection (CSMA)- Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA), Controlled Access- Reservation- Polling- Token Passing, Channelization- Frequency- Division Multiple Access (FDMA), Time - Division Multiple Access (TDMA), - Code - Division Multiple Access (CDMA).

#### BOOKS:

1. Data Communication and Computer Networking - B. A. Forouzan, 3rd ed., 2008, TMH.
2. Advanced Electronic Communication Systems - W. Tomasi, 5 ed., 2008, PEI.
3. Data Communications and Computer Networks - Prakash C. Gupta, 2006, PHI.
4. Data and Computer Communications - William Stallings, 8<sup>th</sup> ed., 2007, PHI.
5. Data Communication and Tele Processing Systems - T. Housely, 2<sup>nd</sup> Edition, 2008, BSP.
6. Data Communications and Computer Networks- Brijendra Singh, 2<sup>nd</sup> ed., 2005, PHI.
7. Telecommunication System Engineering – Roger L. Freeman, 4<sup>th</sup> ed., Wiley-Interscience, John Wiley & Sons, 2004.

  
Page 17 of 22



## Inter Disciplinary course

### Pre Ph.D. Course in Computer Science and Engineering Internetworking

L	T	P
4	0	0

1. Internetworking concepts: Principles of Internetworking, Connectionless Internetworking, Application level Interconnections, Network level Interconnection, Properties of the Internet, Internet Architecture, Wired LANS, Wireless LANS, Point-to-Point WANS, Switched WANS, Connecting Devices, TCP/IP Protocol Suite. IP Address: Classful Addressing: Introduction, Classful Addressing, Other Issues, Sub-netting and Super-netting IP Address: Classless Addressing: - Variable length Blocks, Sub-netting, Address Allocation. Delivery, Forwarding, and Routing of IP Packets: Delivery, Forwarding, Routing, Structure of Router. ARP and RARP: ARP, ARP Package, RARP.
2. Internet Protocol (IP): Datagram, Fragmentation, Options, Checksum, IP V.6. Transmission Control Protocol (TCP): TCP Services, TCP Features, Segment, A TCP Connection, State Transition Diagram, Flow Control, Error Control, Congestion Control, TCP Times. Stream Control Transmission Protocol (SCTP): SCTP Services, SCTP Features, Packet Format, Flow Control, Error Control, Congestion Control. Mobile IP: Addressing, Agents, Three Phases, Inefficiency in Mobile IP. Classical TCP Improvements: Indirect TCP, Snooping TCP, Mobile TCP, Fast Retransmit/ Fast Recovery, Transmission/ Time Out Freezing, Selective Retransmission, Transaction Oriented TCP.
3. Unicast Routing Protocols (RIP, OSPF, and BGP): Intra and Inter-domain Routing, Distance Vector Routing, RIP, Link State Routing, OSPF, Path Vector Routing, BGP. Multicasting and Multicast Routing Protocols: Unicast - Multicast- Broadcast, Multicast Applications, Multicast Routing, Multicast Link State Routing: MOSPF, Multicast Distance Vector: DVMRP.
4. Domain Name System (DNS): Name Space, Domain Name Space, Distribution of Name Space, and DNS in the internet. Remote Login TELNET:- Concept, Network Virtual Terminal (NVT). File Transfer FTP and TFTP: File Transfer Protocol (FTP). Electronic Mail: SMTP and POP. Network Management-SNMP: Concept, Management Components. World Wide Web- HTTP Architecture. Multimedia: Digitizing Audio and Video, Network security, security in the internet firewalls. Audio and Video Compression, Streaming Stored Audio/Video, Streaming Live Audio/Video, Real-Time Interactive Audio/Video, RTP, RTCP, Voice Over IP. Network Security, Security in the Internet, Firewalls.

#### BOOKS:

1. TCP/IP Protocol Suite- Behrouz A. Forouzan, Third Edition, TMH.
2. Internetworking with TCP/IP Comer 3rd edition PHI.
3. High performance TCP/IP Networking- Mahbub Hassan, Raj Jain, PHI, 2005
4. Data Communications & Networking – B.A. Forouzan – 2<sup>nd</sup> Edition – TMH
5. High Speed Networks and Internets- William Stallings, Pearson Education, 2002.

*Forouzan*

*Sanjay Mani*



## Inter Disciplinary course

### Pre Ph.D. Course in Computer Science and Engineering Optimization Techniques

L	T	P
4	0	0

1. Introduction to Optimization Techniques, Origin & development of O.R., Nature & Characteristic, features of O.R., Models & Modeling in Operation Research. Methodology of O.R.
2. Linear Programming - Mathematical Model, Assumptions of Linear Programming, Graphical Method, Principles of Simplex method and its Applications, Two Phase & Big M-method, Revised simplex method, Duality, Dual simplex method- Primal Dual Relationship and sensitivity analysis.
3. Linear Programming: Mathematical formation of linear programming problem, Special types of linear programming problems -Transportation and assignment problems, Unbalanced Assignment problems, Crew based assignment problems, Test for Optimality, Degeneracy in Transportation Problems, Unbalanced Transportation Problems.
4. Definition of Probability, Sample Space, Algebra of Events, Addition and multiplication law of probability, Conditional Probability. Dynamic Programming-Features and applications of dynamic programming.
5. Decision Theory, Integer Programming, Gomory Method and Branch & Bound Method.

#### Books:

1. Kapoor, V.K.: Operation Research, Sultan Chand & Co., New Delhi.
2. Man Mohan, Gupta P.K.: Operation Research, Sultan Chand & Co., New Delhi.
3. Pronsens, Richard: Theory and Problems of Operation Research, McGraw Hill, 1983.
4. Hiller, F.S. & Liberman, G.J., 1974: Introduction to Operations Research, 2nd Edn. Holden
5. Rao, S. S., 1978: Introduction to Optimization: Theory & Applications, Wiley Eastern.
6. Srinath, L.S.: Linear Programming, East-West, New Delhi.

*Signature*

*Daman Maini*

*Signature*

**Inter Disciplinary course**

**Pre Ph.D. Course in Computer Science and Engineering  
Adhoc Wireless and Sensor Networks**

L	T	P
4	0	0

1. AD HOC Wireless Networks: Introduction, Issues in Ad Hoc Wireless Networks, AD Hoc Wireless Internet. MAC Protocols for Ad Hoc Wireless Networks: Introduction, Issues in Designing a MAC protocol for Ad Hoc Wireless Networks, Design goals of a MAC Protocol for Ad Hoc Wireless Networks, Classifications of MAC Protocols, Contention - Based Protocols, Contention - Based Protocols with reservation Mechanisms, Contention - Based MAC Protocols with Scheduling Mechanisms.
2. ROUTING PROTOCOLS: Introduction, Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks, Classification of Routing Protocols, Table -Driven Routing Protocols, On - Demand Routing Protocols, Hybrid Routing Protocols, Routing Protocols with Efficient Flooding Mechanisms, Hierarchical Routing Protocols, Power - Aware Routing Protocols. Transport layer and Security Protocols: Introduction, Issues in Designing a Transport Layer Protocol for Ad Hoc Wireless Networks, Design Goals of a Transport Layer Protocol for Ad Hoc Wireless Networks, Classification of Transport Layer Solutions, TCP Over Ad Hoc Wireless Networks, Other Transport Layer Protocol for Ad Hoc Wireless Networks.
3. QUALITY OF SERVICE: Introduction, Issues and Challenges in Providing QoS in Ad Hoc Wireless Networks, Classification of QoS Solutions, MAC Layer Solutions, Network Layer Solutions, QoS Frameworks for Ad Hoc Wireless Networks. ENERGY MANAGEMENT: Introduction, Need for Energy Management in Ad Hoc Wireless Networks, Classification of Ad Hoc Wireless Networks, Battery Management Schemes.
4. WIRELESS SENSOR NETWORKS: Introduction, Sensor Network Architecture, Data Dissemination, Data Gathering, MAC Protocols for Sensor Networks, Location Discovery, Quality of a Sensor Network, Evolving Standards, Other Issues.

- BOOKS: 1. Ad Hoc Wireless Networks: Architectures and Protocols - C. Siva Ram Murthy and B.S.Manoj, 2004, PHI.
2. Wireless Ad- hoc and Sensor Networks: Protocols, Performance and Control Jagannathan Sarangapani, CRC Press.
  3. Ad- Hoc Mobile Wireless Networks: Protocols & Systems, C.K. Toh ,1 ed. Pearson Education.
  4. Wireless Sensor Networks - C. S. Raghavendra, Krishna M. Sivalingam, 2004, Springer

*Indhu*  
*Danay Main*  
*for*



## Inter Disciplinary course

### Pre Ph.D. Course in Computer Science and Engineering Neural Networks and Fuzzy Logic

L	T	P
4	0	0

1. Fundamentals of Neural Networks: Introduction, Biological Neurons and Memory, Structure & Function of a single Neuron, Artificial Neural Networks (ANN). Typical Application of ANN - Classification, Clustering, Pattern Recognition, Function Approximation. Basic approach of the working of ANN – Training, Learning and Generalization.
2. Supervised Learning: Single-layer Networks, Linear Separability, handling linearly non-separable sets. Training algorithm. Error correction & gradient decent rules. Multi-layer network- Architecture, Back Propagation Algorithm (BPA) – Various parameters and their selection, Applications, Feedforward Network, Radial- Basis Function (RBF) network & its learning strategies.
3. Unsupervised Learning: Winner-takes all Networks, Hamming Networks. Adaptive Resonance Theory, Kohonen's, Self-organizing Maps.  
Neurodynamical models: Stability of Equilibrium states, Hopfield Network, Brain-state-in-a-Box network, Bidirectional associative memories.
4. Fuzzy Logic: Basic concepts of Fuzzy Logic, Fuzzy vs. Crisp set Linguistic variables, membership functions, operations of fuzzy sets, Crisp relations, Fuzzy relations, Approximate reasoning, fuzzy IF-THEN rules, variable inference, techniques, defuzzification techniques, Fuzzy rule based systems. Applications of fuzzy logic.

#### Books:

1. Satish Kumar, "Neural Network : A classroom approach", Tata McGraw Hill.
2. Jacek M. Zurada, "Artificial Neural Networks", West Publication.
3. Rajasekaran & Pai, "Neural networks, Fuzzy logic and genetic algorithms", PHI learning Pvt. Ltd.

*Signature*

*Danar Moins*

*Signature*

## Inter Disciplinary course

### Pre Ph.D. Course in Computer Science and Engineering Mathematical Foundations of Computer Networks

L	T	P
4	0	0

1. Basic algorithms on directed graphs, weighted shortest paths.
2. Networks and routing algebras - fixed-point equations, sequential algorithm to solve the fixed-point equations, generalized distance-vector and link-state routing protocols.
3. Applications to quality-of service intra-domain routing and to policy-based inter-domain routing in the Internet.
4. Network flows - flows and residual networks, Max-flow Min-cut theorem, Ford Fulkerson method and Edmonds-Karp algorithm.
5. Network calculus- Min-plus calculus: integrals and convolutions, Arrival curves and token buckets; service curves and schedulers, Applications to integrated and differentiated services in the Internet.

#### Books:

1. Thomas Cormen, Charles Leiserson, Ronald Rivest, and Clifford Stein. Introduction to algorithms, 2th edition. The MIT Press 2001 [Chapter VI]
2. Jorgen Bang-Jensen and Gregory Gutin. Digraphs: theory, algorithms and applications. Springer, 2002 [Section 7.3 and 9.5]
3. J. L. Sobrinho, An algebraic theory of dynamic network routing, IEEE/ACM Transactions on Networking, 13(5), October 2005.
4. Jean-Yves Le Boudec and Patrick Thiran. Network calculus. Springer, 2006. [Chapter 1, 2, and 3]

*Prin. Dhanu Mair*  
*Kuh*