SCHEME & SYLLABUS FOR
PROGRAM
M.TECH COMPUTER ENGINEERING

Department of Computer Engineering, NIT Kurukshetra (Haryana)
Proposed Scheme for the Course Master of Technology in Computer Engineering

SN	Code	Course Title	Teaching Schedule				Credit
			L	T	P	Total	
First Semester							
1.	COE-501	Advanced Data Structures and Algorithms	3	0	0	3	3
2.	COE-503	Advanced Computer Networks	3	0	0	3	3
3.	COE-505	Advanced Database Systems	3	0	0	3	3
4.		Elective-1	3	0	0	3	3
5.		Elective -2	3	0	0	3	3
6.	COE-511	Lab associated with Advanced Data Structures and Algorithms Laboratory	0	0	2	2	1
7.	COE-513	Lab associated with Advanced Computer Networks Laboratory	0	0	2	2	1
8.	COE-515	Seminar	0	2	0	2	1
Total						**21**	**18**
Second Semester							
1.	COE-502	Advanced Topics in Formal Languages and Automata	3	0	0	3	3
2.	COE-504	Object Oriented Software Modeling	3	0	0	3	3
3.		Elective-3	3	0	0	3	3
4.		Elective-4	3	0	0	3	3
5.		Elective-5	3	0	0	3	3
6.	COE-512	Lab associated with Object Oriented Software Modeling Laboratory	0	0	2	2	1
7.	COE-514	Lab associated with Elective-3	0	0	2	2	1
8.	COE-516	Seminar	0	2	0	2	1
Total						**21**	**18**
Third Semester							
1.	COE-601	Dissertation Part-I	0	0	20	20	10
Total						**20**	**10**
Fourth Semester							
1.	COE-602	Dissertation Part-II	0	0	32	32	16
Total						**32**	**16**

Applicable to Students admitted from 2015 onwards.

List of Elective Courses

Elective-1		Elective-2		Elective-3		Elective-4		Elective-5	
Code	**Course Title**	**Code**	**Course Title**	**Code**	**Course Title**	**Code**	**Course Title**	**Code**	**Course Title**
COE - 517	Number Theory & Cryptography	COE -525	Image Processing	COE -518	Soft Computing	COE -526	Graph Theory and Combinatorics	COE -536	High Performance & Parallel Computing
COE - 519	Optimization Techniques	COE -527	Advanced Architecture	COE -520	Network Security and Cryptography	COE - 528	Wireless Sensor Networks	COE -538	Mobile Computing
COE - 521	Game Theory	COE -529	Grid and Cloud Computing	COE -522	Speech and Language Processing	COE - 530	Natural Language Processing	COE -540	Data Mining and Warehousing
COE - 523	Software Architecture	COE - 531	Distributed Computing	COE -524	Pattern Recognition	COE - 532	Modeling & Simulation	COE -542	Research Methodology
						COE - 534	Human Computer Interaction		

Applicable to Students admitted from 2015 onwards.

Advanced Data Structures and Algorithms (COE-501)

Objective:- To develop the understanding of advanced data structures and algorithms.

Syllabus:-
Complexity of algorithms: worst case, average case, and amortized complexity. Algorithm analysis techniques, Amortized Analysis, Garbage collection, Analysis of Quick sort, Fibonacci Heaps, van Emde Boas Trees, Multithreaded Algorithms, Number Theoretic Algorithms, Strings and String Matching Algorithms, Computational Geometry, Lower Bound Theory – NP Completeness, Approximation Algorithms.

References:-

1. A.V. Aho, J.E. Hopcroft, and J.D. Ullman, Data Structures and Algorithms, Addison Wesley, Reading Massachusetts, USA, 1983.
2. Donald Knuth. The Art of Computer Programming: Fundamental Algorithms, Third Edition. Addison-Wesley, 1997. ISBN 0-201-89683-4
3. Donald Knuth. The Art of Computer Programming Volume 3: Sorting and Searching, Third Edition. Addison-Wesley, 1997. ISBN 0-201-89685-0.
4. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. Introduction to Algorithms, Third Edition. MIT Press and PHI, 2010.
5. Samet, Hanan, Foundations of multidimensional and metric data structures. Morgan Kaufmann, 2006, ISBN 978-0-12-369446-1.
6. Dinesh Mehta and Sartaj Sahni Handbook of Data Structures and Applications, Chapman and Hall/CRC Press, 2007.
7. M.A. Weiss, Data Structures and Algorithms Analysis in C++, Benjamin/Cummins, Redwood City, California, USA, 1994.

Advanced Computer Networks (COE-503)

Objective:- To give the students an understanding of the principles behind the latest advances in computer network technology, from IPv6 extending to pervasive and ubiquitous computing

Syllabus:-
IEEE 802.11a/b/n/g/p, 802.15, and 802.16 standards for Wireless PAN, LAN, and MAN

IPv6 – Header, Addressing, Neighbour Discovery, Auto-Configuration, Header Extensions and options, support for QoS, security, etc., DHCPv6

Mobile IPv6 rationale and operation - intra and inter site

IP Multicasting: Multicast routing protocols, Virtual private network service, multiprotocol label switching

Advanced IP multicast, including IPv6 multicast and SSM

Peer-to-Peer network architectures

Overlay networks, flat routing protocols (DHTs), and peer-to-peer architectures.

OSPF and BGP Routing Protocols

TCP Improvements and Extensions, Performance issues,

TCP Congestion Control – fairness, scheduling and Delay modeling, QoS issues, differentiated services, Transport layer in Wireless Networks

Network Security principles, Security related issues in wireless networks, Public and Private Key Cryptography, Key distribution protocols. Digital Signatures, and digital certificates.

References:-

1. W. R. Stevens. TCP/IP Illustrated, Volume 1: The protocols, Addison Wesley, 1994.
2. G. R. Wright and W. R. Stevens. TCP/IP Illustrated, Volume 2: The Implementation, Addison Wesley, 1995.
3. W. R. Stevens. TCP/IP Illustrated, Volume 3: TCP for Transactions, HTTP, NNTP, and the Unix Domain Protocols, Addison Wesley, 1996.
4. W. Stallings. Cryptography and Network Security: Principles and Practice, 2nd Edition, Prentice Hall, 1998.
5. C. E. Perkins, B. Woolf, and S. R. Alpert. Mobile IP: Design Principles and Practices, Addison Wesley, 1997.
6. Hesham Soliman, Mobilie IPv6: Mobility in a Wireless Internet, Pearson Education, 2004.
7. Respective Internet Drafts and RFCs of IETF.

Advanced Database Systems (COE-505)

Objective:- To develop understanding of distributed database design and query processing.

Syllabus:-

Introduction: Distributed Data Processing, What is a Distributed Database System?, Data Delivery Alternatives, Promises of DDBSs, Distributed DBMS Architecture.

Distributed Database Design: Design Issues, Horizontal Fragmentation, Vertical Fragmentation, Hybrid Fragmentation, Allocation Problem, Information Requirements, Allocation Model, Solution Methods, Data Directory.

Database Integration: Bottom-Up Design Methodology, Schema Matching, Schema Heterogeneity, Linguistic Matching Approaches, Constraint-based Matching Approaches, Learning-based Matching, Combined Matching Approaches, Schema Integration, Schema Mapping.

Overview of Query Processing: Query Processing Problem, Objectives of Query Processing, Complexity of Relational Algebra Operations, Characterization of Query Processors, Layers of Query Processing.

Query Decomposition and Data Localization: Query Decomposition, Normalization, Analysis, Elimination of Redundancy,Rewriting , Localization of Distributed Data , Reduction for Primary Horizontal Fragmentation , Reduction for Vertical Fragmentation, Reduction for Derived Fragmentation , Reduction for Hybrid Fragmentation.

Optimization of Distributed Queries: Query Optimization, Search Space, Search Strategy, Distributed Cost Model, Centralized Query Optimization, Dynamic Query Optimization, Static Query Optimization, Hybrid Query Optimization, Join Ordering in Distributed Queries, Join Ordering, Semijoin Based Algorithms, Join versus Semijoin, Distributed Query Optimization, Dynamic Approach, Static Approach, Semijoin-based Approach, Hybrid Approach.

Multidatabase Query Processing: Issues in Multidatabase Query Processing , Multidatabase Query Processing Architecture, Query Rewriting Using Views, Datalog Terminology, Rewriting in GAV, Rewriting in LAV, Query Optimization and Execution, Heterogeneous Cost Modeling, Heterogeneous Query Optimization, Adaptive Query Processing , Query Translation and Execution.

Introduction to Transaction Management: Definition of a Transaction, Termination Conditions of Transactions, Characterization of Transactions, Formalization of the Transaction Concept, Properties of Transactions, ACID, Types of Transactions, Flat Transactions, Nested Transactions, Workflows.

References:-

Principles of Distributed Database Systems by M. Tamer Özsu • Patrick Valduriez Third Edition, Springer.

Advanced Topics in Formal Languages & Automata (COE-502)

Objective:- The subject aims to start with study of basic concepts of automata theory and then deals with the advanced concepts of Formal Languages in detail.

Syllabus:-

Review of formal languages and automata theory: Regular expressions and regular languages, Finite automata, Context-free grammars and languages, Turing machines, Insolvability, Complexity theory.

Automata and Languages: Finite automata; Moore and Mealy machines, advanced closure properties of regular languages, Two-way finite automata, transformation automaton, Myhill–Nerode theorem, Minimization of finite automata, State complexity, Partial orders and regular languages. Context-free grammars and languages; Closure properties, Unary context-free languages, Ogden's lemma, Applications of Ogden's lemma, interchange lemma, Deterministic context-free languages, Linear languages.

Computability: Computable functions, primitive and recursive functions, universality, halting problem, recursive and recursively enumerable sets, parameter theorem, diagonalization, reducibility, Rice's Theorem and its applications, Godel's incompleteness theorem. Turing machines and variants; Equivalence of different models of computation and Church-Turing thesis, Hilbert's problem, decidability, halting problem, reducibility.

Complexity: Time complexity of deterministic and nondeterministic Turing machines, P and NP, NP- completeness, Cook's Theorem, other NP – Complete problems.

References:-

1. A Second Course in Formal Languages and Automata Theory by Jeffrey Shallit, University of Waterloo, ISBN: 9780521865722, Cambridge University Press.
2. Jeffrey Shallit, "A Second Course in Formal Languages and Automata Theory", Cambridge University Press.
3. Daniel I. A. Cohen John, "Introduction to Computer Theory", Wiley & Sons.
4. Kain, "Theory of Automata & Formal Language", McGraw Hill.
5. John E. Hopcroft, Rajeev Motwani and Jeffrey D. Ullman, "Introduction to Automata Theory, Languages, and Computation", Pearson Education Asia.

Object Oriented Software Modeling (COE-504)

Objectives:- To develop understanding and skill for preparing analysis and design documents for building object-oriented software systems. This course will cover

1) Object-oriented analysis/design concepts
2) UML notation
3) Approaches to transforming a problem into an object oriented analysis model and object oriented design

Syllabus:-

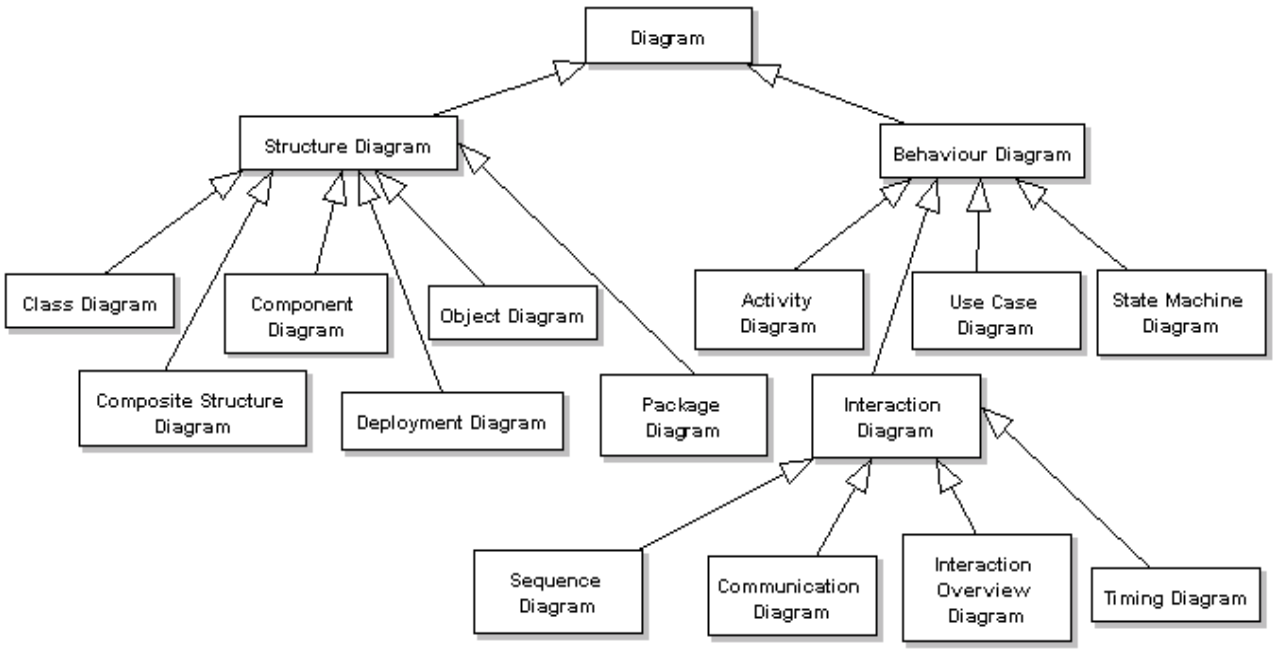
Introduction: Object Oriented system development life cycle, Benefits of OO Methodology.

Overview of Prominent OO Methodologies: The Rumbaugh OMT, The Booch methodology, Jacobson's OOSE methodologies, UML.

Introduction to UML: Important diagrams, notation and their descriptions, versions of UML.

Use case diagram: Requirement Capture with Use case, Building blocks of Use Case diagram - actors, use case guidelines for use case models, Relationships between use cases - extend, include, generalize.

Activity diagram: Elements of Activity Diagram - Action state- Activity state, Object- node, Control and Object flow, Transition (Fork, Merge, Join), Guidelines for Creating Activity Diagrams.
Similarly, study of other types of UML diagrams as shown by the following figure:



References:-

1. Bernd Bruegge, Allen H Dutit, Object-Oriented Software Engineering: Using UML, Patterns and Java, Pearson Education, 2010

2. The Unified Modeling Language User Guide, Booch, Rumbaugh, Jacobson, Addison Wesley, 1999
3. Object Oriented Modeling and Design, James Rumbaugh, et al, Prentice Hall, 1991 or later.
4. The Unified Modeling Language Reference Manual, Second Edition, Rumbaugh, Jacobson and Booch, Addison-Wesley, 2004.
5. UML 2.0 Superstructure Specification, OMG, 2004.
6. Several web sites have good material on UML, e.g.,

http://sourcemaking.com/uml
http://www.agilemodeling.com/essays/umlDiagrams.htm
http://www.ambysoft.com/books/agileModeling.html - Agile Modeling Effective Practices for Extreme Programming and the Unified Process

Number Theory and Cryptography (COE-517)

Objective:- Objective of course is:

1) To introduce the mathematical fundamentals involve in cryptography.
2) To understand the strength and weakness of cryptosystems.
3) To introduce the elliptic curve cryptography.

Syllabus:-

Elementary Number Theory: Divisibility, Division Algorithm, Euclidean Algorithm;Congruences, Complete Residue systems, Reduced Residue systems;Fermat's little theorem, Euler's Generalization, Wilson's Theorem;Chinese Remainder Theorem, Generalized Chinese Remainder Theorem-Euler Phi-function, multiplicative property;Finite Fields, Primitive Roots;Quadratic Residues, Legendre Symbol, Jacobi Symbol;Gauss's lemma,Quadratic Reciprocity Law.

Primality Testing and Factorization: Primality Tests;Pseudoprimes, Carmichael Numbers;Fermat's pseudoprimes, Euler pseudoprimes;Factorization by Pollard's Rho method;Simple Continued Fraction, simple infinite continued fractions;Approximation to irrational numbers using continued fractions;Continued Fraction method for factorization.

Public Key Cryptosystems: Traditional Cryptosystem, limitations;Public Key Cryptography;Diffie-Hellmann key exchange;Discrete Logarithm problem;One-way functions, Trapdoor functions;RSA cryptosystem;Digital signature schemes;Digital signature standards;RSA signature schemes;Knapsack problem;ElGamal Public Key Cryptosystem;Attacks on RSA cryptosystem: Common modulus attack;Homomorphism attack, timing attack;Forging of digital signatures;Strong primes, Safe primes, Gordon's algorithm for generating strong primes;Strong pseudoprimes to the base a.

Elliptic Curve Cryptography: Cubic Curves, Singular points, Discriminant;Introduction to Elliptic Curves, Geometry of elliptic curves over reals;Weierstrass normal form, point at infinity;Addition of two points;Bezout's theorem, associativity;Group structure, Points of finite order;Elliptic Curves over finite fields, Discrete Log problem for Elliptic curves;Elliptic Curve Cryptography;Factorization using Elliptic Curve;Lenstra's algorithm;ElGamal Public Key Cryptosystem for elliptic curves.
Mini Project (Implementation of any Cryptographic Algorithm from above related topics, as an assignment)

Reference:-

1. A Course in Number Theory and Cryptography, Neal Koblitz, (Springer 2006)

2. An Introduction to Mathematical Cryptography, Jill Pipher, Jeffrey Hoffstein, Joseph H. Silverman (Springer, 2008)
3. An Introduction to theory of numbers, Niven, Zuckerman and Montgomery, (Wiley 2006)
4. Elliptic curves: Number theory and cryptography, Lawrence C. Washington, (Chapman & Hall/CRC 2003)
5. An Introduction to Cryptography, R.A. Mollin (Chapman & Hall, 2001)
6. Rational Points on Elliptic Curves, Silverman and Tate (Springer 2005)
7. Guide to elliptic curve cryptography Hankerson, Menezes, Vanstone (Springer, 2004)
8. Elementary Number Theory, Jones and Jones (Springer, 1998)

Optimization Techniques (COE-519)

Objective:-The aim of this syllabus is to introduce different types of optimization techniques like constrained and unconstrained optimization, and optimization in operation research.

Syllabus:-

Unconstrained Optimization: Introduction, Optimizing Single-Variable Functions, conditions for Local Minimum and Maximum, Optimizing Multi-Variable Functions.

Constrained Optimization: Optimizing Multivariable Functions with Equality Constraint: Direct Search Method, Lagrange Multipliers Method, Constrained Multivariable Optimization with inequality constrained: Kuhn-Tucker Necessary conditions, Kuhn –Tucker Sufficient Conditions.

Optimization: Quasi-Newton Methods and line search, least squares optimization, Gauss-Newton, Levenberg- Marquartd, Extensions of LP to Mixed Integer Linear Programming (MILP), Non-Liner Programming, The Newton Algorithm, Non-Linear Least Squares, Sequential Quadratics Programming (SQP), Constrained Optimization, SQP Implementation, Multi-Objective Optimization, Branch and Bound Approaches, Genetic Algorithms and Genetic Programming, Singular Based Optimization, On-Line Real-Time Optimization.

Optimization and Functions of a Complex Variable and Numerical Analysis: The Finite Difference Method for Poisson's Equation in two Dimensions and for the Transient Heat Equation, Eulers Method, The Modified Euler Method and the Runga-Kutta Method for Ordinary Differential Equations, Gaussian Quardative Tranzoidal Rule and Simpson's 1/3 and 3/8 Rules, the Newton Raphson in one and two Dimensions, Jacobi's Iteration Method.

Optimization in Operation Research: Dynamic Programming, Transportation – Linear Optimization Simplex and Hitchcock Algorithms, Discrete Simulation, Integer Programming – Cutting Plane Methods, Separable Programming, Stochastic Programming, Goal Programming, Integer Linear Programming, Pure and Mixed Strategy in theory of Games, Transshipment Problems, Heuristic Methods.

References:-

1. S.S. Rao, Optimization: Theory and Applications, New Age International P. Ltd.
2. G. R. Walsh: M methods of Optimization.
3. H. P. Williams: Model Building in Mathematics Programming.
4. H.P. Williams: Model Solving in Mathematics Programming.
5. G.L. Nemhauser and L.A. Wolsey: Integer and Combinational Optimization, Wiley.
6. R.G. Parker and R.L. Rardin: Discrete Optimization, Academic Press.

7. W. L. Winston: Operations Research: Applications and Algorithms.
8. Ravindren Philips and Solberg, Operation Research Principles and Practice (Second Edition) John Wiley & Sons.

Game Theory (COE-521)

Objective:- Objective of course is to provide a sound foundation of game theory and mechanism design to enable the students to apply them to problem solving (of computer science, communications, electrical engineering, management, and industrial engineering problems) in a rigorous way.

Syllabus:-
Introduction and Outline of the Course, Definitions, Utilities, Rationality, Intelligence, Common Knowledge, Classification of Games.

NON-COOPERATIVE GAME THEORY: Extensive Form Game,Strategic Form Games with Illustrative Examples, Dominant Strategy Equilibria, Pure Strategy Nash Equilibrium with Illustrative Examples and Key Results, Mixed Strategy Nash Equilibrium with Illustrative Examples and Key Results such as the Nash Theorem, Computation of Nash Equilibria and introduction to algorithmic theory, Matrix Games: Saddle Points, Minimax Theorem, Bayesian Games, Bayesian Nash Equilibrium, Evolutionary Game Theory (ESS Strategies), Repeated Game.

MECHANISM DESIGN: The Mechanism Design Environment, Social Choice Functions with Illustrative Examples, Implementation of Social Choice Functions, Incentive Compatibility and Revelation Theorem, Gibbard-Satterthwaite and Arrow Impossibility Theorem, Vickrey-Clarke-Groves (VCG) Mechanisms, Bayesian Mechanisms (dAGVA), Revenue Equivalence Theorem, Myerson Optimal Auction, Further Topics in Mechanism Design.

COOPERATIVE GAME THEORY: Correlated Strategies and Correlated Equilibrium, The Nash Bargaining Problem, Coalitional Games (Transferable Utility Games), The Core, The Shapley Value, Other Solution Concepts: Kernel, Nucleolus.

References:-
1. Martin J. Osborne. An Introduction to Game Theory**.** Oxford University Press. Indian Edition, 2003.
2. Roger B. Myerson. Game Theory: Analysis of Conflict**.** Harvard University Press, 1991.
3. Y. Narahari, Dinesh Garg, RamasuriNarayanam, HastagiriPrakash. Game Theoretic Problems in Network Economics and Mechanism Design Solutions**.** Springer, London, 2009.
4. NPTEL website, http://nptel.ac.in/syllabus/106108053/.

Software Architecture (COE-523)

Objective:- Software architecture has emerged as the central theme over which all large scale software is built; it is the algorithmic counterpart for large programs. This course deals with problem of identifying the concept of architecture and intends to reach the student architecture centric software development methodology. Other topics covered are Architecture Documentation, Architecture Evaluation, and Product Lines Enterprise Architecture.

Applicable to Students admitted from 2015 onwards.

Syllabus:-
Introduction to Software Architecture, The 4+1 View of Software Architecture, Examples of Software Architecture, Architecture Design: Quality attributes, Attribute Driven Design, Architecture Centric Software Development Methodology, Design Patterns, Software Design Function Oriented vs. Object Oriented, Documenting Software Architecture: Stakeholders, Views, Viewsets, View-based documentation, IEEE 1471, ISO 42010, Architecture Description Languages, Architecture Evaluation, Product line architectures, Enterprise Architecture Architecture Knowledge Management

References:-

1. Software Architecture in Practice, Len Bass, Paul Clements, Rick Kazman, 3rd edition.
2. Documenting Software Architectures: Views and Beyond Paul Clements, Felix Bachmann, Len Bass, David Garlen, James Ivers, Reed Little, Robert Nord, Judith Stafford
3. http://www.handbookofsoftwarearchitecture.com/

Image Processing (COE-525)

Course Objectives:- Objective of course is to study the:

1) fundamentals of image processing
2) Image restoration and reconstruction techniques
3) Color image processing
4) Image enhancement, Image Segmentation and Morphology

Syllabus:-

Digital image fundamentals: elements of visual Perception, light and electromagnetic spectrum, image sensing and Acquisition, imaging sampling and quantization, intensity transformations and spatial filtering: basics, histogram processing, smoothing spatial filters

Image restoration and reconstruction: a model of image degradation/restoration process, noise models, restoration in presence of noise only-spatial filtering, estimating the degradation function, inverse filtering, Image Enhancement: Arithmetic and logical operations, pixel or point operations, size operations, Smoothing filters-Mean, Median, Mode filters – Comparative study, Edge enhancement filters – Directorial filters, Sobel, Laplacian, Robert, KIRSCH Homogeneity & DIFF Filters, prewitt filter, Contrast Based edge enhancement techniques. – Comparative study Low Pass filters, High Pass filters, sharpening filters. – Comparative Study, Comparative study of all filters.

Color image processing: fundamentals and models, pseudo color image processing, basics of full color image processing, color transformations, smoothing and sharpening, image segmentation based on color.

Image enhancement: (By FREQUENCY Domain Methods): Design of Low pass, High pass, EDGE Enhancement, smoothening filters in Frequency Domain, Butter worth filter, Homomorphic filters in Frequency Domain Advantages of filters in frequency domain, comparative study of filters in frequency domain and spatial domain.

Image Segmentation: fundamentals, point, line and edge detection, region based segmentation.

Morphology: Dilation, Erosion, Opening, closing, some basic morphological algorithms, gray scale.

References:-

1. R.Gonzalaz and P.Wintz, "Digital Image Processing", Addison Wesley 2nd Ed, 1987.

2. Anil K.Jain, "Fundamentals of Digital Image Processing", PHI 1995.
3. William. K.Pratt, "Digital Image Processing", Wiley Interscience, 2nd Ed, 1991.
4. Milan Sonka vaclan Halavac Roger Boyle ,"Image processing, Analysis, and Machine vision", Vikas Publishing House

Advanced Architecture (COE-527)

Objective:- To understand issues in the architecture of superscalar computing systems.

Syllabus:-
Processor architecture, pipelining, vector processing, superscalar processors, hardware and compiler support for branch prediction, out-of-order Instruction issue, speculative execution and other techniques for high-performance, Instruction and data cache organizations, multilevel caches, parallel memory systems, Support for virtual memory, Multiple processor systems, taxonomy, programming models, message passing systems, Interconnection networks, shared memory system, memory models, cache coherence, I/O systems, parallel disk organizations, Introduction to advanced topics.

References:-

1. Hwang and F.A. Briggs: Computer Architecture and Parallel Processing, McGraw Hill.
2. Hennessy, J.L., and Patterson, D.A., Computer Architecture, A quantitative Approach, Morgan Kaufmann.
3. Stone, H.S., High-Performance Computer Architecture Addison-Wesley.

Grid and Cloud Computing (COE-529)

Objective:- The objectives of this subject are:

1) To provide end-to-end coverage of fundamental grid computing topics as they pertain to both technology and business considerations.
2) To provide overview about system infrastructure in grid. Also to learn about current architecture, services and instantiations of the grid.
3) To provide end-to-end coverage of fundamental cloud computing topics as they pertain to both technology and business considerations.
4) To impart knowledge and understanding of technical underpinnings, supporting technologies and best practices to design, implement and deploy service and cloud computing in enterprises.

Syllabus:-
Introduction: Definition of Grid, history and evolution of Grid Computing, Virtual Organizations, Computational Grid projects around the world, Grid challenges, Grid organizations, Service Oriented Architecture (SOA), Issues in Management of Grid Models.

Architecture: Components of Layered Grid Architecture, Open Grid Services Architecture (OGSA), Grid architecture models, Grid Resource Information Service (GRIS), Resource infrastructure.

Grid Middleware: Globus: Overview, resource specification language, information services, Globus Resource Allocation Manager (GRAM), job submission with managed-job-globusrun, security, scheduling, Grid FTP protocol, overview of other middleware like Condor, Condor-G.

Resource Management and Scheduling: Resource Discovery and Information Services, Information directory services, schedulers and resource brokers, Characterization of resource management problems based on job requirements, algorithms, tools and sample resource management systems, Monitoring, Scheduling, Performance tuning, Debugging and performance diagnostic issues.

Grid Security: Grid security demands and solutions; authentication, authority, assurance, accounting, trust, group communication for large-scale, dynamic, multi-organization environments.

Grid Portals: Functionality and underlying infrastructure for sample general and application specific portals.

Data Management: Key issues for data management in Grids, including file transfer, data replication, data caching issues, catalog issues.

Case Studies: Topics from Seti project, Sun Grid engine, EuroGrid and some other national grid projects.

Advanced Topics: Overview of: Grid simulation, Grid Economy, Semantic Grid, Autonomic Grid, Cloud Computing.

Introduction and Evolution of Computing Paradigms: Overview of Existing Hosting Platforms, Cluster Computing, Grid Computing, Utility Computing, Autonomic Computing, mesh, Introduction to Cloud Computing, Cloud Computing history and evolution, practical applications of cloud computing for various industries, economics and benefits of cloud computing.

Cloud Issues and Challenges: Cloud computing issues and challenges like Security, Elasticity, Resource management and scheduling, QoS (Quality of Service) and Resource Allocation, Cost Management, Big Data.

Data Center: Classic Data Center, Virtualized Data Center (Compute, Storage, Networking and Application), Business Continuity in VDC.

Cloud Computing Architecture: Cloud Architecture model, Types of Clouds: Public Private & Hybrid Clouds, Cloud based services: Iaas, PaaS and SaaS.

Classification of Cloud Implementations: Amazon Web Services, The Elastic Compute Cloud (EC2), The Simple Storage Service (S3), The Simple Queuing Services (SQS), Google AppEngine - PaaS, Windows Azure, Aneka, A Comparison of Cloud Computing Platforms.

Virtualization: Virtualization, Advantages and disadvantages of Virtualization, Types of Virtualization: Resource Virtualization i.e. Server, Storage and Network virtualization, Migration of processes, VMware vCloud – IaaS.

Cloud based Data Storage: Introduction to Map Reduce for Simplified data processing on Large clusters, Design of data applications based on Map Reduce in Apache Hadoop, Task Partitioning, Data partitioning, Data Synchronization, Distributed File system, Data Replication , Shared access to weakly consistent to data stores.

Introduction to Python Runtime Environment: The Datastore, Development Workflow.

References:-

1. Foster, I. and Kesselman, C. (eds.). The Grid: Blueprint for a New Computing Infrastructure. Morgan Kaufmann Publishers, (1999).
2. Luis Ferreira et al., Grid Computing in Research and Education, ibm.com/redbooks, (September 2003).
3. Joshy Joseph and Craig Fellenstein, Grid Computing, Person Edition, (2004).
4. Ahmar Abbas, Grid Computing: A Practical Guide to Technology and Applications, Firewall Media (2004).
5. Maozhen Li, Mark Baker, "The Grid Core Technologies", John Wiley & Sons, (2005).
6. The Complete Cornerstone Guide to Cloud Computing Best Practices, Second Edition, Gerard Blokdijk, Ivanka Menken by Emereo Pty Ltd, 2009
7. Cloud Computing: A practical Approach Anthony Velte, Toby Velte and Robert Elsenpeter by Tata McGrawHill
8. Cloud Computing Principles and Paradigms, Rajkumar Buyya, James Broberg and Goscinski by John Wiley and Sons
9. Raj Kumar Buyya, James Broberg, Andrezei M. Goscinski, Cloud Computing: Principles and Paradigms, 2011
10. Michael Miller, Cloud Computing, 2008
11. Judith Hurwitz, Robin Bllor, Marcia Kaufmann, Fern Halper, Cloud cOmputing for Dummies, 2009

Distributed Computing (COE-531)

Objective:- To understand fundamental concepts of distributed computing and to acquire knowledge about development of fault tolerant protocols for middleware design.

Syllabus:-

Fundamental issues in Distributed Systems, Distributed System Models and Architectures, Classification of Failures in Distributed Systems, Basic Techniques for Handling Faults in Distributed Systems, Logical and Physical Clocks, Physical Clock Synchronization, Interprocess Communication, Message Ordering Protocols, Naming in Distributed Systems, Global State, Termination, and Distributed Deadlock Detection, Distributed Mutual Exclusion, Leader Election, Agreement Protocols, Consensus, FLP impossibility, Fault-Tolerance Issues, Z-path and Z-cycles, Byzantine Generals Problem, Distributed Scheduling and Load Balancing. Distributed File Systems, and Distributed Shared Memory, Security.

References:-

1. Distributed Systems: Concepts and Design; G Colouris, J Dollimore, T Kindberg 3/e Pearson Ed. 2002.
2. Distributed Systems: Principles and Paradigm; Andrew S Tanenbaum, Maarten van Steen 3/e Pearson Ed. 2002.
3. Principles of Distributed Systems, VK Garg, Kluwer Academic Publishers, 1996.
4. Distributed Systems and Algorithmic Approach by Su Kumar Boss, Chamal & Hall.
5. Principles of Distributed Computing by V K Garg, IEEE Press.
6. Distributed Computing by A D Kshem Kalyani & Mukesh Singha.
7. Distributed Algorithms by Nancy Lynch, Morgan Kaufmann Press.
8. Introduction to Distributed Algorithms by G Tel, Cambridge University.

Soft Computing (COE-518)

Course Objectives:- This syllabus covers the different domains of soft computing techniques like neural networks, fuzzy logic, genetic algorithm and swarm optimization.

Syllabus:-

Soft Computing and Artificial Intelligence: Introduction of Soft Computing, Soft Computing vs. Hard Computing, Various Types of Soft Computing Techniques, Applications of Soft Computing, AI Search Algorithm, Predicate Calculus, Rules of Interference, Semantic Networks, Frames, Objects, Hybrid Models.

Artificial Neural Networks and Paradigms: Introduction, Neuron Model, Neural Network Architecture, Learning Rules, Perceptrons, Single Layer Perceptrons, Multilayer Perceptrons, Back propagation Networks: Kohnen's self organizing networks, Hopfield network, Applications of NN.

Fuzzy Logic: Introduction, Fuzzy sets and Fuzzy reasoning, Basic functions on crisp set and fuzzy sets, relations, rule based models and linguistic variables, fuzzy controls, Fuzzy decision making, applications of fuzzy logic.

Neuro-Fuzzy Modeling: Adaptive Networks Based Fuzzy Interface Systems, Classification and Regression Trees, Data Clustering Algorithms, Rule Based Structure Identification, Neuro-Fuzzy Controls, Simulated Annealing, Evolutionary Computation.

Genetic Algorithms and Swarm Optimizations: Introduction, Genetic Algorithm, Fitness Computations, Cross Over, Mutation, Evolutionary Programming, Classifier Systems, Genetic Programming Parse Trees, Variants of GA, Applications, Ant Colony Optimization, Particle Swarm Optimization, Artificial Bee Colony Optimization.

References:-

1. Saroj Kaushik, "Artificial Intelligence", Cengage Learning.
2. Anupam Shukla, "Real Life Applications of Soft Computing", CRC Press.
3. B. Yegnanrayana, "Artificial Neural Networks", PHI.
4. Zimmermann, "Fuzzy Set Theory and its Application", Springer.
5. Jang J.S.R., Sun C.T. and Mizutani E, "Neuro-Fuzzy and Soft computing", Prentice Hall.
6. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", McGraw Hill.
7. D.E.Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley.

Network Security and Cryptography (COE-520)

Objective:- To introduce advance network security and modern cryptography concepts.

Syllabus:-

Network security issues such as Impersonation, Message Confidentiality, Message Integrity, Code Integrity, Denial of Service, Securing Switches and Routers, Firewalls, DMZs, Virtual Private Networks, Network Monitoring and Diagnostic Devices, Virtual LANs.

Theory, foundations, and applications of modern cryptography, Steganography, One-way functions; pseudo-randomness and random number generators; encryption; authentication; symmetric

cryptography, asymmetric cryptography: public-key cryptosystems; digital signatures, message authentication codes, remote user authentication, key exchange and applications; side-channel attacks, and replay attacks.
Digital Certificates and PKIs, Different PKIs: PGP (Pretty Good Privacy), Web of trust, applications.
X.509: X.500, Certification Authority (CA), Registration Authority (RA), Root - CA, X.509 Protocols, Hierarchy of Trust, Simple PKI (SPKI) / Simple Distributed Security Infrastructure (SDSI); Access Control Mechanisms including Role based access control.
Anonymity and Privacy issues, Smartcard integration with PKIs, Risks Impact on E-Commerce and E- Business.

References:-

1. Bernard Menezes, Network Security and Cryptography, 2010, Cengage Learning India, ISBN-13 978-8-131-513491.
2. William Stalling and Lawrie Brown, Computer Security: Principles and Practice, Pearson Education, 2010
3. A.J. Menezes, P. Van Oorschot and S. Vanstone, Handbook of Applied Cryptography, 2006, CRC Press, ISBN-10: 0-8493-8523-7.
4. Cryptography & Network Security, Atul Kahate, TMH.
5. Michel Abdalla, David Pointcheval, Pierre-Alain Fouque, Damien Vergnaud. Applied Cryptography and Network Security: 7th International Conference, ACNS 2009, Paris-Rocquencourt, France, June 2-5, 2009, Proceedings, Springer Science & Business Media, 2009.

Speech and Language Processing (COE-522)

Objective:- This subject covers the overview and description of automatic speech recognition system. The main emphasis is given on statistical approaches for the design and development of ASR.

Syllabus:-

Mechanics of Speech: Speech Production Mechanism, Nature of Speech Signal, Discrete Time Modeling of Speech Production, Representation of Speech Signals, Classification of Speech Sounds, Phones, Phonemes, Phonetics, IPA and Phonetic Alphabets, Articulatory Features, Auditory Perceptions, Anatomical Pathways From Ear to the Perception of Sound Peripheral Auditory System.

Spectral Analysis of Speech Signal: Time Domain Parameter of Speech Signal, Methods of Extracting The Parameters: Energy Filterbank Analysis, Short Time Fourier analysis, Formant Extraction, Pitch Extraction; Noise Reduction Techniques, Spectral Estimation, Feature Analysis: MFCC, PLP, RASTA, PLP-RASTA; TRAP.

Statistical Framework of ASR: Probability, Bayes' Theorem, Covariance and Correlation, Gaussian Mixture Model, ASR Framework: Feature Extraction, Acoustic Model, Pronunciation Model, Language Model, Decoder; Unit Selection, Limitation of Basic HMM and Applications, Advanced HMM, Refinement of HMM, Hybrid HMM/ANN.

Language Processing: Formal Language Theory: Chomsky Hierarchy, Chart Parsing for Context-Free Grammars, Stochastic Language Models: Probabilistic Context-Free Grammar, N-gram Language Models, Complexity measure of Language Models: N-Gram Smoothing, Deleted Interpolation Smoothing, Backoff Smoothing, Class n-grams, Performance of N-gram Smoothing,

Adaptive Language Models: Cache Language Models, Topic-Adaptive Models, Maximum Entropy Models.

References:-

1. Speech and language processing, Daniel Jurafsky and James H. Martin, University of Colorado, Boulder.
2. Fundamentals of Speech Recognition, Lawrence Rabiner, Biing Hwang Juang and B. Yegnarayana, Pearson Edition
3. Speech Recognition – Theory and C++ Implementation, Claudio Becchetti, Klucio Prina Ricotti, Fondazione Ugo Bordoni, Rome, Italy.
4. Spoken Language Processing – A Guide to Theory, algorithm and system development, X. Huang, A. Acero, H. W. Hon.

Pattern Recognition (COE-524)

Course Objectives:- Objective of course is to:

1) The course aims to provide an introduction to the basic principles, techniques, and applications of Pattern Recognition and Machine Learning.
2) To enable students to identify, formulate and solve machine learning problems that arise in practical applications.

Syllabus:-

Probability Theory and Statistics: Probability theory, Bayesian probabilities, Probability densities, Skewness and Kurtosis, Expectations and Covariances, Multivariate Gaussian Distribution, Combination of Random Variables; Moment Estimation, Estimating the mean and variance, Law of Large Numbers; Measure Theory, Multiple Dimensional Spaces, Metric Space, Normed Vector Space, Dot Product Space, Pre-Hilbert and Hilbert; Decision Theory, Minimizing the misclassification rate, Minimizing the expected loss, Inference and Decision, Loss functions for regression.

Parameter Estimation and Classification: Maximum Likelihood Estimation, Maximum A-Posteriori (MAP) Estimation, Maximum Entropy Estimation, Minimum Relative Entropy Estimation, Maximum Mutual Information Estimation (MMIE); Model Selection, Akaike Information Criterion (AIC)Bayesian Information Criterion (BIC); Linear Models for Classification, Discriminant Functions, Two classes, Multiple classes, Least squares for classification, Fisher's linear discriminant, Relation to least squares, Fisher's discriminant for multiple classes, The perceptron algorithm; Probabilistic Generative Models, Continuous inputs, Maximum likelihood solution, Discrete features, Exponential family; Probabilistic Discriminative Models, Fixed basis functions, Logistic regression, Iterative reweighted least squares, Multiclass logistic regression, Probit regression, Canonical link functions.

Clustering and Learning: Learning Algorithms, Risk Minimization, Empirical Risk Minimization, Capacity and Bounds on Risk, Structural Risk Minimization; Decision and Regression Trees, Vector Quantization (VQ); Basic Clustering Techniques, Standard k-Means (Lloyd) Algorithm, Generalized Clustering, Over-partitioning, Merging, Modifications to the k-Means Algorithm, k-Means Wrappers, Rough k-Means, Fuzzy k-Means, k-Harmonic Means Algorithm, Hybrid Clustering Algorithms; Estimation using Incomplete Data, Expectation Maximization (EM); Semi-Supervised Learning.

Kernel Methods and Support Vector Machines: The Two-Class Problem, Dual Representation, Soft Margin Classification; Origins of Kernel methods, Kernel Mapping, The Kernel Trick; Constructing Kernels, Support Vector Machines: Formulation and Computation; Radial Basis Function Networks; Positive Semi-Definite Kernels, Linear Kernel, Polynomial Kernel, Gaussian Radial Basis Function (GRBF) Kernel, Cosine Kernel, Fisher Kernel, GLDS Kernel, GMM-UBM Mean Interval (GUMI) Kernel.

References:-

1. Pattern Recognition and Machine Learning, Christopher M. Bishop, Springer.
2. Machine Learning with SVM and other Kernel methods, K.P. Soman R.Loganathan,
3. V.Ajay, PHI Learning Private Limited.Machine Learning, Tom Mitchell, McGraw Hill, 1997.
4. Fundamentals of Speaker Recognition, Homayoon Beigi, Springer.

Graph Theory and Combinatorics (COE-526)

Objective:- To study graph theory, fundamentals, trails, circuits, trees, matrices, directed graphs, graph coloring, labeling, graph decompositions, cycles, domination, symmetries counting, principle of exclusion and inclusion, generating functions, and recurrence relations.

Syllabus:-

Graph fundamentals: Walks, paths, directed graphs, knots, cycles, neighborhood, clique, reachability, connectivity, spanning tree, knot detection algorithms.

Graph coloring: Problem and model, greedy and random coloring algorithms, edge coloring, coloring trees, coloring planar and arbitrary graph.

Graph traversal: Tarry's traversal algorithm, search algorithms, BFS algorithms and applications, classical and Awerbuch's DFS algorithm, DFS with neighbor knowledge, spanning tree construction using flooding and DFS, GHS, Awerbuch, Korach-Kutten-Moran MST algorithms and applications, synchronizers.

Routing: Shortest path algorithms, Dijkstra, Bellman-Ford, Floyd-Warshall, Chandi-Misra algorithms, Johnson's algorithm, link state, distance vector, and interval routing algorithms, maximum flow, Ford-Fulkerson method, maximum bipartite matching, push-relabel algorithm, relabel-to-front algorithm.

Maximal Independent Set (MIS): Rank-based MIS algorithms, Luby's MIS algorithm, MIS construction from vertex coloring.

Domination algorithms: Greedy MDS algorithms, Guha-Khuller algorithm, connected dominating sets, MIS-based and pruning-based algorithms, weakly connected dominating sets.

Matching: Unweighted and weighted matching algorithms, matching from edge coloring.

Vertex cover: Unweighted and weighted vertex cover algorithms, pricing algorithm, bipartite matching-based algorithms.

Applicable to Students admitted from 2015 onwards.

References:-

1. Douglas B. West, Introduction to Graph Theory, PHI.
2. David Avis, Alain Hertz, Odile Marcotte (Eds.), Graph Theory and Combinatorial Optimization, Springer.
3. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, Introduction to Algorithms, PHI.
4. Sukumar Ghosh, Distributed Systems: An Algorithmic Approach, Chapman & Hall/CRC.
5. Kayhan Erciyes, Distributed Graph Algorithms for Computer Networks, Springer.
6. Yvonne-Anne Pignolet, Thomas Locher, Roger Wattenhofer, Principles of Distributed Computing, Available online.
7. Herbert S. Wilf, Algorithms and Complexity, Available online.
8. Michel Raynal, Distributed Algorithms for Message-Passing Systems, Springer.
9. Nancy Lynch, Distributed Algorithms, Morgan Kaufmann.
10. Gerard Tel, Introduction to Distributed Algorithms, Cambridge Univ. Press

Wireless Sensor Networks (COE- 528)

Course Objectives:- To understand issues and research challenges of Wireless Sensor Networks**.**

Syllabus:-

Wireless Sensor Networks (WSN) – Design Issues, Unique constraints and Challenges, Applications of WSN, MAC layers and routing protocols in WSN, Localization and Tracking, Topology Control in WSNs, Clustering and Time Synchronization, Data Retrieval Techniques in WSNs: Sensor databases, distributed query processing, Data dissemination and aggregation schemes, Operating Systems for WSN, Security issues in WSN, Future direction of WSNs.

References:-

1. C. Siva Ram Murthy & B.S. Manoj, Mobile Ad hoc Networks – Architectures & Protocols, Pearson Education, New Delhi, 2004
2. C M Cordeiro & D.P. Agrawal, Adhoc & Sensor Networks – Theory and Applications, ISBN 981-256-682-1, World Scientific Singapore, 2006
3. C. S. Raghvendra, Wireless Sensor Networks, Springer-Verlag, 2006 (Available as E-Book at NIT Kurukshetra Purchased in 2006)
4. Holger Karl and Andreas Willig, Protocols and Architectures for Wireless Sensor Networks, John Wiley and Sons, 2006, ISBN-13 978-0-470-09510-2.
5. Feng Zhao and Leonidas Guibas, Wireless Sensor Networks- An Information Processing Approach, Morgan Kaufmann Publication, ISBN 978-1-55860-914-3.

Natural Language Processing (COE- 530)

Course Objectives:- Objectives of course are:

1) Introduction to various recent statistical methods in natural language processing.
2) Develop familiarity to linguistics and their application to part-of-speech tagging.
3) Develop background to various tools and aspects of NLP like syntax and semantic analysis, parsing, machine translation, information retrieval and statistical discourse processing.

Applicable to Students admitted from 2015 onwards.

Syllabus:-

Introduction to Natural Language Processing (NLP): Definition, History, Applications of NLP, Goals of NLP.

Words and Phonetics: Regular expressions and Automata, Morphology and phonetics fundamentals, morphological diversity of Indian languages, morphology paradigms, finite state machine based morphology, Computational Phonology and Text-to-Speech, Probabilistic Models of Pronunciation and Spelling, N-grams, HMMs and Speech Recognition, Wordnet and linking.

Parsing: Part-of Speech Tagging, theories of parsing, syntactic and statistical parsing, parsing algorithms, hybrid of rule based and probabilistic parsing, scope ambiguity and attachment ambiguity resolution, Tree banks.

Discourse and dialogue: discourse and dialogue analysis, anaphora resolution, named entity resolution, event anaphora, Information extraction and retrieval.

Applications: sentiment analysis, text entailment, machine translation, automated speech recognition systems, question-answering based systems, shallow parsers.

References:-

1. Jurafsky, D. & J. Martin, "Speech and Language Processing: An Introduction to Natural Language Processing Computational Linguistics, and Speech Recognition" Prentice Hall, 2000.
2. Grosz, B.J., Sparck Jones, K. & Webber, B.L. (eds) "Readings in natural language processing", Los Altos, CA. Morgan Kaufmann, 1986.
3. Allen, J., "Natural Language Understanding", Redwood City, CA: 1994. Benjamin/Cummings.
4. Bharti, Akshar,Chaitanya Vineet, Sangal Rajeev, "Natural Language Processing", Prentice Hall.

Modeling & Simulation (COE- 532)

Course Objectives:- The objective is to introduce students to basic simulation methods and tools for modeling and simulation of continuous, discrete and hybrid systems.

Syllabus:-

Introduction to Simulation and Modeling: Nature of Simulation Systems, Models and Simulation, Continuous and Discrete Systems, system modeling, concept of simulation, Components of a simulation study, Principles used in modeling, Static and Dynamic physical models, Static and Dynamic Mathematical models Introduction to Static and Dynamic System simulation, Advantages, Disadvantages and pitfalls of Simulation.

System Simulation and Continuous System Simulation: Types of System Simulation, Monte Carlo Method, Comparision of analytical and Simulation methods, Numerical Computation techniques for Continuous and Discrete Models, Distributed Lag Models, Cobweb Model. Continuous System models, Analog and Hybrid computers, Digital-Analog Simulators, Continuous system simulation languages, Hybrid simulation, Real time simulations.

System Dynamics & Probability concepts in Simulation: Exponential growth and decay models, logistic curves, Generalization of growth models, System dynamics diagrams, Multi segment models, Representation of Time Delays. Discrete and Continuous probability functions, Continuous Uniformly Distributed Random Numbers, Generation of a Random numbers, Generating Discrete distributions, Non-Uniform Continuously Distributed Random Numbers, Rejection Method.

Simulation of Queueing Systems and Discrete System Simulation: Poisson arrival patterns, Exponential distribution, Service times, Normal Distribution Queuing disciplines, Simulation of single and two server queue. Application of queuing theory in computer system, Discrete Events, Generation of arrival patterns, Simulation programming tasks, Gathering statistics, Measuring occupancy and Utilization, Recording Distributions and Transit times.

Introduction to Simulation languages and Analysis of Simulation output: GPSS: Action times, Succession of events, Choice of paths, Conditional transfers, program control statements SIMSCRIPT: Organization of SIMSCRIPT Program, Names & Labels, and SIMSCRIPT statements. Estimation methods, Relication of Runs, Batch Means, Regenerative techniques, Time Series Analysis, Spectral Analysis and Autoregressive Processes.

References:-

1. Gorden G., System simulation, Prentice Hall.
2. Seila, Simulation Modeling, Cengage Learning
3. Law.,Simulation Modeling And Analysis, McGraw Hill
4. Deo, System Simulation with Digital Computer, PHI

Human Computer Interaction (COE- 534)

Course Objectives:- The students will be able to understand the basics concepts, tools and techniques of HCI (Human Computer Interaction). The students will gain principles and skills for designing and evaluating interactive systems. Students will be able to gather functional requirements, identify the problem, form a solution and design a system that is usable by people.

Syllabus:-

Introduction to Human-Computer Interaction.

Task-centred system design: task-centered process, development of task examples, evaluation of designs through a task-centered walk-through.

User-centred design and prototyping: assumptions, participatory design, methods for involving the user, prototyping, low fidelity prototypes, medium fidelity

Methods for evaluation of interfaces with users: goals of evaluation, approaches, ethics, introspection, extracting the conceptual model, direct observation, constructive interaction, interviews and questionnaires, continuous evaluation via user feedback and field studies, choosing an evaluation method.

Psychology of everyday things: psychopathology of everyday things, examples, concepts for designing everyday things.

Beyond screen design: characteristics of good representations, information visualization, Tufte's guidelines, visual variables, metaphors, direct manipulation.

Graphical screen design: graphical design concepts, components of visible language, graphical design by grids.

Design principles and usability heuristics: design principles, principles to support usability, golden rules and heuristics, HCI patterns.

HCI design standards: process-oriented standards, product-oriented standards, strengths and limitations of HCI Standards.

Past and future of HCI: the past, present and future, perceptual interfaces, context-awareness and perception.

References:-

1. Yvonne Rogers, Helen Sharp, Jenny Preece, Interaction Design: Beyond Human Computer Interaction, 3rd Edition, Wiley, 2011, ISBN-10: 0470665769
2. Dix A., Finlay J., Abowd G. D. and Beale R. Human Computer Interaction, 3rd edition, Pearson Education, 2005.
3. Preece J., Rogers Y., Sharp H., Baniyon D., Holland S. and Carey T. Human Computer Interaction, Addison-Wesley, 1994.
4. B. Shneiderman; Designing the User Interface, Addison Wesley 2000 (Indian Reprint).
5. Dix A., Finlay J., Abowd G. D. and Beale R. Human Computer Interaction, 3rd edition, Pearson Education, 2005.
6. Preece J., Rogers Y., Sharp H., Baniyon D., Holland S. and Carey T. Human Computer Interaction, Addison-Wesley, 1994.
7. B. Shneiderman; Designing the User Interface, Addison Wesley 2000 (Indian Reprint).
8. Jacob Nieilsen; Useability Engineering; Morgan Kaufmann, Academic Press, London, 1993.

High Performance and Parallel Computing (COE-536)

Objective:- To understand approaches to achieve higher performance in modern computing systems despite inherent limitations in hardware support.

Syllabus:-

Parallel Processing Concepts, Levels of parallelism,instruction, transaction, task, thread, memory, function,Dataflow Models, Demand-driven Computation etc., Architectures, N-wide superscalar architectures, multi-core, multi-threaded, Processor Architecture, Interconnect, Communication, Memory Organization, and Programming Models in high performance computing architectures, Memory hierarchy and transaction specific memory design, 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, Fundamental Limitations Facing Parallel Computing, Bandwidth Limitations, Latency Limitations, Latency Hiding/Tolerating Techniques and their limitations, Power-Aware Computing and Communication, Power-aware Processing Techniques, Power-aware Memory Design, Power-aware Interconnect Design, Software Power Management,Petascale Computing, Optics in Parallel Computing, Quantum Computers, Recent developments in Nanotechnology and its impact on HPC.

References:-

1. Highly Parallel Computing, by George S. Almasi and Alan Gottlieb
2. Advanced Computer Architecture: Parallelism, Scalability, Programmability", by Kai Hwang, McGraw Hill 1993
3. Parallel Computer Architecture: A hardware/Software Approach, by David Culler Jaswinder Pal Singh, Morgan Kaufmann, 1999.
4. Scalable Parallel Computing, by Kai Hwang, McGraw Hill 1998.
5. Principles and Practices on Interconnection Networks, by William James Dally and Brian Towles, Morgan Kauffman 2004.
6. GPU Gems 3 --- by Hubert Nguyen (Chapter 29 to Chapter 41)
7. Introduction to Parallel Computing, AnanthGrama, Anshul Gupta, George Karypis, and Vipin Kumar, 2nd edition, Addison-Welsey, 2003.
8. Petascale Computing: Algorithms and Applications, David A. Bader (Ed.), Chapman & Hall/CRC Computational Science Series, 2007.

Mobile Computing (COE-538)

Objective:- To understand modern trend of mobile computing and to acquire knowledge about the methodology followed in developing secure computing applications for cellular, MANET, and sensor environment.

Syllabus:-

Challenges in mobile computing, cellular Vs ad hoc mobile computing environments, coping with uncertainties, resource scarcity, bandwidth, and mobility, Routing in MANETs, TORA, TORA-based computing protocols, Fundamental problems, Synchronization, Mutual exclusion, Coordinator election, Agreement problems, Termination in cellular systems and MANETs, Handling fundamental challenges in faulty distributed environments, Causal message delivery, Publish/Subscribe, Concepts of graph theory applicable to MANETs, Minimum spanning tree, Ring, Tree, Hybrid architectures, Fault tolerance, Coordinated and Uncoordinated Check pointing, No blocking protocols.

References:-

1. Theodore S. Rappaport, Wireless Communications: Principles and Practice, Second Edition, Prentice Hall, 2002.
2. Ivan Stojmenovic, Handbook of Wireless Networks and Mobile Computing, John Wiley & Sons, 2002.
3. Mohd. Ilyas & Imad Mahgoub, Mobile Computing Handbook, CRC Press/Aurbach Publications, ISBN 0-8493-1971-4, Boca Raton USA, 2005.

Data Mining and Warehousing (COE-540)

Course Objectives:- To provide graduates in computing with in-depth knowledge, advanced skills and understanding in the areas of Data Warehousing and Data Mining and a range of techniques, conceptual models and tools to develop into professionals in the areas of 'Data, Information and Knowledge Management', 'Knowledge Discovery', 'Business Intelligence and Decision Support Systems', potentially working in a wide range of application areas.

Applicable to Students admitted from 2015 onwards.

Syllabus:-

Introduction: Fundamentals of data mining, Data Mining Functionalities, Classification of Data Mining systems, Major issues in Data Mining, Data Warehouse and OLAP Technology for Data Mining Data Warehouse, Multidimensional Data Model, Data Warehouse Architecture, Data Warehouse Implementation, Further Development of Data Cube Technology, From Data Warehousing to Data Mining.

Data Preprocessing: Needs Preprocessing the Data, Data Cleaning, Data Integration and Transformation, Data Reduction, Discretization and Concept Hierarchy Generation.

Data Mining Primitives, Languages, and System Architectures: Data Mining Primitives, Data Mining Query Languages, Designing Graphical User Interfaces Based on a Data Mining Query Language Architectures of Data Mining Systems.

Concepts Description: Characterization and Comparison: Data Generalization and Summarization-Based Characterization, Analytical Characterization: Analysis of Attribute Relevance, Mining Class Comparisons: Discriminating between Different Classes, Mining Descriptive Statistical Measures in Large Databases.

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

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

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

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

References:-

1. Data Mining – Concepts and Techniques - JIAWEI HAN & MICHELINE KAMBER Harcourt India.
2. Data Mining Introductory and advanced topics –Magraret Dunham, Pearson Education
3. Data Mining Techniques – Arun Pujari, University Press.
4. Data Warehousing in the Real World – Sam Anahory & Deninis Murray, Pearson Edn Asia.
5. Data Warehousing Fundamentals – Paulraj Ponnaiah, Wlley Student Edition.
6. The Data Warehouse Life cycle Tool kit – Ralph Kimball, Willey Student Edition.
7. Various Research Paper (Journal & Conference).

Research Methodology (COE-542)

Objective:- Objective of this course is:

1) To understand research terminology
2) To gain insights into how scientific research is conducted.
3) To help in critical review of literature and assessing the research trends, quality and extension potential of research and equip students to undertake research.
4) To critically analyze published research
5) To learn and understand various research methods.
6) To identify the influencing factor or determinants of research parameters.
7) To test the significance, validity and reliability of the research results.
8) To help in documentation of research results.
9) To learn legal or ethical issues for an investigation.

Syllabus:-

Introduction: Meaning and significance of research and scholarship; difference between undergraduate and research education; skills, habits and attitudes for research; status of research in India; course objectives.

Thinking skills: Problem solving, creativity, problem finding and formulation, Levels and styles of thinking; common-sense and scientific thinking; examples. Problem solving strategies – reformulation or rephrasing, techniques of representation, logical thinking, division into sub-problems, verbalization, awareness of scale; Importance of graphical representation; examples. Creativity – some definitions, illustrations from day to day life; intelligence versus creativity; gift or skill; creative process; requirements for creativity – role of motivation and open vs closed minds; multiple approaches to a problem, analytical vs analogical reasoning, puzzle solving; examples; prepared mind; Creative problem solving using Triz. Problem finding and literature survey, Information gathering – reading, searching and documentation; types, attributes and sources of research problems; problem formulation. Prescriptions for developing creativity and problem solving.

Experimental and modeling skills: Scientific method; role of hypothesis in experiment; units and dimensions; dependent a n d independent variables; control in experiment; precision and accuracy; need for precision; definition, detection, estimation and reduction of random errors; statistical treatment of data; definition, detection and elimination of systematic errors; design of experiments; experimental logic; documentation; Types of models; stages in modeling; types of models; curve fitting; the art of making approximations; problem representation; logical reasoning; mathematical skills; finite element and Monte Carlo techniques of numerical simulation; Two case studies illustrating experimental and modeling skills.

Effective communication - oral and written: Examples illustrating the importance of effective communication; stages and dimensions of a communication process. Oral communication –verbal and non-verbal, casual, formal and informal communication; interactive communication; listening; form, content and delivery; various contexts for speaking- conference, seminar etc; visual aids Written communication - form, content and language; layout, typography and illustrations; contexts for writing – paper, thesis, reports etc. Prescriptions for developing communication skills.

Publishing and patenting: Difference between publishing and patenting; relative importance of various forms of publication; choice of journal and reviewing process; stages in the realization of a paper or a patent and how to handle these

Stress and time management, Interpersonal skill, professional ethics: Psychological phases of a PhD process; stress points; aims of supervisors; mismatches between scholar and supervisor and related problems. Managing self; empathy; managing relationships with your supervisor, colleagues, and supporting staff; listening; assertiveness; teamwork; sense of humor. Duration and stages of a PhD process; long term and short term goals; time tabling and deadlines. Profession; integrity, objectivity, fairness and consistency; loyalty; plagiarism and research ethics; safety.

References:-

1. E. M. Phillips and D. S. Pugh, "How to get a PhD - a handbook for PhD students and their supervisors", Viva books Pvt Ltd, 2010.
2. Handbook of Science Communication, compiled by Antony Wilson, Jane Gregory, Steve Miller, Shirley Earl, Overseas Press India Pvt Ltd, New Delhi, 1st edition 2005.
3. G. L. Squires, "Practical physics", Cambridge University Press.