REVISED SYLLABUS

Academic Year 2019-2020

Department of Computer Science

School of Mathematics, Statistics and Computational Sciences

Central University of Rajasthan

NH-8 Jaipur- Ajmer Highway, Bandarsindri
Kishangarh -305802
District-Ajmer, Rajasthan
Website: www.curaj.ac.in

Central University of Rajasthan
School of Mathematics, Statistics and Computational Science
Department of Computer Science

Coursework for the Doctoral Program (Ph.D):-

The Degree of Doctor of philosophy is granted for research work in areas recognized by the academic Departments of the University. The research work shall be an original work characterized either by the discovery of facts, or by a fresh approach towards the interpretation and application of facts, or development of equipment making a distinct advancement in instrument technology. It shall evince the candidate's capacity for critical examination and sound judgment and shall represent original contribution to the existing knowledge.

The Department of Computer Science offer a variety of courses that enables the students to get a deep and state of art understand of their field of specialization, while at the same time acquiring an excellent background in other relevant areas of computer science.

Keeping in view the tradition of academic excellence, the following goals of the Department of Computer Science have been laid for doctoral research:

1. To develop deep and broad understanding of fundamentals and state of the art of knowledge in the chosen area through courses work and self-study.
2. To develop synergy between creativity, innovation and the frontiers of knowledge in the chosen area of study.
3. To develop ability and skills to carry out independent research and development to face the challenges posed to mankind on specific problems.
4. To develop abilities to identify new possibilities in the computer application domain and to undertake research and development through one's own initiatives.

On joining the Ph.D program, the student is assigned a faculty advisor/ mentor, who will help the student choose the appropriate course/ area. The first semester course work aim is to fill whatever gaps there are in the students' background, as well as to provide the foundation in analysis and in other basic subject which are necessary preparation for the more specialized course in the following years.

Scheme for the course work:-

The total credits in the Ph.D.course work are 12. The credits are distributed as follows:

1. Research Methodology for Computer Science (4 credits)
2. Core subjects of computer Science (4 credits)
3. Specialized course (area of research based) with the research supervisor (4 credits)

The detail syllabuses of the course work are:

CSC-701: Research Methodology: (Course credits: **4)**

Course Outline: -

The proposed course covers the way to identify research problem and formulation of hypotheses to solve it in different ways. The designed course also covers various Data Analysis & Tools, Interpretation mechanism and presentation tools to illustrate results in an understandable format. The proposed course also covers various report writing tools and common syntax to write quality research papers in reputed conference and journals.

Objectives: -

1) The basic objective of the course is to identify the facts and analyze research problem.
2) Identify the required data analysis tools to perform data analytic operations.
3) Design research methodology to solve identified problem.
4) To understand Performance comparison methods and to evaluate the performance of the proposed method.

Unit-1: Introduction to Research Methodology

- Research Problem and Research Design
- Formulation of Hypotheses

Unit-2: Data Analysis and Interpretation

- Data Analysis: Statistical Methods
- Data Analysis: Computer Processing
- Interpretation and Presentation of Results

Unit-3: Data Analysis Tools

- Spreadsheet/Weka/R
- Citation Analysis Tools:
    - ❖ Refwork, Mendle etc.
    - ❖ Citation Data Bases: Web of Science and Scopus

Unit-4: Report Writing

- Reference Styles and Citations
- Research Report Writing

- Style Manuals
- IPR and Plagiarism

Reference Books

1. **CONNAWAY (L S) & POWELL (R R).** Basic Research methods for librarians (Ed. 5), (2010) Libraries unlimited. California.
2. **GLOOTENBERG (A).** Research methodology in Library and Information Science, (2013) Uxbridge: Koros.
3. **KOTHARI (C R).** Research methodology: Methods & Techniques (Rev. Ed.), (2006) New Age International. New Delhi.
4. **ROIG (M**). Avoiding plagiarism, self-plagiarism, and other questionable writing practices: A guide to ethical writing, (2006).
5. **VAUGHAN (L).** Statistical methods for the information professional: A practical, painless approach to understanding, using and interpreting statistics (Ed. 2), (2004) Information Today, Medord.
6. **WILLEMESE (I).** Statistical methods and calculation skills (Ed. 3), (2009) Juta. Cape Town.
7. **GRIFFITHS (D).** Microsoft excel basic formulae: Learn key formulae to learn simple data analysis, (2015).
8. **WITTEN (IH), FRANK (E), HALL (MA) & PAL (CJ).** Data mining: Practical machine learning tools and techniques (Ed. 4), (2017) Cambridge. United States.
9. **VISWANATHAN (V).** Data analytics with R: A hands-on approach (Ed. 2), (2015).

Course outcomes:-

1) Ph.d Scholar should able to learn tools for various data handling techniques such as Weka and R.
2) Able to implement the code in R Language for the proposed algorithm.
3) Learn various types of reference styles for books, conferences and journals.
4) Students able to learn report writing tools such as Latex.
5) Develop the Capability to compare the results of proposed approaches with various existing methods.

CSC-702: Core courses in Computer Science :

The candidate must choose any one of the following:

Objective: After completion of this course students will be able to draw 2 dimensional graphical objects using geometrical algorithms and performs operations on them.

1. **Computer Graphics**

   Unit-I :-

   Introduction, Geometrical shapes drawing algorithms, Clipping, Polygon Filling,

   Unit-II: -

   Geometric Transformations and Representation, Hidden Surfaces, Shading, Coloring.

   Unit-III:-

   Fractal Graphics: Basic Concepts, Feedback System, Classical Fractals, Dimension, Iterated Function System, L- System Any other relevant topic.

Reference Books:

1. Donald Hearn and Paulin Baker, Principles of Computer Graphics, TMH
2. H. O. Peitgen, H. Jurgen and D. Saupe, Fractals and Chaos, New Frontier of Science, Springer Verlag, New York, 1994.

Learning Outcomes:

- Display Devices
- Input Devices
- Line Drawing Algorithms
- Circle and Ellipse Drawing Algorithms
- 2D Transformations
- Line and Polygon clipping
- Coler Fill Methods
- 2D Projections
- Introduction of Fractal Graphics

2. Computer Networks:

Course outline: The designed course covers the topics of computer networks. The topics of computer networks are basics of signals, conversion of signals from analog to digital and from digital to analog. Course will give introduction to OSI Model for computer communication system and practical explore of communication protocol model which is TCP/IP layer architecture. Course will also cover detail functionalities and basic services provided by each and every layer.

Objectives of the Course: -

1) The course demonstrates OSI and TCP/IP Model.
2) Clear understanding of Guided Media characteristics and various Network Topology and Hardware building blocks.
3) Demonstration of challenges and issues in Data Link Layer functionalities.
4) Demonstration and Explanation of routing algorithms in Network Layer.
5) Demonstration of Various Application layer concepts.

Unit-I

Introduction, OSI vs TCP/IP, Layers and their protocols, Physical Layer, Data Link Layer,

Unit-II

Sliding Window Protocols, Medium Access Control Sub layer, Wireless MAC, Repeaters, Hubs, Bridges, Switches, Routers, Gateways,

Unit-III

Network Layer Distance Vector vs Link State Routing, Shortest Path Routing, Multicast Routing and reliable Multicast, Quality of Service, Network Layer in the Internet, Transport Layer, UDP vs TCP,

Unit-IV:

Application Layer, IPv4 and IPv6, advanced topics in Computer networks.

Reference Books:

1. Computer Networks — Andrew S Tanenbaum, 4th Edition. Pearson Education/PHI
2. Data Communications and Networking – Behrouz A. Forouzan.Third Edition TMH.
3. An Engineering Approach to Computer Networks-S.Keshav, 2nd Edition, Pearson Education.
4. Understanding communications and Networks, 3rd Edition, W.A. Shay, Thomson.

Outcomes of the Course:-

1. Student should be able to understand various layer functionalities.
2. Able to understand various addressing schemes.
3. Students able to understand difference between TCP and UDP.
4. Gain the knowledge of application layer protocols to perform the operations of end user.

3. Mobile Computing:

Prerequisites to the Course:-

Computer Networks.
Data Communication.

Course Outline: -

The proposed course introduces the fundamentals of Wireless Communication, issues challenges in wireless communication. The course in detail explanation various generation of Wireless Networks generation those are 2G, 3G and 4G.The proposed course covers technical details layer wise, which are Physical layer parameters such as modulation, demodulation and multiplexing techniques. MAC Layer issues such as various channel accessing schemes those are pure aloha, slotted aloha and p-persistent. The course covers in detail technical details such as packet formats of IEEE-802.11 standards for Medium accesses control to avoid collisions. Network Layer issues and challenges and details of various routing algorithms such as AODV, DSR and TORA protocols. Various TCP Enhancements for existing TCP Version which are TCP-RENO ,Tahoe and SACK protocols for reliable and end-to-end communication for improving the performance.

Objectives:-

1) The objective is to understand various generations of Mobile Communication such as 2G, 3G and 4G.
2) Demonstrate various issues and challenges in Physical layer such as analog to digital conversion and various modulation and demodulation techniques.
3) Illustration of various physical layer issues like inter symbol interference, ISI Mitigation. Physical layer parameter such as refraction, reflection and signal to noise ratio to improve the quality.
4) Demonstrate the Various MAC Layer challenges in Wireless Networks when compared to structured Networks.
5) Study of various Routing Layer Protocols suitable for Wireless Ad-Hoc Networks and Protocol operations.

6) Various TCP Layer issues and challenges for Wireless Networks.

UNIT-I

Issues in Wireless Communication, Mobile Computing applications, Layers Wise discussion, Wireless MAC Layer issuers,

UNIT-II

Network and TCP layer issues. Mobile Transport Layer : Traditional TCP, Indirect TCP, Snooping TCP, Mobile TCP, Fast retransmit/fast recovery, Transmission /time-out freezing, Selective retransmission,

UNIT-III

Transaction oriented TCP, Aggregation, Clustering and Data Fusion. Localization in WSN. Database Issues: Hoarding Techniques, caching invalidation mechanisms, client server computing with adaptation,

UNIT-IV

Power-aware and context-aware computing, transactional models, query processing, recovery, and quality of service issues. Any other relevant topic related to mobile computing.

Reference Books:

1. JochenSchiller,"MobileCommunications",*Addison-Wesley*.(Chapters 4,7,9,10,11),second edition, 2004.
2. Stojmenovic and Cacute, "Handbook of Wireless Networks and Mobile Computing", *Wiley*, 2002, ISBN0471419028.
3. Reza Behravanfar, "Mobile Computing Principles: Designing and Developing Mobile Applications with UML and XML", ISBN: 0521817331, Cambridge University Press, October 2004,
4. Adelstein, Frank, Gupta, Sandeep KS, Richard III, Golden , Schwiebert, Loren, "Fundamentals of Mobile and Pervasive Computing", ISBN: 0071412379, McGraw-Hill Professional, 2005.

Outcomes:-

1) Students are able to understand the difference between structure networks and Wireless Networks.
2) Get knowledge of various differences between guided and unguided media.
3) Understand the benefits of various Layer addressing schemes in communication protocol architecture.
4) Performance evaluation of designed protocols in various Network Simulators to perform simulation of various layer protocol operations and its performance evaluation with existing protocols.
5) Design of efficient protocols operation to improvise the performance Wireless Networks.

4. **Data Mining and Data ware housing**

Learning Objectives & Outcomes:-

- The student will learn to approach data mining as a process, by demonstrating competency in the use of data mining to the decision-support level of organizations
- The students will learn to categorize and carefully differentiate between situations for applying different data-mining techniques
- Identify appropriate methods to adress a given problems with data mining methods such as frequent pattern mining, association, correlation, classification, prediction, and cluster and outlier analysis
- Able to design and implement data-mining solutions for different applications
- Proficiency in evaluating and comparing different models used for Data Mining

UNIT-I
Introduction to Data Mining, Stages of the Data Mining Process, Data Warehouse and OLAP,

UNIT-II
Multidimensional data model, OLAP operations, Knowledge Representation Methods, Representing input data and output knowledge, Visualization techniques,

UNIT-III
Experiments with Weka – visualization Data Mining Algorithm: Association rules, Classification, Clustering, Prediction,

UNIT-IV
Experiments with Weka, Mining real data Applications of Data mining and recent advances in data mining

Reference Books:

1. Introduction to Data Mining - Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Pearson Education, 2007
2. Ian H. Witten and Eibe Frank, *Data Mining: Practical Machine Learning Tools and Techniques (Second Edition)*, Morgan Kaufmann, 2005, ISBN: 0-12-088407-0.
3. Data Mining – Concepts and Techniques - Jiawei Han and MichelineKamber, 2nd Edition, Morgan Kaufmann, 2006.
4. Insight into Data Mining – Theory and Practice - K.P.Soman, ShyamDiwakar, V.Ajay, PHI, 2006.

5. **Cryptography & Network Security:**

Course Outline: - The designed course covers basic security aspects to protect network from various kind of attacks. Various kinds of encryption and decryption techniques to protect data from malicious users. Course covers DES and RSA logarithms which are basic symmetric and asymmetric algorithms. Course also covers various authentication mechanisms.

Objectives:-

- Understand security fundamentals.
- Able to learn Cryptography Principles such as key exchange, digital signature and certificates.
- Demonstration of various encryption decryption schemes by taking plain text.
- Generation Message Authentication codes for different kinds of messages.

Unit-I

Security Attacks (Interruption, Interception, Modification and Fabrication), Security Services (Confidentiality, Authentication, Integrity, Non-repudiation, access Control and Availability) and Mechanisms,

Unit-II

A model for Internetwork security, Internet Standards and RFCs, Buffer overflow & format string vulnerabilities, TCP session hijacking, ARP attacks, route table modification,

Unit-III

UDP hijacking, and man-in-the-middle attacks. Conventional Encryption Principles, Conventional encryption algorithms, cipher block modes of operation, location of encryption devices, key distribution Approaches of Message Authentication, Secure Hash Functions and HMAC.

Unit-IV

IP Security Overview, IP Security Architecture, Authentication Header, Encapsulating Security Payload, Combining Security Associations and Key Management. Any other related topic.

References:

1. Fundamentals of Network Security by Eric Maiwald (Dreamtech press)
2. Network Security - Private Communication in a Public World by Charlie Kaufman, Radia Perlman and Mike Speciner, Pearson/PHI.
3. Cryptography and network Security, Third edition, Stallings, PHI/Pearson
4. Principles of Information Security, Whitman, Thomson.
5. Network Security: The complete reference, Robert Bragg, Mark Rhodes, TMH.
6. Introduction to Cryptography, Buchmann, Springer.

Outcomes:-

1. Students will able to understand the security features to improve the reliability in communication system.
2. Able to find the encrypt message by using various encryption mechanisms.
3. Able to generate various message authentication codes and message digest codes to improve the security aspects in data transmission.

6. Advanced Operating System

Operating systems are the heart of the Computer system. They act as an interface between the Hardware and the user. This course is designed to provide in-depth understanding of the operating systems.

Course Objectives

- Provide basic understanding of the functions and types of operating systems.
- To introduce the concepts of process management, memory management, file management and deadlocks.
- Do practical exercises on scheduling techniques.
- Laboratory exercises to be covered in Lab sessions.

Unit-I

Issues in communication, Remote Procedure Call, Remote Method Invocation,Message- and Stream-Oriented communication,

Unit-II

Processes and threads, Code migration and distributed scheduling, Naming, Clock Synchronization, Distributed mutual exclusion and distributed deadlocks, Distributed transaction,

Unit-III

Consistency models, Replication, Distributed file systems (NFS, AFS & coda), Security in distributed systems, Distributed middleware: CORBA, other related topics

References:

Abraham Silberschatz, Peter B. Galvin, Operating System Concepts, John Wiley &Sons

Andrew S. Tannenbaum, Modern Operating systems, Pearson Education.

Andrew S. Tannenbaum, Distributed Operating systems, Pearson Education.

Outcomes:-

At the end of this course, the student will be able to:

- Develop in-depth understanding of the functions and concepts related to operating systems.
- Demonstrate understanding of CPU and disk scheduling algorithms.
- Understand how different kinds of Operating systems work.

7.Compiler Design:

Course Outline: - The proposed course covers various phases of Compiler which are lexical phase, syntax phase, semantic phase, code generation and code optimization. Course also covers various parsing techniques such as LEX and YACC.

Course Objectives:-

1) To understand various models to produce tokens which are inputs syntax phase.
2) Try to understand various parsing techniques such as top-down and bottom-up parsing techniques.
3) Symbol Table generation and mechanisms to store information while scanning source code from various phases of the compiler.
4) Semantic analysis to check the meaning of the sentences in a particular sentence.

UNIT-I

Compiler Structure: Analysis-synthesis model of compilation, various phases of a compiler, tool based approach to compiler construction.
Lexical analysis: Interface with input parser and symbol table, token, lexeme and patterns, difficulties in lexical analysis, error reporting and implementation. Regular grammar & language definition, Transition diagrams, design of a typical scanner using LEX of Flex.

UNIT-II

Syntax Analysis: Context free grammars, ambiguity, associability, precedence, top down parsing, top down parsing, recursive descent parsing, transformation on the grammars, predictive parsing LL(1) grammar, Nor LL(1) grammar, Bottom up parsing, operator precedence grammars, LR parsers (SLR, LALR, LR), Design of a typical parser using YACC or Bison.

UNIT-III

Syntax directed definitions: Inherited and synthesized attributes, dependency graph, evaluation order, bottom up and top down evaluation of attributes, L- and S-attributed definitions. Type checking: type: type system, type expressions, structural and name equivalence of types, type conversion, overloaded function and operators, polymorphic function. Run time system: storage organization, activation tree, activation record, parameter passing symbol table, dynamic storage allocation. Intermediate code generation: intermediate representation, translation of declarations, assignments, Intermediate Code generation for control flow, Boolean expressions and procedure calls, implementation issues.

UNIT-IV

Code generation and instruction selection: Issues, basic blocks and flow graphs, register allocation, code generation, DAG representation of programs, code generation from DAGS, peep hole optimisation, code generator generators, specification of machine.

Code optimisation: source of optimisations, optimisation of basic blocks, loops, global dataflow analysis, solution to iterative dataflow equations, code improving transformations, dealing with aliases, data flow analysis of structured flow graphs.

Text Book:

1. K. C. Louden, "Compiler Construction, Principle and Practice" Thomson Books, 2006
2. Alfred V. Aho, Ravi Sethi& Jeffrey D. Ullman, "Compilers Priciples, Techniques & Tools". Pearson, 1998.
3. Levine, Mason, and Brown, "Lex&Yacc", O' Reilly, 1998.

References:

1. S. S. Muchnick Harcourt Asra, "Advanced Compiler Design implementation", Morgan Kaufman, 2006.
2. Allen, "Modern Compiler Implementation in C", Cambridge Uty. Press 1997
3. Alan Holub, "Compiler Design in C", PHI, 2004.

Outcomes: -

1) Students are able to understand the functionality of compiler design various phases.
2) Able to learn functionalities of various phases.
3) Able to design phases of compiler as a programming exercise.
4) Able Design various parsing techniques such as SLR, LALR and CLR.

8.Intelligent Systems:

Prerequisites to course:

Discrete Mathematics, Software Engineering

Objectives & Outline of the course:-

The objective of the course is to present an overview of artificial intelligence (AI) principles and approaches. Develop a basic understanding of the building blocks of AI as presented in terms of intelligent agents: Search, Knowledge representation, inference, logic, and learning. Students will implement a small AI system in a team environment. The knowledge of artificial intelligence plays a considerable role in some applications students develop for courses in the program.

i. To have a basic proficiency in a traditional AI language including an ability to write simple to intermediate programs and an ability to understand code written in that language.
ii. To have an understanding of the basic issues of knowledge representation and blind and heuristic search, as well as an understanding of other topics such as minimax, resolution, etc. that play an important role in AI programs.

iii. To have a basic understanding of some of the more advanced topics of AI such as learning, natural language processing, agents and robotics, expert systems, and planning.

Unit-I:-

Introduction to Intelligent System: AI, Man Vs Computers, Simulation of Intelligent Behavior, AI techniques, Intelligent Agent. Application of Intelligent Systems

Unit-II:-

Expert System: Introduction, basic Architecture, Types of problem solved by Expert System, Features, Limitations, Knowledge Elicitation/Acquisition: Stages of Knowledge Acquision, Techniques of knowledge Elicitation, Expert System Tools, Application of Expert System Technologies.

Unit-III: -

Machine Learning: Introduction, Algorithmic models of learning. Learning Classifiers, probabilistic models, value functions, behaviors and programs from experience, Bayesian, maximum a posteriori, and minimum description length frameworks, Decision trees,

Unit-IV:-

Neural networks, support vector machines, Bayesian networks, bag of words classifiers, N-gram models; Markov and Hidden Markov models. Introduction to Neural networks, types and examples of neural networks. Any other related topics

References:

1. Russel, S. and Norvig, P. (2003). Artifiical Intelligence: A Modern Approach. 2nd Edition. New York: Prentice-Hall.
2. Peter Jackson, Introduction to Expert System (3rd Edition), Addition Wesley.
3. Bishop, C. (2006). Pattern Recognition and Machine Learning. Berlin: Springer-Verlag.

Outcomes:-

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

i. Design a knowledge based system.
ii. Explain what constitutes "Artificial" Intelligence and how to identify systems with Artificial Intelligence.
iii. Ability to apply Artificial Intelligence techniques for problem solving.
iv. Use classical Artificial Intelligence techniques, such as search algorithms, minimax algorithm, and neural networks.
v. Have read and analyzed important historical and current trends addressing artificial intelligence.

9. ADVANCED COMPUTER ARCHITECTURE:

Outline of the Course:-

The outline of the course is basic understand of circuit logic design and storage information in various formats in the memory, various addressing modes and various registers to store data temporarily. Various multi-processor architectures.

Course objectives:-

The course is designed to train the graduates in:

- Architecture of digital computers.
- Architecture of various digital units of a computer.
- Usage of digital computers in industry and research.

Unit-I :-

Fundamentals of Computer design, Changing faces of computing and task of computer Designer, Technology trends, Cost price and their trends.

Unit-II: -

Pipelines : Introduction ,basic RISC instruction set ,Simple implementation of RISC instruction set, Classic five stage pipe line for RISC processor, Basic performance issues in pipelining , Pipeline hazards, Reducing pipeline branch penalties.

Unit-III:-

Memory hierarchy design Instruction level parallelism the hardware approach - Instruction-level parallelism, dynamic scheduling, Dynamic scheduling using Tomasulo's approach, and Branch prediction, high performance instruction delivery- hardware based speculation. Multi Processors and Thread level Parallelism- Introduction, Characteristics of application domain, Systematic shared memory architecture, Distributed shared – memory architecture, Synchronization.

Unit-IV:-

Inter connection and networks – Introduction; Interconnection network media, Practical issues in interconnecting networks, Examples of inter connection, Cluster, Designing of clusters.

Intel architecture: Intel IA- 64 ILP in embedded and mobile markets Fallacies and pit falls

TEXT BOOKS:

1. John L. Hennessy, David A. Patterson, Computer Architecture: A Quantitative Approach, 3rd Edition, An Imprint of Elsevier.
2. Kai Hwang, "Advanced computer architecture"; TMH. 2000
3. D. A. Patterson and J. L. Hennessey, "Computer organization and design", Morgan Kaufmann, 2nd Ed. 2002

Course Outcomes:

Graduates after completing the course shall gain:

- Ability to understand architecture of digital computers.
- Ability to apply digital computers in solving complex problems in industry and research.
- Ability to take up advanced course in Computer Architecture.

10. Design & Analysis of Algorithms

Course Outline:-

Advanced Algorithm is seen as an empirical thought of design and analysis course which is a fundamental and important part of computer science. This course introduces students to advanced techniques for the design and analysis of algorithms, and explores a variety of applications which cover several advanced topics like P,NP Complete problems,Btree, Fibonacci heaps, Disjoint sets, hashing, network design, algorithms in machine learning,internet algorithms, and nearest neighbor algorithms. It also boost various useful ideas, including randomization, probabilistic analysis, amortized analysis, competitive analysis, eigenvalues, high dimensional geometry, and random walks etc.

Course objectives:

The course is designed to train the graduates in:

- Advanced topics in algorithm.
- To develop concept, ideas for any problem.
- To be enable to formalize with theoretical computer algorithms.

Unit-I:-

Introduction: Algorithm, Psuedo code for expressing algorithms, Performance Analysis-Space complexity, Time complexity, Asymptotic Notation- Big oh notation, Omega notation, Theta notation and Little oh notation, Probabilistic analysis, Amortized analysis. Disjoint

Unit-II

Sets- disjoint set operations, union and find algorithms, spanning trees, connected components and bi-connected components.

Unit-III

Dynamic Programming: General method, applications-Matrix chain multiplication, Optimal binary search trees, 0/1 knapsack problem, All pairs shortest path problem, Travelling sales person problem, Reliability design.

Unit-IV

Backtracking: General method, applications-n-queen problem, sum of subsets problem, graph coloring, Hamiltonian cycles, Travelling salesman Problem.

Branch and Bound: Hamiltonian cycles, travelling salesman Problem

NP-Hard and NP-Complete problems: Basic concepts, non-deterministic algorithms, NP - Hard and NPComplete classes, Cook's theorem. Any other related topic.

References:

1. Fundamentals of Computer Algorithms, Ellis Horowitz, Satraj Sahni and Rajasekharam, Galgotia publications pvt.Ltd.

2. Algorithm Design: Foundations, Analysis and Internet examples, M.T.Goodrich and R.Tomassia,Johnwiley and sons.

3. Introduction to Algorithms, second edition, T.H.Cormen, C.E.Leiserson, R.L.Rivest,and C.Stein,PHI Pvt. Ltd./ Pearson Education

4. Introduction to Design and Analysis of Algorithms A strategic approach, R.C.T.Lee, S.S.Tseng, R.C.Chang and T.Tsai, McGraw Hill.

5. Data structures and Algorithm Analysis in C++, Allen Weiss, Second edition, Pearson education.

6. Design and Analysis of algorithms, Aho, Ullman and Hopcroft,Pearson education.

7. Algorithms – Richard Johnson baugh and Marcus Schaefer, Pearson Education

Course Outcomes:

Graduates after completing the course shall gain:

- Ability to understand algorithms.
- Ability to develop concepts, logics towards solving a unknown problem in IT and research.
- Ability to get formalizes theoretical concepts of computer algorithms.

CSC-703: Advanced courses in the field of Computer Science (4 credits):-

Students must choose any one of the following as per their Specialization:-

Cloud Computing :-

Pre-requests to the course: -

Computer Networks.
Operating System.

COURSE OUTLINE: - Cloud computing is a service oriented paradigm for internet users to avail the services. It is a model and it enables for ubiquitous and on-demand accesses to share a pool of resources, which are minimal efforts required for users as well as service providers. This course will give details about various cloud computing services such as software as a service, platform as a service and Infrastructure as service to the service providers to run applications without any interruption and to save the IT Infrastructure cost while hosting applications over the Internet.

Objectives:-

1) Demonstrate the various Distributed technologies to perform the complex task in highly distributed environment.
2) Demonstrate the service oriented architecture to provide on-demand services to Internet users.
3) Design service level agreements (SLA) to meet the guaranty services in Cloud Environment.
4) Design Energy efficient Scheduling techniques to balance the Workload in a distributed environment.
5) Design Energy Efficient model for sustainable cloud platform for next decade various novel service integration paradigm.

Unit-I:-

Introduction to Cloud Computing: Cloud Computing in a Nutshell, Roots of Cloud Computing, Layers and Types of Clouds, Desired features of Cloud, Cloud Infrastructure Management. Infrastructure as Service Providers, Platform as Service Providers. **Migrating into a Cloud**: Introduction, Broad Approaches to Migration into the Cloud, The seven-step Model of Migration into a Cloud, Conclusions.

Unit-II:

Infrastructure as a Service (IAAS):-

Virtual Machine Provisioning and Migration Services: Introduction and Inspiration, Background and Related Work, Virtual Machine Provisioning and Manageability, Virtual Machine Migration Services, VM Provisioning and Migration in Action, Provisioning in the Cloud Context.

Unit-III:-

On the Management of Virtual Machine for Cloud Infrastructure: The Anatomy of Cloud Infrastructure, Distributed Management of Virtual Infrastructure, and Scheduling Techniques for Advanced Reservation of capacity, Capacity Management to meet SLA Commitments, Conclusions and Future Work.

Unit-IV

Fundamental Cloud Architectures : Work Load Distribution Architecture, Resource Pooling Architecture , Dynamic Scalability Architecture , Elastic Resource Capacity Architecture, Service Load Balancing Architecture, Cloud Bursting Architecture.

Advanced Cloud Architecture: Hypervisor Clustering Architectures, Load Balanced Virtual Server Instance Architecture, Non-Disruptive Service Relocation Architecture, Zero Downtime architecture, Cloud Balancing architecture.

References:

1. Cloud Computing Concepts, Technology &Architecture by Thomas Erl. Pearson Publishers.
2. Cloud Computing Principles and Paradigms Edited by Rajkumar Buyya , James Broberg and Andrzej Goscinski.

Outcomes:-

1) Get knowledge on basic concepts required to develop cloud computing applications.
2) To develop applications for cloud computing to provide on-demand services required for users.
3) Understand the concept of service oriented architecture such as IaaS, PaaS and SaaS.
4) Design and implement a novel cloud computing application in simulation environment.
5) Comparative Study and analysis of different economic cloud computing models with existing conventional software developing methodologies.

Security Engineering.

Prerequisite:-

Computer Networks.
Number Theory**.**

Course Outline:-

The course describes about various security attacks and security service mechanisms. It covers a model of Internet security. Course covers various encryption and decryption algorithms and various key distribution mechanisms. It also covers various security standards such as Kerberos, X.509, PGP and IP Security.

Objectives: -

1) Demonstration of security services such as confidentiality, Authentication, Integrity and Non-repudiation.
2) To understand various kind of attack over Internet.
3) Study of various prevention mechanisms to various kind of attacks over the internet.
4) Detail study of security standards to protect network security.

Syllabus:-

Unit-I

Security Attacks, Services (Confidentiality, Authentication, Integrity, Non-repudiation, access Control and Availability) and Mechanisms, A model for Internetwork security, Internet Standards and RFCs, Buffer overflow & format string vulnerabilities, TCP session hijacking.

Unit-II:-

ARP attacks, route table modification, UDP hijacking, and man-in-the-middle attacks. Conventional Encryption Principles, Conventional encryption algorithms, cipher block modes of operation, location of encryption devices, key distribution Approaches of Message Authentication.

Unit-III:

Network Security Overview ,Types of Security Attacks and Services, Internet Standards ,Symmetric Encryption ,Asymmetric Encryption , Kerberos ,X.509 ,PGP ,S/MIME , IP Security , Project Day, SSL ,TLS ,SNMP ,

Unit-IV:

Wireless Security, Cellular Security, DoS , DDoS , Firewalls , Database Security ,Intrusion Detection and Identification ,Obfuscation , Computer Forensics.

References

1. Network Security Essentials (Applications and Standards) by William Stallings Pearson Education.
2. Hack Proofing your network by Ryan Russell, Dan Kaminsky, Rain Forest Puppy, Joe Grand, David Ahmad, Hal Flynn IdoDubrawsky, Steve W.Manzuik and Ryan Permeh, wileyDreamtech
3. Fundamentals of Network Security by Eric Maiwald (Dreamtech press)
4. Network Security - Private Communication in a Public World by Charlie Kaufman, Radia Perlman and Mike Speciner, Pearson/PHI.
5. Principles of Information Security, Whitman, Thomson.
6. Cryptography and network Security, Third edition, Stallings, PHI/Pearson
7. Network Security: The complete reference, Robert Bragg, Mark Rhodes, TMH
8. Introduction to Cryptography, Buchmann, Springer.

Learning Outcomes:-

1) Student able to learn knowledge about security fundamentals and security features.
2) Gain the knowledge about encryption and decryption mechanisms to protect data.
3) Capacity to analyze and detect various kind of network security attacks such as DOS , DDOS with some kind of data collected from the various layer protocols over the network.
4) Performance evaluation of various existing approaches to detect well known security attacks.

GRID COMPUTING

Prerequisites:

- Computer Networks
- Distributed Computing

Outline of the Course: -

The proposed course work illustrates the infrastructure frame work for distributed and Cluster computing. Course work describes the protocol frame work for open source grid frame work to proper utilization of infrastructure based on the load availability. Resource utilization and task execution time should be minimizing while executing the workflows in highly distributed heterogeneous environment.

Objectives:

1) Demonstrate the Infrastructure required performing group of similar task together to solve a particular problem.
2) Grid Architecture and standards to establish IT Infrastructure to solve particular tasks.
3) To understand various Grid Service models to provide effective IT Infrastructure for IT needs.
4) To learn virtualization of Hardware, Software and Networking for effective services and resource utilization based on the need and demand.
5) To learn programming methodology and Simulators to demonstrate and validate the proposed protocols in grid service architecture.

UNIT I: INTRODUCTION

Evolution of Distributed computing: Scalable computing over the Internet – Technologies for network based systems – clusters of cooperative computers – Grid computing Infrastructures – cloud computing – service oriented architecture – Introduction to Grid architecture and standards – Elements of Grid – Overview of Grid architecture.

UNIT II: GRID SERVICES

Introduction to Open Grid Services Architecture (OGSA) – Motivation – Functionality Requirements – Practical & Detailed view of OGSA/OGSI – Data intensive grid service models – OGSA services.

UNIT III: VIRTUALIZATION

Cloud deployment models: public, private, hybrid, community – Categories of cloud computing: Everything as a service: Infrastructure, platform, software – Pros and Cons of cloud computing – Implementation levels of virtualization – virtualization structure – virtualization of CPU, Memory and I/O devices – Virtual clusters and Resource Management – Virtual for data center automation.

UNIT IV: PROGRAMMING MODEL

Open source grid middleware packages – Globus Toolkit (GT4) Architecture, Configuration – Usage of Globus – Main components and Programming model – Introduction to Hadoop Framework – Mapreduce, Input splitting, map and reduce functions, specifying input and output parameters, configuring and running a job – Design of Hadoop file system, HDFS concepts, command line and java interface, dataflow of File read & File write.

TEXTBOOK

1. Ahmar Abbas, “Grid Computing: A Practical Guide to Technology and Application”, Charles River Media, 2005.
2. Kai Hwang, Geoffery C. Fox and Jack J. Dongarra, “Distributed and Cloud Computing: Clusters, Grids, Clouds and the Future of Internet”, First Edition, Morgan Kaufman Publisher, an Imprint of Elsevier, 2012.

REFERENCES

1. Bart Jacob, “Introduction to Grid Computing”, IBM Red Books, Vervante, 2005.
2. Tom White, “Hadoop the Definitive Guide”, First Edition. O”Reilly, 2009.
3. Joshy Joseph and Craig Fellenstein, “G rid Com puting”, Pearson Education, 2003.
4. Ian Foster and Carl Kesselm an, “The Grid2: Blueprint for a New Computing Infrastructure”, Morgan Kaufman, 2004.

Outcomes:

- Understand the concept of various distributed platforms such as cluster computing, Distributed Computing and Cloud Computing.
- Know the basic concepts of Grid Infrastructure and practical and overall view of OGSA/OGSI.
- Understanding of Research Challenges and issues in Data Grid and Computational Grid.
- Understanding of Virtualization and its practical impact on Grid Infrastructure to enhance the performance of infrastructure.
- Hands on practice on Gridsim and CloudSim Simulator to know the performance of proposed protocols in Grid Environment.

Information Retrieval System

COURSE OUTLINE

Information retrieval is the process through which a computer system can respond to a user's query for text-based information on a specific topic. IR was one of the first and remains one of the most important problems in the domain of natural language processing. Web search is the application of information retrieval techniques to the largest corpus of text anywhere. The course focuses on IR methods for the processing, indexing, querying, organisation, and classification of textual documents, including hypertext documents available on the world-wide-web.

Prerequisites

- Students must know Data Base Management Systems.
- They must also have the concept of different types of algorithms used for searching data.
- They must also have minimal knowledge of natural language such as thesaurus, synonyms, etc.

Objectives:

- To provide the foundation knowledge in information retrieval.
- To present scientific support in the field of information search and retrieval.
- Demonstrate the usage of different data/file structures in building computational search engines.
- Students will be able to learn different indexing techniques to apply database systems.

Unit-I

Goals and history of IR.The impact of the web on IR. Introduction: Definition, Objectives, Functional Overview, Relationship to DBMS, Digital libraries and Data Warehouses. Information Retrieval System Capabilities: Search, Browse, Miscellaneous, Data Structures:

Unit-II:

Introduction, Stemming Algorithms, Inverted file structures, N-gram data structure, PAT data structure, Signature file structure, Hypertext data structure, Automatic Indexing: Classes of automatic indexing, Statistical indexing, Natural language, Concept indexing,

Unit-III

Hypertext linkages, User Search Techniques: Search statements and binding, Similarity measures and ranking, Relevance feedback, Selective dissemination of information search, Weighted searches of Boolean systems, Searching the Internet and hypertext. Information

Unit-IV:

Visualization: Introduction, Cognition and perception, Information visualization technologies.

References :

1. Kowalski, Gerald, Mark T Maybury: Information Retrieval Systems: Theory and Implementation, Kluwer Academic Press, 1997.
2. Frakes, W.B., Ricardo Baeza-Yates: Information Retrieval Data Structures and Algorithms, Prentice Hall, 1992.
3. Modern Information RetrivalBy Yates Pearson Education.
4. Information Storage &RetievalBy Robert Korfhage – John Wiley & Sons.
5.Christopher D. Manning, PrabhakarRaghavan and HinrichSchütze, *Introduction to Information Retrieval*, Cambridge University Press. 2008.

Learning Outcomes

After the completion of the course, the students will be able to:

- Understand basic concepts and techniques in Information Retrieval.
- Understand how statistical models of text can be used for other IR applications, for example, clustering.
- Use data structures and indexing methods in information retrieval systems.
- Understand the measures to evaluate the performance of algorithms.

Robotics

Unit-I:

Fundamental of Robotics: Robot anatomy, Co-ordinate system, Type and classification, speed of motion, Pay Load, Need of Robots, Different Applications.

Unit-II:

Elements of robots – links, joints, actuators, and sensors: Position and orientation of a rigid body, Homogeneous transformations, Representation of joints, link representation using D-H parameters,

Unit-III:

Examples of D-H parameters and link transforms, different kinds of actuators, Purpose of sensors, internal and external sensors, common sensors – encoders, tachometers, strain gauge based force-torque sensors, proximity and distance measuring sensors, and vision.

Unit-IV:

Kinematics of serial robots- Direct and inverse kinematics problems, Examples of kinematics of common serial manipulators, workspace of a serial robot, Inverse kinematics of constrained and redundant robots, Tractrix based approach for fixed and free robots and multi-body systems, simulations and experiments, Solution procedures using theory of elimination, Inverse kinematics solution for the general 6R serial manipulator. Other relevant topics.

References:

1. Ghosal, A., Robotics: Fundamental Concepts and Analysis, Oxford University Press, 2nd reprint, 2008.
2. Fu, K., Gonzalez, R. and Lee, C. S. G., Robotics: Control, Sensing, Vision and Intelligence¸ McGraw- Hill, 1987.
3. Research papers from Instructors group and other researchers in the field.

Natural Language Processing

Objective: After completion of this course students will be able to design a model of a prototype language.

Unit-I:-

Introduction, Level of Language Analysis, Organization of Natural language, Grammars: Grammars and sentence Structure, Transition Network Grammars.

Lexicon, Parsing with Features, Augmented Transition Networks, Various Lexicon Resource & Knowledge Source.

Unit-II:-

Natural Language: Auxiliary Verbs and Verb Phrases, Movement Phenomenon in Language, Handling questions in Context-Free Grammars, Hold mechanisms in ATNs. Concept of parsing:Human preferences in Parsing, Encoding uncertainty, Deterministic Parser, POS Tagger, Stemmer,Ambiguity Resolution, Any other relevant topic.

Unit-III

Sound : Biology of Speech Processing; Place and Manner of Articulation; Word Boundary Detection; Argmax based computations; HMM and Speech Recognition.

Words and Word Forms : Morphology fundamentals; Morphological Diversity of Indian Languages; Morphology Paradigms; Finite State Machine Based Morphology; Automatic Morphology Learning; Shallow Parsing; Named Entities; Maximum Entropy Models; Random Fields.

Unit-IV:-

Structures : Theories of Parsing, Parsing Algorithms; Robust and Scalable Parsing on Noisy Text as in Web documents; Hybrid of Rule Based and Probabilistic Parsing; Scope Ambiguity and Attachment Ambiguity resolution.

Meaning : Lexical Knowledge Networks, Wordnet Theory; Indian Language Wordnets and Multilingual Dictionaries; Semantic Roles; Word Sense Disambiguation; WSD and Multilinguality; Metaphors; Coreferences.

Web 2.0 Applications : Sentiment Analysis; Text Entailment; Robust and Scalable Machine Translation; Question Answering in Multilingual Setting; Cross Lingual Information Retrieval (CLIR).

References:

1. JAMES ALLEN, Natural Language Understanding, 2/e, Pearson Education, 2003.
2. D. JURAFSKY, J. H. MARTIN, Speech and Language Processing, Pearson Education, 2002.
3. Christopher D. Manning, HinrichSchütze, Foundations of Statistical Natural Language Processing, The MIT Press, Cambridge, Massachusetts.1999.
4. U. S. TIWARY, TANVEER SIDDIQUI, Natural Language Processing and Information Retrieval, Oxford University Press (2008).
5. Charniack, Eugene, Statistical Language Learning, MIT Press, 1993.

Learning Outcomes:

- Levels of Language Analysis
- Organization of Natural language Understanding Systems
- Linguistic Background: An outline of English syntax.
- Grammars and Parsing
- Morphological Analysis
- Parsing with Features
- Various Lexicon Resource & Knowledge Source
- Grammars for Natural Language
- Ambiguity Resolution

High Performance Computing

Prerequisites:

Computer Networks.
Operating Systems.

Outline of the Course: -

The proposed course describes computer architecture which can support for parallel processing to improve the processing speed. The designed course will give an overall description to design parallel algorithms to solve mathematical problems like matrix factorization, linear programming and solving system of equations. The designed course illustrates the design of parallel algorithms for mathematical problems.

Objectives:-

1) Demonstrate the scientific application execution methodology in Highly Distributed Computing Environment.
2) To study Processor Architecture and Memory Hierarchies which support for HPC.
3) To learn Programming strategies for parallel computing to solve highly complex scientific problems.
4) To understand the parallel computer concepts different types of parallel architecture, hard ware design and compilers principles.
5) Illustration of well-known mathematical examples to understand the basic concepts of parallel computation which are highly required to solve scientific applications.
6) Detail study of various kinds of mathematical examples where parallel computations are involved, for example in linear algebra solving system of equations and matrix decomposition, Fourier transforms.

Unit-I:-

Parallel Processing Concepts, Levels of parallelism (instruction, transaction, task, thread, memory, and function), Models (SIMD, MIMD, SIMT, SPMD, Dataflow Models, and Demand-driven Computation etc), and Architectures: N-wide superscalar architectures, multi-core, multi-threaded.

Unit-II:

Parallel Programming with CUDA, Processor Architecture, Interconnect, Communication, Memory Organization, and Programming Models in high performance computing architectures: (Examples: IBM CELL BE, Nvidia Tesla GPU, Intel Larrabee Microarchitecture and Intel Nehalem microarchitecture), Memory hierarchy and transaction specific memory design,

Unit-III:

Thread Organization, Fundamental Design Issues in Parallel Computing, Synchronization, Scheduling, Job Allocation, Job Partitioning, Dependency Analysis, Mapping Parallel Algorithms onto Parallel Architectures, Performance Analysis of Parallel Algorithms. Other related topics.

References

High Performance Computing (RISC Architectures, Optimization & Benchmarks), Charles Severance, Kevin Dowd, Oreilly

High Performance Computing (RISC Architectures, Optimization & Benchmarks), Georg Hager, Gerhard Wellein, CRC Press

Introduction to High-Performance Scientific Computing (Scientific and Engineering Computation), Lloyd D. Fosdick, Elizabeth R. Jessup

Learning Outcomes:-

1) Able to understand the difference between sequential architecture and parallel architecture to execute the scientific applications.
2) Understand the way to develop parallel algorithm and way of execution on parallel computing environment.
3) Analysis of time and space complexity for a particular mathematical problem in sequential as well as parallel.
4) Writing programs for to solve Partial differential equations (PDE) and Matrix decomposition.
5) Solve some Computational biology applications using Dynamic programming approaches.

Image Processing & Pattern Recognition.

COURSE OUTLINE: -

The course focuses on basic and essential topics in Digital Image Processing, including Pixels, Pre Processing of images, Image Restoration, Segmentation, Morphological Properties and Pattern Recognition.

Objectives:-

1) Learn about the basics of images
2) Design various kinds of mathematical models to perform Imaging operations.
3) Demonstrate the various kinds of operations on different images for various applications.
4) Work on real time applications like segmentation, restoration, object detections, bio-metric application.
5) To identify the limitation of the proposed model and try to find the models overcome the limitations.

Syllabus:-

Unit-I:

Basic concepts and fundamental problems, Image Digitization and its properties, Image preprocessing, Image Segmentation, Image Representation and description, Any other relevant topic.

Unit-II

Introduction: Basic concepts and fundamental problems, Image Digitization and its properties, Image preprocessing

Unit-II

Spatial Domain Filtering, Filtering in the Frequency domain, Image Restoration, Image Compression, Wavelet based Image Compression, Morphological Image Processing, Image

Unit-III

Segmentation, Image Representation and description. .

References:

1. Pattern Recognition and Image Analysis: Earl Gose, Richard Johnsonbaugh, Prentice Hall of India Private Limited, 1999.
2. Digital Image Processing: Rafel C. Gonzalez Richard E. Woods, Second edition, Addison-Wisley
3. Pattern Recognition principles: Julus T. Tou and Rafel C. Gonzalez, Addison –Wesley publishing company.
4. Digital Image Processing: A K Jain, PHI.

Learning Outcomes:-

Graduates after completing the course shall gain:

(1) Ability to enhance student skill in digital image processing, emphasizing problem solving techniques such as doing experiments, collecting data, find out features, recognizing patterns, segmentations, and numeric computations exercises.
(2) Ability to understand the thought-provoking applications spread throughout, establishing a strong and meaningful bridge with Images, Signals and computer science.
(3) To be able to have understanding of the topics and enable students to develop their problem-solving skills, hands-on experience with concepts and enhance the opportunity for computational exploration and experimentation.

Ad-Hoc & Sensor Networks

Outline of the Course: -

The proposed course covers a special class of Wireless Networks which are Ad-Hoc Networks in which structure of networks varying with respect to time. In real life these networks play vital role in advanced communication system. The best practical examples of Ad-Hoc Networks is VANETs, it is practical implementation of Ad-Hoc networks to serve various on-demand application of internet users. Now-a-Days most of the applications require ad-hoc networks because of on-demand to perform day-to-day needs. The proposed course covers research issues in various layers. One of the major concerns is energy management in Wireless Ad-Hoc Networks to design adaptive protocols.

Objectives: -

1) Demonstration of available spectrum for Wireless Communication for various operations.
2) Get knowledge about spectrum allocation details to various applications.
3) The need of Ad-Hoc Networks for various applications.
4) Channel allocation mechanism for various on-demand applications using Ad-Hoc Networks.
5) Various Network Layer protocol operations for routing the packets.
6) Energy Management scheme while transmitting the data.

Syllabus -:-

Unit-I:

Introduction to Ad Hoc Networks, Data Transmission, Basics of Wireless, Sensors and Applications, Data Retrieval in Sensor Networks, Sensor Network Platforms and Tools. ROUTING: Cellular and Ad hoc wireless networks – 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.
Unit-II:

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

Unit-II:
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.

Unit-III

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.

Unit-IV

SENSOR NETWORKS: Introduction – Sensor Network architecture – Data Dissemination – Data Gathering –MAC Protocols for sensor Networks – Location discovery – Quality of Sensor Networks. Evolving Standards – Other Issues – Recent trends in Infrastructure less Networks

References:

1. Ad Hoc and Sensor Networks – Theory and Applications, *Carlos Corderio Dharma P.Aggarwal*, World Scientific Publications, March 2006, ISBN – 981-256-681-3

2.Wireless Sensor Networks: An Information Processing Approach, Feng Zhao, Leonidas Guibas,Elsevier Science, ISBN – 978-1-55860-914-3 (Morgan Kauffman).

3. C. Siva Ram Murthy and B.S.Manoj, "Ad hoc Wireless Networks – Architectures andProtocols', Pearson Education, 2004

4. Feng Zhao and Leonidas Guibas, "Wireless Sensor Networks", Morgan Kaufman Publishers, 2004.
5. C.K.Toh, "Adhoc Mobile Wireless Networks", Pearson Education, 2002.
6. ThomasKrag and SebastinBuettrich, 'Wireless Mesh Networking', O'Reilly Publishers, 2007.

Outcomes:-

1) Get knowledge about the various connectivity mechanisms to share information for various applications.
2) Basic understand of signals and physical layer medium for transmitting the data in the form of analog signal.
3) Channel allocation strategy to improve the connectivity in Ad-Hoc Networks.
4) Able to Design and Develop new routing protocol for MANETs.
5) Gain the Detail knowledge of various kind routing protocol such as proactive, reactive and hybrid kind to improve the performance of Ad-Hoc Networks.

Real Analysis &Topology

Unit-I:

Real Analysis: Sets and Functions, Numerical Sequence and Series, Metric Spaces and its Topology, Sequence and Series of Functions

Unit-II

Topology: Topological spaces. Open sets, Closed sets. Interior points, Closure points. Limit points, Boundary points, exterior points of a set, Closure of a set, derived set, Dense subsets.

Unit-III:

Basis, sub base, relative topology. Continuous functions, open & closed functions, homeomorphism, compactness, Connectedness, Separation Axioms. Any other relevant topic.

References:

1. R. R. Goldberg, Methods of Real Analysis, Second Edition, Willey.
2. S A Naimpally, Topology with Applications, World Scientific Publications.
3. 2. W. J. Pervin, Foundations of General Topology
4. 5. Topology, A First Course By: J. R. Munkers Prentice Hall of India Pvt. Ltd

High Speed Networks:

Course objectives:-

The course is designed to train the graduates in:

1) Advanced Concepts of Computer Networks.
2) Detailed understanding of network protocols.
3) Designing Networks for Industry and Research.

Unit-I:

Frame Relay Networks – Asynchronous transfer mode – ATM Protocol Architecture,ATM logical Connection – ATM Cell – ATM Service Categories – AAL. High Speed LAN's: Fast Ethernet – Gigabit Ethernet– Fibre Channel – Wireless LAN's, WiFi andWiMax Networks applications, requirements – Architecture of 802.11.

Unit-II

Queuing Analysis – Queuing Models – Single Server Queues – Effects of Congestion –Congestion Control – Traffic Management – Congestion Control in Packet Switching Networks – Frame Relay Congestion Control.

Unit-III

TCP Flow control – TCP Congestion Control – Retransmission – Timer Management – Exponential RTO backoff – KARN's Algorithm – Window management – Performance of TCP over ATM. Traffic and Congestion control in ATM – Requirements – Attributes – Traffic Management Frame work, Traffic Control – ABR traffic Management – ABR rate control, RM cell formats – ABR Capacity allocations – GFR traffic management.

Unit-IV

Integrated Services Architecture – Approach, Components, Services- Queuing Discipline – FQ – PS – BRFQ – GPS – WFQ – Random Early Detection – Differentiated Services. RSVP – Goals & Characteristics, Data Flow, RSVP operations – Protocol Mechanisms– Multiprotocol Label Switching – Operations, Label Stacking – Protocol details – RTP – Protocol Architecture – Data Transfer Protocol– RTCP.

References:-

TEXTBOOKS:
1. William Stallings, "High speed networks and internet", Second Edition, Pearson Education,2002.
REFERENCES:
1. Warland, Pravin Varaiya, "High performance communication networks", Second Edition , Jean Harcourt Asia Pvt. Ltd., , 2001.

2. Irvan Pepelnjk, Jim Guichard, Jeff Apcar, "MPLS and VPN architecture", Cisco Press, Volume 1 and 2, 2003.

3. Abhijit S. Pandya, Ercan Sea, “ATM Technology for Broad Band Telecommunication Networks”, CRC Press, New York, 2004.

Learning Course Outcomes:

- Ability to understand advanced concepts in computer networks.
- Ability to design Computer Networks in industry and research.
- Ability to take up research in Computer Networks.