CURRICULUM AND DETAILED SYLLABI

FOR

M.TECH DEGREE PROGRAMME

IN

COMPUTER SCIENCE AND ENGINEERING

COMPUTER SCIENCE AND ENGINEERING

SEMESTERS I TO IV

2020 SCHEME

(AUTONOMOUS)

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, Autonomous Institution Affiliated to APJ Abdul Kalam Technological University)

MAR IVANIOS VIDYANAGAR, NALANCHIRA, THIRUVANANTHAPURAM – 695015, KERALA.

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MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

Vision and Mission of the Institution

Vision:

To be an Institution moulding globally competent professionals as epitomes of Noble Values.

Mission:

To transform the Youth as technically competent, ethically sound and socially committed professionals, by providing a vibrant learning ambience for the welfare of humanity.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Vision and Mission of the Department

Vision:

To be a Centre of Excellence in Computer Science and Engineering providing quality education and research for the betterment of the society.

Mission:

To impart sound knowledge in theoretical and applied foundations of Computer Science and Engineering, and to train the students to solve real life issues to effectively define and shape life.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. Graduates will be successful professionals with the expertise to expand the horizon of knowledge through research and development and thereby attain exceptional careers.
2. Graduates will demonstrate professional attitude and ethics while providing solutionsindividually and as a team in societal and environmental contexts.

PROGRAMME OUTCOMES (POs)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
4. An ability to engage in research-oriented works using recent computational tools and techniques, adhering to professional, ethical, environmental and societal aspects.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

M. Tech Computer Science and Engineering

For the students admitted from 2020-21

Scheduling of Courses

i) Knowledge Segments and Credits

Every course of M. Tech Programme is placed in one of the seven categories as listed in table below. No semester shall have more than six lecture-based courses and two laboratory courses, and/or drawing/seminar/project courses in the curriculum.

Table 1: Credit distribution and the Knowledge Domains

Sl. No.	Category	Category Code	Number of Courses	Total Credits
1	Programme Core Courses	PCC	7	24
2	Programme Elective Courses	PEC	5	15
3	Laboratory Courses	PCC	2	02
4	Mandatory Credit Course (Research Methodology)	MCC	1	2
5	Seminar	PWS	2	4
6	Mini Project		1	2
7	Project		2	18
			Total Mandatory Credits	**67**

*Note: 67 credits have been the requirement for award of degree in all M. Tech Programmes of the College which was approved by the University.

ii) Semester-wise Credit Distribution

Semester	I	II	III	IV	Total Credits
Credits for Courses	22	19	14	12	**67**

SEMESTER I							
Slot	**Category Code**	**Course No.**	**Courses**	**L**	**T**	**P**	**Credit**
A	PCC	MA0P60A	Mathematical Foundations of Computing Systems	3	0	0	3
B	PCC	CS1P60A	Topics in Database Technology	3	1	0	4
C	PCC	CS1P60B	Advanced Data Structures and Algorithms	3	1	0	4
D	PCC	CS1P60C	Advanced Software Engineering	3	0	0	3
E	PEC	CS1PXX	Elective I	3/2	0/1	0	3
S	MCC	MC0P60A	Research Methodology	0	2	0	2
T	PCC	CS1P68A	Algorithm Design laboratory	0	0	2	1
U	PWS	CS1P69A	Seminar I	0	0	2	2
			TOTAL	15	4	4	**22**

SEMESTER II							
Slot	**Category Code**	**Course No.**	**Courses**	**L**	**T**	**P**	**Credit**
A	PCC	CS1P60D	Soft Computing	3	1	0	4
B	PCC	CS1P60E	Operating System Design	3	0	0	3
C	PCC	CS1P60F	Advanced Computer Networks	3	0	0	3
D	PEC	CS1PXXX	Elective II	3/2	0/1	0	3
E	PEC	CS1PXXX	Elective III	3/2	0/1	0	3
T	PCC	CS1P68B	Network & OS Laboratory	0	0	2	1
W	PWS	CS1P69B	Mini Project	0	0	4	2
			TOTAL	15	1	6	**19**

ELECTIVE I

Slot	Category Code	Course No.	Courses	L	T	P	Credit
E	PEC	CS1P61A	Data Mining &Warehousing	2	1	0	3
		CS1P61B	Data Compression Techniques	2	1	0	3
		CS1P61C	Advanced Topics in Distributed Systems	3	0	0	3
		CS1P61D	Advanced Complier Design	3	0	0	3
		CS1P61E	Cloud Computing	3	0	0	3

ELECTIVE II

Slot	Category Code	Course No.	Course	L	T	P	Credit
D	PEC	CS1P62A	Parallel Algorithms	3	0	0	3
		CS1P62B	Parallel Computer Architecture	3	0	0	3
		CS1P62C	Computational Geometry	3	0	0	3
		CS1P62D	Semantic Web Technology	3	0	0	3
		CS1P62E	Image Processing	2	1	0	3

ELECTIVE III

Slot	Category Code	Course No.	Course	L	T	P	Credit
E	PEC	CS1P63A	Machine Learning	2	1	0	3
		CS1P63B	Advanced Graph Theory	3	0	0	3
		CS1P63C	Cyber Laws and ethics	3	0	0	3
		CS1P63D	Principles of Information Security	2	1	0	3

SEMESTER III							
Slot	Category Code	Course No.	Courses	L	T	P	Credit
A	PEC	CS1PXXX	Elective IV	3	0	0	3
B	PEC	CS1PXXX	Elective V	3	0	0	3
U	PWS	CS1P79A	Seminar II	0	0	2	2
W	PWS	CS1P79B	Project – Phase 1	0	0	12	6
			TOTAL	**6**	**0**	**14**	**14**

ELECTIVE IV

Slot	Category Code	Course No.	Course	L	T	P	Credit
A	PEC	CS1P71A	Complexity Theory	3	0	0	3
		CS1P71B	Distributed Algorithms	3	0	0	3
		CS1P71C	Advanced Computer Graphics	3	0	0	3
		CS1P71D	Ad-hoc and Sensor Networks	3	0	0	3

ELECTIVE V

Slot	Category Code	Course No.	Course	L	T	P	Credit
B	PEC	CS1P72A	Principles of Network Security	3	0	0	3
		CS1P72B	Fuzzy Set Theory & Applications	3	0	0	3
		CS1P72C	Decision Support Systems	3	0	0	3
		CS1P72D	Advanced Software Project Management	3	0	0	3

SEMESTER IV							
Slot	Category Code	Course No.	Courses	L	T	P	Credit
W	PWS	CS1P79C	Project Phase – II	0	0	24	12
			TOTAL	0	**0**	**24**	**12**

PART B
SEMESTER - I
SYLLABUS

Course No	Course Name	Category	L	T	P	Credit
MA0P60A	MATHEMATICAL FOUNDATIONS OF COMPUTING SYSTEMS	PCC	3	0	0	3

COURSE OVERVIEW:

Goal of this course is to expose the students to the fundamental concepts of counting techniques, theorem proving. It also introduces the idea of graphs, trees and graphs theoretic algorithms.

COURSE OUTCOMES

After the completion of the course the student will be able to:

CO 1	Construct proofs using direct proofs, proof by contraposition, proof by contradiction and proof by cases
CO 2	Solve problems using counting techniques and combinatorics.
CO 3	Apply the concept of random variables, probability distributions in practical distributions.
CO 4	Demonstrate the knowledge of fundamental concepts of graph theory
CO 5	Identify and solve problems using different algebraic structures.

SYLLABUS

Techniques for theorem proving, principle of complete induction- Recursive definitions - Generating functions - Fundamental principles of counting - pigeonhole principle - countable and uncountable sets - principle of inclusion and exclusion – applications – derangements - permutation and combination theory – Properties of Probability Methods of Enumeration- Conditional Probability- Independent Events- Bayes Theorem,-Mathematical Expectation- Random variables Discrete Distribution- Binomial Distribution- Mean and variance - The Poisson Distribution- Continuous Distribution- Uniform and Exponential Distributions - Normal Distribution- Graphs and algorithms - Groups and subgroups - homomorphism theorems - cosets and normal subgroups - Lagrange’s theorem- rings- finite fields.

REFERENCES

1. J. P. Tremblay, R. Manohar, “Discrete Mathematical Structures with Application to Computer Science”, Tata McGraw Hill, 2000.
2. Kenneth H. Rosen, “Discrete Mathematics and its Applications”, 7/e, McGraw Hill Inc, 2011.

COURSE PLAN

Module	Contents	No. of hours
I	Techniques for theorem proving: Direct Proof, Proof by Contra position, Proof by exhausting cases and proof by contradiction , Linear-time temporal logic and Branching-time logic-Syntax, Semantics, Practical patterns of specifications, Important equivalences, Adequate sets of connectives.	8
II	Principle of mathematical induction, principle of complete induction. Recursive definitions, Generating functions, function of sequences calculating coefficient of generating function, solving recurrence relation by substitution and generating functions Solution methods.	7
III	Fundamental principles of counting, pigeonhole principle, countable and uncountable sets, principle of inclusion and exclusion – applications, derangements, permutation and combination, Pascal's triangles, binomial theorem	7
IV	Probability theory – Properties of Probability, Methods of Enumeration, Conditional Probability, Independent Events, Bayes Theorem, Mathematical Expectation, Random variables, Discrete Distribution, Binomial Distribution, Mean and variance , Poisson Distribution, Continuous Distribution, Uniform and Exponential Distributions, Normal Distribution.	8
V	Graphs, Terminology, Euler tours, planar graphs, Hamiltonian graphs, Euler's formula (proof), Warshall's algorithm, Decision Trees, weighted trees , four colour problem (without proof) and the chromatic number of a graph, five colour theorem, chromatic polynomials.	7
VI	Groups and subgroups, homomorphism theorems, cosets and normal subgroups, Lagrange's theorem, rings, polynomial arithmetic, quadratic residues, reciprocity, discrete logarithms, elliptic curve arithmetic.	8
	Total Hours	45

Course No	Course Name	Category	L	T	P	Credit
CS1P60A	TOPICS IN DATABASE TECHNOLOGY	PCC	3	1	0	4

COURSE OVERVIEW

The goal of this course is to understand transaction processing, query optimization, principles of distributed databases and the recent advances in database technology.

COURSE OUTCOMES

After the completion of the course the student will be able to:

CO 1	Apply transaction processing concepts
CO 2	Apply query processing and optimization
CO 3	Design distributed and parallel database
CO 4	Distinguish temporal and spatial database
CO 5	Apply advances in database technology

SYLLABUS

Transactions & Serializability: Concurrent executions, Serializability, Types, Deadlock, Recoverability, Concurrency Control: Lock based protocols, timestamp based protocols, Concurrency Control Techniques

Query Processing and Optimization: Relational algebra transformations, Query size and I/O cost estimation, I/O cost for basic data management algorithms, Heuristic Query Optimization

Parallel Systems, Distributed Systems, Functions, Distributed RDB design, Transparency, Distributed Transactions, Commit Protocols, Concurrency Control, Deadlocks, Recovery

Enhanced Data Models, Triggers, Temporal Databases, Spatial and geographical data management,k-d trees, quad trees and R-trees, Deductive Databases, XML Databases

Concepts for Object Databases, Encapsulation of Operations, Type and Class Hierarchies, Complex Objects, ODMG, ODL, OQL.

Information Retrieval and Web Search, Types of Queries in IR Systems, Text Preprocessing, Inverted Indexing, Web Search and Analysis.

REFERENCES

1. R. Elmasri, S.B. Navathe, “Fundamentals of Database Systems”, 5/e, Pearson Education/Addison Wesley, 2011.
2. Patrick O'Neil , Elizabeth O'Neil , “Database: Principles, Programming and Performance”, 2/e, Morgan Kaufmann, 2011.
3. Thomas Cannolly and Carolyn Begg, “Database Systems, A Practical Approach to Design, Implementation and Management”, 3/e, Pearson Education, 2010.
4. Henry F Korth, Abraham Silberschatz, S. Sudharshan, “Database System Concepts”, 5/e, Tata McGraw Hill, 2006.

COURSE PLAN

Module	Contents	No. of hours
I	Query Processing Algorithms – Query Optimization Techniques – Transaction Management: Transaction Processing Concepts - Concurrency Control – Deadlocks – Recovery Techniques	**12**
II	Database Security: threats to databases, control measures, database security and DBA, Discretionary access control, Mandatory access control (role-based only), SQL injection. Database System Architectures: Centralized and Client-Server Architectures – Server System Architectures	**10**
III	Parallel Systems- Distributed Systems – Parallel Databases: I/O Parallelism – Inter and Intra Query Parallelism – Inter and Intra operation Parallelism – Distributed Database – Functions – Distributed RDB design- Transparency– Distributed Transactions - Commit Protocols – Concurrency Control – Deadlocks – Recovery - Distributed Query Processing.	**12**
IV	Temporal Databases – Time in Databases, Spatial and geographical data management: geographical data, representation, spatial queries, indexing spatial data, k-d trees, quad trees and R-trees	**6**
V	Concepts for Object Databases: Object Identity – Object structure – Type Constructors – Encapsulation of Operations – Methods – Persistence – Type and Class Hierarchies – Inheritance – Complex Objects, ODMG, ODL, OQL, basic OQL queries. Object Relational Systems – Case studies: Oracle and Informix.	**11**
VI	Semi-structured Data and XML Databases: XML Data Model – DTD – XPath and XQuery – Example Queries. Storing, RDF (Fundamental Concepts only).	**9**
	Total Hours	**60**

Course No	Course Name	Category	L	T	P	Credit
CS1P60B	ADVANCED DATA STRUCTURES AND ALGORITHMS	PCC	3	1	0	4

COURSE OVERVIEW

Goal of this course is to introduce different advanced data structures and algorithms to analyze and establish correctness of algorithms. This course aims to introduce various classes of the algorithms.

COURSE OUTCOMES

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

CO 1	Analyze a given problem and apply appropriate advanced data structures to solve it efficiently.
CO 2	Explain number theoretic algorithms and string-matching algorithms.
CO 3	Apply flow networks to solve real world problems.
CO 4	Explain the theory behind various classes of algorithms.
CO 5	Apply geometric algorithms to solve real world problems.
CO 6	Design new algorithms, establish the proof of correctness and analyze the efficiency.

SYLLABUS

Amortized Analysis – aggregate, accounting and potential methods.

Advanced data structures: binomial heap, Fibonacci heap, Disjoint sets -Applications.

Number-Theoretic algorithms: GCD algorithm, Extended Euclid's Algorithm. Primality testing-Miller-Rabin test. Integer factorization - Pollard Rho heuristic. String matching: Rabin-Karp, Knuth-Morris-Pratt algorithms.

Network flow algorithms: flow properties, augmenting path, Ford-Fulkerson method, Edmonds-Karp heuristics, Maxflow-min cut theorem. Push-relabel, relabel-to-front algorithms

Probabilistic algorithms: Numerical algorithms: Integration, Counting. Monte-Carlo algorithms - verifying matrix multiplication, min-cut in a network. Las Vegas algorithms, selection sort, quick sort, Dixon's factorization. Complexity classes in randomized algorithms – RP, PP, ZPP, BPP

Geometric Algorithms: Plane sweep technique, role of sweep- line status and event-point schedule, line segment intersection problem. Convex Hull: Graham's scan algorithm, Jarvis March algorithm. Finding the closest pair of points, proof of correctness. Overview of Complexity classes – P, NP, Co-NP, NP-hard, NP-complete. Space complexity.

REFERENCES:

1. T. H. Cormen, C. E. Leiserson, R. L. Rivest and C. Stein, "Introduction to algorithms", Prentice-hall of India Private Limited, New Delhi, 2010.
2. Gilles Brassard and Paul Bratley, "Fundamentals of algorithms", Prentice-hall of India Private Limited, New Delhi, 2001.
3. Rajeev Motwani, Prabhakar Raghavan, "Randomized Algorithms", Cambridge University Press, 2000.

COURSE PLAN

Module	Contents	No. of hours
I	Amortized Analysis – aggregate, accounting and potential methods Advanced data structures: binomial heap, Fibonacci heap, disjoint sets – applications	**10**
II	Number-Theoretic algorithms: GCD algorithm, Extended Euclid's algorithm Primality testing, Miller-Rabin test Integer factorization - Pollard Rho heuristic	**10**
III	Network flow algorithms: flow properties, augmenting path Ford-Fulkerson method, Edmonds-Karp heuristics Maxflow-mincut theorem push-relabel, relabel-to-front algorithms	**12**
IV	String matching: Rabin-Karp, Knuth-Morris-Pratt algorithms. Overview of Complexity classes – P, NP, Co-NP, NP-hard, NP-complete. Space complexity.	**08**
V	Probabilistic algorithms: Numerical algorithms: Integration, Counting Monte-Carlo algorithms - verifying matrix multiplication, min-cut in a network. Las Vegas algorithms, selection sort, quick sort, Dixon's factorization. Complexity classes in randomized algorithms – RP, PP, ZPP, BPP	**10**
VI	Geometric Algorithms: Plane sweep technique, role of sweep- line status and event-point schedule, line segment intersection problem. Convex Hull : Graham's scan algorithm, Jarvis March algorithm. Finding closest pair of points, proof of correctness	**10**
	Total Hours	**60**

Course No	Course Name	Category	L	T	P	Credit
CS1P60C	ADVANCED SOFTWARE ENGINEERING	PCC	3	0	0	3

COURSE OVERVIEW:

The goal of this course is to introduce the concepts and principles in Software Engineering and apply them for building quality software. It also includes the necessary methods for testing the software.

COURSE OUTCOMES

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

CO 1	Explain Software Engineering principles
CO 2	Apply software engineering concepts to design a software
CO 3	Evaluate software correctness through testing
CO 4	Analyze software reliability and upkeep of software

SYLLABUS

Software Process modelling, Software development Life Cycle, Software Requirements Engineering, Software Project Planning, Risk Management, Software Design, Programming, Testing, Software Reliability, Maintenance, software tools

Software Process Models – Waterfall Model – V Model, prototyping Model – Spiral Model – Agile methods. Tools and Techniques for Process Modelling

Requirements Engineering, Types of Requirements. Requirements Elicitation, Requirements Analysis.

Object Oriented (OO) design, representing designs using UML OO Design Patterns, OO Measurement

Testing the Programs. Principles of System Testing, Function Testing, - Performance Testing,

Software Reliability – Concepts. Software Reliability models. Reliability - Availability and Maintainability. Capability Maturity models

REFERENCES

1) Shari Lawrence Pfleeger, Joanne M Atlee, "Software Engineering Theory and Practice", 4/e, Pearson Education, 2011.

2) Software Engineering: A Practitioner's Approach, Roger S Pressman, 7/e, McGraw Hill Int.Ed., 2010.

3) K.K Aggarwal & Yogesh Singh, "Software Engineering", New Age International, 2008.
4) Ian Somerville, "Software Engineering", 10/e, Pearson,2017
5) Carlo Ghezzi, Mehdi Jazayeri, Dino Mandrioli, "Fundamentals of Software Engineering", 2/e, PHI Learning Private Ltd., 2010.
6) Pankaj Jalote, "An Integrated Approach to Software Engineering", 3/e, Springer 2005.

COURSE PLAN

Module	Contents	No. of hours
I	Introduction: Role of Software Engineering, Quality of software process and product. Systems Approach to Software Engineering. An Engineering Approach to Software Engineering How has Software Engineering Changed? Modeling the Process and Life Cycle	**6**
II	Software Process Models – Waterfall Model – V Model, prototyping Model – Spiral Model – Agile methods. Tools and Techniques for Process Modeling. Planning and Managing the Project Tracking project progress - Project personnel and organization. Effort and schedule estimation. Risk Management – Process Models, Project Management	**7**
III	Requirements Engineering, Types of Requirements. Requirements Elicitation, Requirements Analysis. Requirements Documentation, Requirements validation. Software Design, Types of Cohesion. Designing Modules, Design Methodology. Design Principles	**9**
IV	Object Oriented (OO) design, Representing designs using UML OO Design Patterns, OO Measurement. Designing Modules, Design Methodology. Programming Standards and Procedures, Programming Guidelines, Documentation	**8**
V	Testing the Programs. Principles of System Testing, Function Testing, - Performance Testing, Acceptance Testing - Installation Testing, Automated System Testing. Test Documentation, Testing Safety Critical Systems	**8**
VI	Software Reliability – Concepts. Software Reliability models. Reliability - Availability and Maintainability. Capability Maturity models. Software Maintenance concepts. Software Maintenance models, CASE	**7**
	Total Hours	**45**

Course No	Course Name	Category	L	T	P	Credit
CS1P61A	DATA MINING & WAREHOUSING	PEC	2	1	0	3

COURSE OVERVIEW

The course focuses on basic concepts of data mining techniques and covers data warehousing, and data mining algorithms. The course enables students to understand and practice the fundamental and advanced concepts of Data Warehousing and Data Mining.

COURSE OUTCOMES

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

CO 1	Explain Data warehousing, OLAP and basic data mining activities
CO 2	Apply data mining algorithms for classification and clustering
CO 3	Make use of association rule mining techniques
CO 4	Explain Web mining and Spatial mining

SYLLABUS

Data Mining - Concepts and Applications, Data Mining Stages, Data Mining Models, Data Warehousing (DWH) and On-Line Analytical Processing (OLAP), Application of Data Mining Principles, Applications of DWH

Data Pre-processing: Data Pre-processing Concepts Classification Models: Introduction to Classification and Prediction, Decision Tree- ID3, C4.5

Naive Bayes Classifier, Rule based classification- 1R. Neural Networks-Back propagation. Support Vector Machines, Lazy Learners-K Nearest Neighbour Classifier

Accuracy and error Measures evaluation. Prediction-Linear Regression and Non-Linear Regression Association Rules Mining, Cluster Analysis, Categorization of clustering methods.

Advanced Data Mining Techniques: Web Mining- Web Content Mining, Web Structure Mining, Web Usage Mining. Text Mining. Social Network Analysis- characteristics of social networks. Link mining - Tasks and challenges.

REFERENCES

1. Margaret H Dunham, "Data Mining – Introductory and Advanced Topics", Pearson India, 2005.
2. Ali, A. B. M. S. and Wasimi, S. A., "Data Mining - Methods and Techniques", Cengage Publishers,2009.
3. Ian H. Witten, Eibe Frank, Mark A. Hall," Data Mining: Practical Machine Learning Tools and Techniques", 3/e, Morgan Kaufmann, 2011.
4. J. Han, M. Kamber, "Data Mining: Concepts and Techniques", 3/e, Morgan Kaufman, 2011.

COURSE PLAN

Module	Contents	No. of hours
I	Data warehousing – Multidimensional data model, OLAP operation, Warehouse schema, Data Warehousing architecture, warehouse server, Metadata, OLAP engine, Data warehouse Backend Process , Data Warehousing to Data Mining.	6
II	Basic Data Mining Tasks, Data Mining Issues, Data Mining Metrics, Data Mining from a Database Perspective, Knowledge Discovery in Database Vs Data mining. Data Preprocessing: Preprocessing, Cleaning, Integration, Transformation, Reduction, Discretization, Concept Hierarchy Generation, Introduction to DMQL. Case study	8
III	Similarity measures, Bayes Theorem, Classification - regression, Bayesian classification, Decision tree based algorithm-ID3, Neural network based algorithm- supervised learning, back propagation, gradient-descent algorithm, Rule based algorithm-IR, PRISM, Case Study	8
IV	Clustering algorithms – Hierarchical algorithm – Dendrograms- Single link algorithm, Partitional algorithm, Minimum spanning tree, squared error, K-means, PAM algorithm, Case study	8
V	Association Rules :Apriori algorithm, Sampling algorithm, Partitioning algorithm, Parallel and distributed algorithms, Web mining-web content mining, web structure mining, web usage mining, Case study	8
VI	Spatial mining- spatial queries, spatial data structures, Generalization and specialization, spatial classification, spatial clustering, Introduction to temporal mining. Case study	7
	Total Hours	**45**

Course No	Course Name	Category	L	T	P	Credit
CS1P61B	DATA COMPRESSION TECHNIQUES	PEC	2	1	0	3

COURSE OVERVIEW

The course focuses on theoretical foundations of data compression, concepts and algorithms for lossy and lossless data compression. The course also covers signal modelling and its applications to speech, image and video processing.

COURSE OUTCOMES

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

CO 1	Explain the fundamental concepts in data compression
CO 2	Make use of compression techniques like Huffman Coding algorithm and Dictionary based techniques
CO 3	Describe lossy compression techniques
CO 4	Apply vector quantization techniques for image compression

SYLLABUS

Compression Techniques, Compression ratio, lossless & lossy compression, Huffman coding, Non binary Huffman Algorithms, Adaptive Coding, Arithmetic Coding, Finite Context Modeling.

Huffman Coding: Minimum Variance Huffman Codes, Length of Huffman Codes, Adaptive Huffman Coding, Applications, Golomb codes, Rice codes, Tunstall codes. Arithmetic Coding: Coding a sequence, Generating a binary code, Comparison of Huffman and arithmetic coding, Applications

Dictionary Techniques-Static Dictionary, Diagram coding, Adaptive Dictionary, LZ77, LZ78, LZW algorithms, Applications. Context-based Compression-Prediction with partial match (ppm), Burrows Wheeler Transform (BWT), CALIC, JPEG standard, JPEG-LS, Run-Length Coding, JBIG, JBIG2.

Lossy Coding-Distortion Criteria, Rate Distortion Theory. Scalar Quantization: Quantization problem, Uniform Quantizer, LloydMax Quantizer, Adaptive Quantization, Nonuniform Quantization, Entropy-Coded Quantization

Vector Quantization: LBG Algorithm, Tree Structured and Structured Vector Quantizers. Differential Coding: Basic algorithm, DPCM. Transform Coding: Transforms of Interest, JPEG.

REFERENCES

1) David Solomon, Data compression: the complete reference, 2/e, Springer-verlag, New York.,2007.
2) Stephen Welstead, Fractal and wavelet Image Compression techniques , PHI, 1999.
3) Khalid Sayood, Introduction to data compression, Morgan Kaufmann Publishers, 2005.

COURSE PLAN

Module	Contents	No. of hours
I	Compression techniques, Compression ratio, lossless &lossy compression, Huffman coding, Nonbinary Huffman Algorithms, Adaptive Coding, applications, Arithmetic Coding, applications, Finite Context Modeling.	**7**
II	Dictionary based Compression, Sliding Window Compression, LZ77,LZ78, LZW compression. Predictive Coding - prediction and partial match, move to front coding, Run Length encoding.	**8**
III	Speech Compression & Synthesis: Digital Audio concepts, Sampling Variables, Lossless compression of sound, lossy compression & silence compression	**9**
IV	Image Compression, Transform based techniques, Wavelet Methods, adaptive techniques. Images standards, JPEG Compression, ZigZag Coding .	**9**
V	Video Compression- motion compensation, MPEG standards, recent development in Multimedia Video compression, packet video	**6**
VI	Fractal techniques. Comparison of compression algorithms, Implementation of compression algorithms.	**6**
	Total Hours	**45**

Course No	Course Name	Category	L	T	P	Credit
CS1P61C	ADVANCED TOPICS IN DISTRIBUTED SYSTEMS	PEC	3	0	0	3

COURSE OVERVIEW

The course imparts deeper understanding in the architecture and issues of distributed systems, Distributed algorithms and Hadoop system.

COURSE OUTCOMES

CO 1	Explain conceptual and practical aspects of distributed systems.
CO 2	Make use of Hadoop systems for distributed file management.
CO 3	Explain different distributed Algorithms.
CO 4	Describe algorithms in general synchronous networks.

SYLLABUS

Distributed System: Overview, System Architecture, Processes, Threads, Virtualization, Clients, Servers, Code migration

Hadoop: Introduction, Comparison with Other Systems, Analyzing Data with Hadoop, Map and Reduce, Scaling Out

Map Reduce Types, Input and Output Formats, Map Reduce Features, Counters, Sorting, Joins, Side Data Distribution, Administering Hadoop, Monitoring, Maintenance

Synchronization and Election, Distributed Mutual Exclusion, Timestamp Algorithms Voting

Algorithms in General Synchronous Networks, Leader Election, Breadth First Search

REFERENCES

1. Andrew S. Tanenbaum, Maarten Van Steen." Distributed Systems – Principles and Paradigms ", 2/e, PHI, 2004.
2. Randy Chow Theodore Johnson, "Distributed Operating Systems and Algorithm Analysis", Pearson Education, 2009.
3. Nancy A. Lynch, Morgan, " Distributed Algorithms", Kaufmann Publishers, Inc, 1996.
4. Tom White, "Hadoop: The Definitive Guide", 1/e, O'reilly, 2012.
5. Eric Sammer, "Hadoop Operations: A Guide for Developers and Administrators", O'reilly, 2012.
6. Boris Lublinsky, Kevin T. Smith, Alexey Yakubovich, "Professional Hadoop Solutions", John Wiley, 2013.

COURSE PLAN

Module	Contents	No. of hours
I	Distributed System: Overview, System Architecture, Processes –Threads – Virtualization – Clients – Servers – Code migration, Communication – Message Oriented – Stream Oriented – Multicast Communication, Naming – Flat – Structured – Attribute Based Naming.	8
II	Hadoop: Introduction – Comparison with Other Systems, Analyzing Data with Hadoop – Map and Reduce – Scaling Out – Data Flow –Combiner Functions, Hadoop Distributed File System – Concepts and Basic Operations.	7
III	Map Reduce Types – Input and Output Formats, Map Reduce Features– Counters – Sorting – Joins – Side Data Distribution, Administering Hadoop – Monitoring – Maintenance.	7
IV	Distributed Algorithms: Models of Distributed Computation – Preliminaries – Causality – Distributed Snapshots – Modeling a Distributed Computation – Failures in a Distributed System.	8
V	Synchronization and Election – Distributed Mutual Exclusion –Timestamp Algorithms – Voting – Fixed Logical Structure – Path Compression, Election – The Bully Algorithm.	7
VI	Algorithms in General Synchronous Networks – Leader Election –Breadth First Search – Minimum Spanning Tree – Shortest Path–Maximal Independent Set.	8
	Total Hours	**45**

Course No	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1P61D	ADVANCED COMPILER DESIGN	PEC	3	0	0	3	2020

COURSE OVERVIEW

Goal of this course is to make aware of the importance of code optimization in compiler design. It focuses on various intermediate representations, data flow analysis and optimization techniques, register allocation technique, machine code generation techniques and back end design of compilers.

COURSE OUTCOMES

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

CO 1	Explain theory behind the design of a compiler.
CO 2	Apply global code optimization techniques to design code optimizers.
CO 3	Design a machine code generator.
CO 4	Apply low level optimization techniques.

SYLLABUS

Review of compiler phases, Informal Compiler Algorithm Notation(ICAN), Symbol Table Structure, Intermediate Representations, Run Time Issues, Control Flow Analysis, Data Flow Analysis, Dependence analysis & Dependence graphs, Alias analysis.

Global Optimizations – constant folding – algebraic simplification and reassociation – constant and copy propagation – dead code elimination, Redundancy Elimination – common sub expression elimination – loop invariant code motion – partial redundancy elimination – code hoisting, Value numbering.

Loop Optimizations – strength reduction and induction variable elimination, Procedure Optimization techniques, Static Single Assignment (SSA) form - variable renaming.

Machine Dependent tasks: Register Allocation, Code Scheduling. Introduction to inter-procedural analysis and optimization, Machine code generation, Optimizing for Parallelism and Locality – Introduction to Affine Transform Theory.

REFERENCES:

1. Steven S. Muchnick, “Advanced Compiler Design and Implementation”, Morgan Kauffmann, 1997.
2. Alfred V. Aho, Monica S. Lam, Ravi Sethi and Jeffrey D. Ullman, “Compilers: Principles, Techniques and Tools”, Pearson Education, 2009.
3. Andrew W. Appel, “Modern Compiler Implementation in Java”, Cambridge University Press, 2009.
4. Keith D. Cooper, Linda Torczon, “Engineering a Compiler”, 2/e, Morgan Kauffmann, 2011.

COURSE PLAN

Module	Contents	No. of hours
I	Review of compiler phases, Informal Compiler Algorithm Notation(ICAN), Symbol Table Structure – local and global symbol tables, Intermediate Representations – HIR – MIR and LIR, Run Time Issues.	**6**
II	Control Flow Analysis – basic blocks – DFS – dominators and post dominators – loops – dominator tree, Data Flow Analysis – reaching definitions – available expressions, – live variable information, Dependence analysis & Dependence graphs, Alias analysis.	**9**
III	Global Optimizations – constant folding – algebraic simplification and reassociation– constant and copy propagation – dead code elimination, Redundancy Elimination – common subexpression elimination – loop invariant code motion – partial redundancy elimination – code hoisting, Value numbering.	**8**
IV	Loop Optimizations – strength reduction and induction variable elimination, Procedure Optimization techniques, Static Single Assignment (SSA) form – dominance frontier – pi-functions – variable renaming.	**8**
V	Machine Dependent tasks: Register Allocation – graph coloring – coalescing, Code Scheduling – Instruction Scheduling – Speculative Scheduling – Software pipelining.	**7**
VI	Low Level Optimization techniques, Introduction to inter-procedural analysis and optimization, Machine code generation, Optimizing for Parallelism and Locality – Introduction to Affine Transform Theory.	**7**
	Total Hours	**45**

Course No	Course Name	Category	L	T	P	Credit
CS1P61E	CLOUD COMPUTING	PEC	3	0	0	3

COURSE OVERVIEW:

The course enables students to get an understanding of cloud computing architectures. It also focuses on different types of cloud services.

COURSE OUTCOMES:

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

CO 1	Explain the basic concepts of cloud services.
CO 2	Make use of cloud service for various applications.
CO 3	Describe cloud scheduling tasks and its applications.
CO4	Make use of cloud for collaborating Databases and files.

SYLLABUS

Cloud Computing, History of Cloud Computing, Cloud Architecture, Cloud Storage, Why Cloud Computing Matters, Advantages of Cloud Computing

Cloud Services Web-Based Application, Pros and Cons of Cloud Service Development, Types of Cloud Service Development, Software as a Service, Platform as a Service, Web Services

Centralizing Email Communications, Collaborating on Schedules, Collaborating on To Do Lists. Collaborating Contact Lists, Cloud Computing for the Community, Collaborating on Group Projects and Events, Cloud Computing for the Corporation

Exploring Online Planning and Task Management, Collaborating on Event Management, Collaborating on Contact Management, Collaborating on Project Management

Collaborating via Web-Based Communication Tools, Evaluating Web Mail Services, Evaluating Web Conference Tools, Collaborating via Social Networks and Groupware

REFERENCES

1. Dan C. Marinescu, Cloud computing: Theory and Practice, Morgan Kaufmann, 2013
2. Kai Hwang, Geoffrey C. Fox, Jack J. Dongarra, Distributed and Cloud Computing, From Parallel Processing to the Internet of Things, 1/e, Morgan Kaufmann , 2011
3. Michael Miller, Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online, Que Publishing, 2008.
4. Haley Beard, Cloud Computing Best Practices for Managing and Measuring Processes for On demand Computing, Applications and Data Centers in the Cloud with SLAs, Emereo Pty Limited, 2008.

COURSE PLAN

Module	Contents	No. of hours
I	Cloud Computing – History of Cloud Computing – Cloud Architecture – Cloud Storage – Why Cloud Computing Matters – Advantages of Cloud Computing – Disadvantages of Cloud Computing – Companies in the Cloud Today	5
II	Cloud Services Web-Based Application – Pros and Cons of Cloud Service Development – Types of Cloud Service Development – Software as a Service – Platform as a Service – Web Services – On-Demand Computing	7
III	Discovering Cloud Services Development Services and Tools – Amazon Ec2 – Google App Engine – IBM Clouds. Centralizing Email Communications – Collaborating on Schedules – Collaborating on To-Do Lists	8
IV	Collaborating Contact Lists – Cloud Computing for the Community – Collaborating on Group Projects and Events – Cloud Computing for the Corporation. Collaborating on Calendars, Schedules and Task Management – Exploring Online Scheduling Applications	9
V	Exploring Online Planning and Task Management – Collaborating on Event Management – Collaborating on Contact Management – Collaborating on Project Management – Collaborating on Word Processing - Collaborating on Databases – Storing and Sharing Files	8
VI	Collaborating via Web-Based Communication Tools – Evaluating Web Mail Services – Evaluating Web Conference Tools – Collaborating via Social Networks and Groupware – Collaborating via Blogs and Wikis.	8
	Total Hours	**45**

Course Code	Course Name	Category	L	T	P	Credit
MC0P60A	RESEARCH METHODOLOGY	MCC	0	2	0	2

COURSE OBJECTIVES:

Goal of this course is to prepare the student to do the M. Tech project work with a research bias. The student will be able to formulate a viable research problem, do a critical analysis of publications in the area of research, and identify the appropriate research methodology. The student will be able to write a technical paper based on the project findings.

COURSE OUTCOMES:

After the completion of the course the student will be able to:

CO 1	Explain research ethics
CO 2	Explain Citation, Impact factor and Plagiarism.
CO 3	Explain the need for IPR in fostering research work, leading to creation of improved products, thus helping in economic growth and social benefits.
CO 4	Explain research problem formulation.
CO 5	Analyze research related information
CO 6	Write a technical paper

SYLLABUS

Introduction to Research Methodology- Meaning of research, types of research, research problem-scope-objectives, data collection and analysis, literature review.

Ethical issues- Research ethics, Plagiarism, Effective technical writing.

Developing a Research Proposal, Format of research proposal-presentation-assessment by a review committee.

Copy right-royalty-Intellectual property rights and patent law, Patents, Designs, Process of Patenting and Development, Procedure for grant of patents.

Scope of Patent rights, Licensing and transfer of technology, Patent information and databases, Geographical Indications. Administration of Patent system- Biological systems- Computer software.

REFERENCES

1. Stuart Melville and Wayne Goddard, *Research methodology: an introduction for science & engineering students.*
2. Wayne Goddard and Stuart Melville, *Research Methodology: An Introduction*.
3. Ranjit Kumar, 2nd Edition, *Research Methodology: A Step by Step Guide for beginners*.
4. Halbert, *Resisting Intellectual Property*, Taylor & Francis Ltd ,2007.
5. Mayall, *Industrial Design*, McGraw Hill, 1992. ▯ Niebel, “Product Design”, McGraw Hill, 1974.
6. Asimov*, Introduction to Design*, Prentice Hall, 1962.
7. Robert P. Merges, Peter S. Menell, Mark A. Lemley, *Intellectual Property in New Technological Age*, 2016.
8. Ramappa T.*, Intellectual Property Rights Under WTO*, S. Chand, 2008.

COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Research Methodology: Motivation towards research, Types of research. Professional ethics: Ethical issues -ethical committees. Copy right - royalty - Intellectual property rights and patent law - Reproduction of published material - Plagiarism. New developments in IPR of Biological Systems, Computer Software etc. Citation and acknowledgement, Impact factor. Identifying major conferences and important journals in the concerned area.	**6**
II	Defining and formulating the research problem -Literature Survey, Choose two papers in the area and analyze to understand how the authors have undertaken literature review, identified the research gaps, developed the objectives, formulated their problem and developed a hypothesis.	**5**
III	Research design and methods: Analyze the chosen papers to understand formulation of research methods, both analytical and experimental methods.	**4**
IV	Data Collection and analysis: Analyze the chosen papers and study the methods of data collection, data processing, analysis strategies, and tools used for analyzing the data.	**5**
V	Technical writing - Structure and components, contents of a typical technical paper, difference between abstract and conclusion, layout, illustrations and tables, bibliography, referencing and footnotes-	**5**
VI	Identification of a simple research problem – Literature survey - Research design - Methodology –paper writing based on a hypothetical result.	**5**
	Total hours	**30**

Course No	Course Name	Category	L	T	P	Credit
CS1P68A	ALGORITHM DESIGN LABORATORY	PCC	0	0	2	1

COURSE OVERVIEW

The course aims to offer students an experience on implementing different advanced data structures and algorithms.

COURSE OUTCOMES

After the completion of the course the student will be able to:

CO 1	Implement different advanced data structures.
CO 2	Implement number theoretic algorithms and pattern matching algorithms.
CO 3	Implement algorithms that solve flow network problems.
CO 4	Implement randomized algorithms to solve problems.
CO 5	Implement algorithms to solve convex hull problems.

SYLLABUS

Binomial heap, Fibonacci heap, Disjoint sets, Primality testing, Integer factorization, Rabin-Karp algorithm, Knuth-Morris-Pratt algorithm, Dinic's algorithm, Push-relabel algorithm, Relabel-to-front algorithm, Pseudo random generator, Randomized min-cut algorithm, Randomized selection algorithm, Graham's scan algorithm, Jarvis march algorithm

REFERENCES

1. T. H. Cormen, C. E. Leiserson, R. L. Rivest and C. Stein, "Introduction to algorithms", Prentice-hall of India Private Limited, New Delhi, 2010.

COURSE PLAN

Module	Contents	No. of hours
I	Fibonacci heap	4
II	Dinic's algorithm	2
III	Primality testing	2
IV	Graham's scan algorithm	3
V	Push-relabel algorithm	2
VI	Relabel-to-front algorithm	2
VII	Pseudo random generator	2
VIII	Randomized min-cut algorithm	2
IX	Randomized selection algorithm	2
X	Jarvis march algorithm	3
XI	Integer factorization	2
XII	Rabin-Karp algorithm	2
XIII	Knuth-Morris-Pratt algorithm	2
	Total Hours	**30**

COURSE NO	COURSE NAME	CATEGORY	L	T	P	CREDITS
CS1P69A	SEMINAR I	PWS	0	0	2	2

COURSE OVERVIEW

To make students

1. Identify the current topics in the specific stream.
2. Collect the recent publications related to the identified topics.
3. Do a detailed study of a selected topic based on current journals, published papers and books.
4. Present a seminar on the selected topic on which a detailed study has been done.
5. Improve the writing and presentation skills.

Approach:

Students shall make a presentation for 20-25 minutes based on the detailed study of the topic and submit a report based on the study.

Expected Outcome:

Upon successful completion of the seminar, the student should be able to

1. Get good exposure in the current topics in the specific stream.
2. Improve the writing and presentation skills.
3. Explore domains of interest so as to pursue the course project..

SEMESTER - II SYLLABUS

Course No	Course Name	Category	L	T	P	Credit
CS1P60D	SOFT COMPUTING	PCC	3	1	0	4

COURSE OVERVIEW

The goal of this course is to familiarize the salient approaches in soft computing, based on artificial neural networks, fuzzy logic, and genetic algorithms. It also includes applications of soft computing in different research areas in Computer Science / Information Technology.

COURSE OUTCOMES:

After the completion of the course the student will be able to:

CO 1	Apply various neural network architectures to solve problems.
CO 2	Illustrate the use of fuzzy systems in solving problems.
CO 3	Explain the genetic algorithm concepts and their applications.
CO 4	Implement a Soft Computing solution to solve computing problems.

SYLLABUS

Artificial Neural Network, Mathematical model, Properties, Typical architectures: single layer, multilayer, competitive layer.

Different learning methods: Supervised, Unsupervised & reinforced; Common activation functions; Feed forward, Feedback & recurrent neural networks.

Models Of Neural Network : Architecture, Algorithm & Application of – McCulloch-Pitts. Back propagation, ADALINE, MADALINE, Discrete Hopfield net, BAM, Maxnet.

Fuzzy Sets & Logic : Fuzzy versus Crisp; Fuzzy sets—membership function, linguistic variable, basic operators, properties; Fuzzy relations—Cartesian product, Operations on relations; Crisp logic—Laws of propositional logic, Predicate logic, Fuzzy logic, Defuzzification methods.

Genetic Algorithm - Basic concept; Fitness function, Selection of initial population, Cross over, Mutation, Inversion, Deletion, Constraints Handling; Evolutionary Computation.

Applications: Travelling Salesman Problem, Graph Coloring problem. Hybrid Systems : GA based BPNN(Weight determination); Neuro Fuzzy Systems—Fuzzy BPNN--fuzzy Neuron, architecture, learning; Fuzzy Logic controlled G.A.

REFERENCES

1. S.N. Sivanandam, S.N. Deepa, “Principles of Soft Computing”, 2/e, John Wiley India, 2012.
2. S. Haykin, “Neural Networks - A Comprehensive Foundation”, 2/e, Pearson Education, 2005.
3. T.S. Rajasekaran, G.A. Vijayalakshmi Pai, “Neural Networks, Fuzzy Logic & Genetic Algorithms – Synthesis and Applications”, Prentice-Hall India, 2003.
4. Sanchez, Takanori, Zadeh, “Genetic Algorithm and Fuzzy Logic System”, World Scientific, 1997.
5. Goldberg David, “Genetic Algorithms”, Pearson Education, 2006. 6. Zimmermann H. J, “Fuzzy Set Theory & Its Applications”, Allied Publishers Ltd, 1991.

COURSE PLAN

Module	Contents	No. of hours
I	Artificial Neural Network, Basic concept of Soft Computing; Basic concept of neural networks, Mathematical model. Properties of neural networks, Typical architectures: single layer, multilayer, competitive layer.	**9**
II	Different learning methods: Supervised, Unsupervised & reinforced; Common activation functions; Feed forward, Feedback & recurrent neural networks; Application of neural networks; Neuron.	**10**
III	Models Of Neural Network : Architecture, Algorithm & Application of – McCulloch-Pitts. Back propagation NN, ADALINE, MADALINE, Discrete Hopfield net, BAM, Maxnet	**10**
IV	Fuzzy Sets & Logic : Fuzzy versus Crisp; Fuzzy sets—membership function, linguistic variable, basic operators, properties; Fuzzy relations—Cartesian product, Operations on relations; Crisp logic—Laws of propositional logic, Inference; Predicate logic— Interpretations, Inference; Fuzzy logic—Quantifiers, Inference; Defuzzification methods.	**10**
V	Genetic Algorithm Basic concept; role of GA in optimization, Fitness function, Selection of initial population, Cross over(different types), Mutation, Inversion, Deletion, Constraints Handling; Evolutionary Computation.	**10**
VI	Applications: Travelling Salesman Problem, Graph Coloring problem. Hybrid Systems : GA based BPNN(Weight determination); Neuro Fuzzy Systems—Fuzzy BPNN--fuzzy Neuron, architecture, learning; Fuzzy Logic controlled G.A.	**11**
	Total Hours	**60**

Course No	Course Name	Category	L	T	P	Credit
CS1P60E	OPERATING SYSTEM DESIGN	PCC	3	0	0	3

COURSE OVERVIEW:

Students will be able to gain understanding on configuration and functions of typical kernel. Course includes process management, file systems and basic concepts of distributed operating system.

COURSE OUTCOMES

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

CO 1	Discuss the configuration and functions of a typical OS Kernel.
CO 2	Explain concepts implemented in modern operating systems.
CO3	Illustrate scheduling algorithms used in Linux operating systems
CO4	Discuss issues in distributed systems.

SYLLABUS

Process Management, Process Scheduling, Real-Time Scheduling Policies. System Calls, Interrupts and Interrupt Handlers, Kernel Synchronization, Kernel Synchronization Methods, Timers and Time Management - Memory Management, Virtual Filesystem, I/O Schedulers Distributed Operating System, strategies for ordering events in a distributed system. Issues with distributed mutual exclusion-Solutions, Heuristic. Deadlock Handling strategies

REFERENCES

1. Robert Love, —Linux Kernel Development, 3/e, Addison-Wesley, 2010.
2. Advanced Concepts in Operating Systems – Singhal
3. Daniel Bovet, Marco Cesati, —Understanding the Linux Kernel‖, 3/e, OReilly Media Inc., 2005.
4. Operating Systems Concepts, 9th Edition- Silberschatz, Galvin, Gagne
5. Linux Kernel Architecture – Wolfgang Mauerer.
6. Reilly Christian Benvenuti, —Understanding Linux Network Internals, 1/e, OReilly Media Inc.,2005.
7. Jonathan Corbet, Alessandro Rubini, Greg Kroah-Hartman, —Linux Device Drivers, 3/e, OReilly Media Inc., 2005.

COURSE PLAN

Module	Contents	No. of hours
I	Introduction - Process Management - Process Descriptor and the Task Structure, Process Creation, The Linux Implementation of Threads, Process Termination. Process Scheduling - Policy, Linux Scheduling Algorithm and Implementation, Preemption and Context Switching, Real-Time Scheduling Policies. System Calls - Communicating with the Kernel, Syscalls, System Call Handler, System Call Implementation, and System Call Context. * Linux commands like ps, pmap may be used to understand how the address space changes during process creation and thread creation.	7
II	Interrupts and Interrupt Handlers - Registering an Interrupt Handler, Writing an Interrupt Handler, Interrupt Context, Interrupt Control, Bottom Halves – Task Queues, Softirqs, Tasklets, Work Queues (Students are not expected to memorize the system calls used/ structure formats of the different constructs used in implementing Bottom Halves. The main highlight should be to understand the way in which the different constructs are used) * Students may be encouraged to implement their own interrupt handler in a custom compiled kernel.	7
III	Kernel Synchronization – Introduction, Critical Regions and Race Conditions, Locking, Deadlocks, Contention and Scalability (Self Study – These topics are already covered in undergraduate classes). Kernel Synchronization Methods - Atomic Integer and Atomic Bitwise Operations (Concepts only), Spin Locks - Types, Semaphores – Types, Mutexes, Completion Variables, BKL: The Big Kernel Lock, Sequential Locks, Preemption Disabling.	7
IV	Timers and Time Management - Kernel Notion of Time, Jiffies, Hardware Clocks and Timers, Using Timers, Delaying Execution. Memory Management - Pages and Zones, functionality of kmalloc(), kfree(), vmalloc(). Slab Layer – Design, PerCPU Allocations. The Virtual File system – VFS objects, data structures their relationship and functionalities.	8
V	The Block I/O Layer - Request Queues, I/O Schedulers – Types, Scheduler Selection. Portability – Issues related to Word size and Data types, Data Alignment, Byte Order, Time, Processor Ordering.	7
VI	Distributed processing – client/ server and clusters. Distributed process management - process migration, distributed global states, distributed mutual exclusion, distributed deadlock.	9
	Total Hours	**45**

Course No	Course Name	Category	L	T	P	Credit
CS1P60F	ADVANCED COMPUTER NETWORKS	PCC	3	0	0	3

COURSE OVERVIEW

This course imparts a deeper understanding of protocols, Switching, VPN, quality of service and congestion management. It also helps to analyze the issues of transmitting real time data and to identify the technologies that can transmit data efficiently.

COURSE OUTCOMES

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

CO 1	Explain existing technologies for transmitting data in real time without congestion.
CO 2	Design computer networks with optimal routing.
CO 3	Explain current QoS architectures and mechanisms, and QoS implementation challenges in future networks
CO 4	Choose appropriate and advanced techniques to build the computer network

SYLLABUS

Network Architecture: Reference models of OSI, TCP/IP-Internet Protocol-IPV4 and IPV6-Packet switching-Cell switching in ATM-Internetworking devices.

Switching Basics. Managing the LAN switch as a networking device-Spanning Tree protocol (STP). Virtual LANs and frame-tagging-Securing network devices using packet filters and firewall - Routers - Network Address Translation (NAT).

Path Vectors and Policies -Routing Information Protocol-Border Gateway Protocol -Multicast Routing - Inter-Gateway Routing Protocol - Inter-Domain Routing Protocol -Congestion Management.

Quality of Service: Requirements and parameters of Quality of Service, Peer to Peer Networks: Gnutella, BitTorrent. Node Lookup in Peer to Peer Networks, Virtual Private Networks- Overlay and Peer-to-Peer VPN.

Network Management: SNMP, Network Installation and Maintenance; Network and System Management, Network Management System platform, Emerging network types: Data Center, 4G mobile networks (LTE, Wi-Max), OSN, SDN, Network virtualization, DTN, Vehicular Ad-hoc Network, VoIP, BDN.

REFERENCES

1. Larry L. Peterson, Bruce S. Davie, “Computer Networks – A Systems Approach”, Elsevier Fourth Edition, 2008.
2. William Stallings, “SNMP, SNMPv2, SNMPv3, and RMON 1 and 2,” AddisonWesley, 2005.
3. Douglas Comer, “Automated network management systems current and future capabilities,” Pearson Prentice-Hall, 2007
4. Jim Guichard, Ivan Pepelnjak, " MPLS and VPN Architectures: A Practical Guide to Understanding, Designing and Deploying MPLS and MPLS-Enabled VPNs," Cisco Press, October 2000

COURSE PLAN

Module	Contents	No. of hours
I	Network Architecture: Reference models of OSI, TCP/IP, ATM. Protocol implementation issues. Physical address, Logical address. Internet Protocol: Packet Format (IPV4 and IPV6), Features of IPv6, CIDR notation, Subnetting, Supernetting, DHCP. Packet switching: Datagrams, Virtual circuit switching, Fragmentation of IP packets. Cell switching in ATM, Gigabit Networks. Internetworking devices: Repeaters, Hubs, Bridges, LAN switches, Routers and Gateway.Experiment: Familiarization of Networking Devices	**8**
II	Switching Basics. Managing the LAN switch as a networking device, basic switch configuration. Spanning Tree protocol (STP). Virtual LANs and frame-tagging. Routing between VLANs. Securing network devices using packet filters and firewall by applying access control lists (ACL). Routers: Router functions, Classification of routers, Features of IP Routers, Filtering, Network Address Translation (NAT).Experiment: Configuring Routers and Switches	**8**
III	Path Vectors and Policies - Computing Paths– Routing Information Prot ocol – OSPF - OSPF – Intermediate System to Intermediate System - B order Gateway Protocol - Multicast Routing - Inter-Gateway Routing Protocol - Inter-Domain Routing Protocol Congestion Management: Congestion control in Data Networks and Internets, Random Early Detection (RED). TCP congestion control: Additive increase/Multiplicative decrease, Slow start, Fast retransmit and Fast recovery. Congestion-Avoidance Mechanisms – DECbit-Random Early Detection -Source-Based Congestion Avoidance – Tahoe- Reno- and Vegas	**8**
IV	Quality of Service: Requirements and parameters of Quality of Service, Integrated Services, Resource Reservation Protocol (RSVP), Differentiated Services.Peer to Peer Networks: Gnutella, BitTorrent. Node Lookup in Peer to Peer Networks	**7**
V	Introduction to Virtual Private Networks- Overlay and Peer-to-Peer VPN ,Major VPN Topologies ,MPLS VPN Architecture ,MPLS VPN Routing Model ,MPLS VPN Packet Forwarding ,MPLS VPN Spanning more than One AS. Network Management: Managed Network: The History of SNMP Management, Internet Organizations and standards, Internet Documents. The SNMP communication Model – The SNMP Architecture, Administrative Model, SNMP Specifications, SNMP Operations, SNMP MIB Group, Functional Model.Network Installation and Maintenance; Network and System Management, Network Management System platform, Current Status and Future of Network Management.	**7**
VI	Emerging network types: Data Center, 4G mobile networks (LTE, Wi-Max), Online social networks (OSN), Software Defined Networking, Network virtualization, Delay Tolerant Network (DTN), Vehicular Ad-hoc Network, VoIP, Body area networks (BDN) and case studies.	**7**
	Total Hours	**45**

Course No	Course Name	Category	L	T	P	Credit
CS1P62A	PARALLEL ALGORITHMS	PEC	3	0	0	3

COURSE OVERVIEW

The goal of this course is to expose the students to theoretical and practical knowledge on parallel algorithms.

COURSE OUTCOMES

After the completion of the course the student will be able to:

CO 1	Explain the different models of parallel computation and interconnection architectures.
CO 2	Illustrate the basic parallel algorithmic techniques.
CO 3	Make use of parallel algorithms for sorting, searching, merging and analyze the time complexity.
CO 4	Analyse the complexity of parallel algorithms for matrix operations and graphs.

SYLLABUS

Models of Parallel Computation: SIMD, MIMD, PRAM (EREW, CREW, CRCW), Performance Measures-Time, Processors, Space, Work Performance metrics - speedup, utilization, efficiency, scalability Interconnection Architectures
Basic Parallel Algorithmic Techniques-Balancing, Pointer Jumping, Divide-and-Conquer, Partitioning, Pipelining, Accelerated Cascading, prefix computation, Systolic Computation
PRAM Algorithms: Parallel Reduction, Min/Max, Prefix Sums, List Ranking, Pre-order Tree Traversal
Sorting – Sorting on a linear array – sorting on a mesh – sorting on EREW SIMD computer – MIMD enumeration sort – MIMD quicksort – sorting on other networks. Searching and Merging
Matrix operations – matrix-by-matrix multiplications – mesh multiplications – cube multiplication - Matrix by vector multiplication, Linear array multiplication – tree multiplications, Solving numerical problems – solving systems of linear equations – SIMD algorithms and MIMD algorithms, solving partial differential equations, computing eigenvalues.
Graph Algorithms – computing connectivity matrix – finding connected components – Spanning trees, all pairs shortest path – traversing combinatorial spaces. Parallel Complexity (Lower bounds, NC Class and P-Completeness).

REFERENCES

1. AnanthGrama, Anshul Gupta, George Karypis, Vipin Kumar "Introduction to Parallel Computing", Second Edition ,Addison Wesley
2. S.G.Akl, "Design and Analysis of parallel algorithms", PrenticeHall, Inc. 1989.
3. Joseph F Jájá, "An Introduction to Parallel Algorithms", Addison-Wesley, 1992.
4. S.G.Akl, "Parallel Sorting algorithm", Academic Press, 1985.
5. M.J.Quin, "Parallel computing – theory and Practice", McGrawHill, New York, 1994.
6. S. Lakshmivarahan and S.K.Dhall, "Analysis and design of Parallel Algorithms – Arithmetic & Matrix problems", McGrawHill, New York, 1990.
7. M .J. Quin, "Parallel Programming in C with MPI and openMP", Tata McGraw Hill, 2007.

COURSE PLAN

Module	Contents	No. of hours
I	Introduction -From serial to parallel thinking: common gotchas **Models of Parallel Computation**: SIMD, MIMD, PRAM (EREW, CREW, CRCW), **Performance Measures**-Time, Processors, Space, Work **Performance metrics** - speedup, utilization, efficiency, scalability	7
II	**Interconnection Architectures** (Linear Array, Meshes, Trees, Hyper cubes, Butterfly Networks, Cube Connected Cycles, Benes Networks); **Basic Parallel Algorithmic Techniques**-Balancing, Pointer Jumping, Divide-and-Conquer, Partitioning, Pipelining, Accelerated Cascading, prefix computation, Systolic Computation	8
III	**PRAM Algorithms:** Parallel Reduction, Min/Max, Prefix Sums, List Ranking, Pre-order Tree Traversal **Sorting**– Sorting on a linear array – sorting on a mesh – sorting on EREW SIMD computer .	7
IV	**Sorting (cont.)** – MIMD enumeration sort – MIMD quicksort – sorting on other networks. Searching and Merging. **Matrix operations** – matrix-by-matrix multiplications – mesh multiplications – cube multiplication - Matrix by vector multiplication.	8
V	**Matrix operations (cont.)** –Linear array multiplication – tree multiplications. Solving numerical problems – solving systems of linear equations – SIMD algorithms and MIMD algorithms, solving partial differential equations, computing eigenvalues.	**9**
VI	**Graph Algorithms** – computing connectivity matrix – finding connected components – Spanning trees, all pairs shortest path – traversing combinatorial spaces. Parallel Complexity (Lower bounds, NC Class and P-Completeness).	**6**
	Total Hours	45

Course No	Course Name	Category	L	T	P	Credit
CS1P62B	PARALLEL COMPUTER ARCHITECTURE	PEC	3	0	0	3

COURSE OVERVIEW

The goal of this course is to expose the students to the performance of processors, instruction level parallelism, vector architecture, multiprocessor systems, cache coherence and Interconnection networks.

COURSE OUTCOMES

After the completion of the course the student will be able to:

CO 1	Identify techniques in improving performance of processors.
CO 2	Make use of pipelining techniques to achieve better performance.
CO 3	Demonstrate the pipelining mechanisms of superscalar processors.
CO 4	Apply the basic concepts of GPU and CUDA programming.
CO 5	Interpret the multiprocessor systems and the concept of cache coherence.
CO 6	Explain the concepts of multithreading and hyper-threading.

SYLLABUS

Classes of parallelism and parallel architecture, principles of computer design, Instruction level parallelism -concepts and challenges. Data dependencies and hazards, instruction-level parallelism.

Dynamic Scheduling- Tomasulo's approach, Hardware based speculation. ILP using multiple issue and static scheduling, ILP using dynamic scheduling, multiple issue and speculation. Data level parallelism-Vector architecture-Vector instruction types, Vector-Access memory schemes.

Super scalar processors, VLIW processors, vector processing and array processing. Basic concepts of GPU and CUDA programming. Organization of GPU based systems.

Multiprocessor system interconnects- hierarchical bus system, Crossbar switch and multiport memory. Multistage networks. Centralized shared memory architecture.

Multiprocessor cache coherence, Schemes for enforcing coherence - Snooping protocol. Distributed shared memory and Directory based coherence. Concept of multithreading and hyper-threading.

REFERENCES

1. Hennessy J. L., D. Patterson, “Computer Architecture A quantitative Approach”, 5/e, Morgan Kauffman 2012.
2. DezsoSima, Terence Fountain, Peter Kacsuk, “Advanced Computer Architectures A Design Space Approach”, Pearson Education India, 2009.
3. Kai Hwang, & Naresh Jotwani, “Advanced Computer Architecture, Parallelism, Scalability and Programmability”, 2nd edition, McGraw Hill Publications, 2011

COURSE PLAN

Module	Contents	No. of hours
I	Classes of parallelism and parallel architecture, Performance measurements, quantitative principles of computer design, Instruction level parallelism - concepts and challenges. Data dependencies and hazards, Basic compiler techniques for exposing instruction-level parallelism.	**7**
II	Dynamic Scheduling- Tomasulo's approach, Hardware based speculation. ILP using multiple issue and static scheduling, ILP using dynamic scheduling, multiple issue and speculation.	**8**
III	Data level parallelism-Vector architecture-Vector instruction types, Vector-Access memory schemes. Super scalar processors, VLIW processors, vector processing and array processing.	**7**
IV	Basic concepts of GPU and CUDA programming. Organization of GPU based systems. Case study- Intel Core i7.	**7**
V	Multiprocessor system interconnects - hierarchical bus system, Crossbar switch and multiport memory. Multistage networks. Centralized shared memory architecture.	**8**
VI	Multiprocessor cache coherence, Schemes for enforcing coherence - Snooping protocol, Limitations. Distributed shared memory and Directory based coherence. Concept of multithreading and hyper-threading. Case Study: Simulation Tool	**8**
	Total Hours	**45**

Course No	Course Name	Category	L	T	P	Credit
CS1P62C	COMPUTATIONAL GEOMETRY	PEC	3	0	0	3

COURSE OVERVIEW:

Goal of this course is to fill the gap between geometric properties and algorithm design. It also helps to familiarize data structures used for developing efficient algorithms and to learn efficient techniques for solving geometric problems.

COURSE OUTCOMES

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

CO 1	Develop efficient algorithms by exploiting geometric properties.
CO 2	Make use of different data structures for geometric problems.
CO 3	Identify properties of objects, express them as lemmas and theorems and prove their correctness.
CO 4	Apply learned algorithms in diversified fields.

SYLLABUS

Introduction to Computational Geometry, Visibility Problems, Algorithm for computing point visible region inside a polygon.

Convex Hulls, Convex Hull Algorithms in the Plane, Triangulation, Applications in the plane.

Data Structures for geometric problems, Doubly Connected Edge List, Quad trees, Kd-trees and Binary Space Partition trees.

Geometric Searching, Planar Straight Line Graph (PSLG), Point Location Problem, Plane Sweep Technique, Slab method, Regularization of PSLG, Monotone polygons, Range Searching.

Kernel of a simple polygon, Linear time algorithm for computing Kernel. Visibility graph, Shortest path for a point Robot.

REFERENCES

1. Franco P. Preparata, Michael Ian Shamos, “Computational Geometry- An Introduction”, Texts and Monographs in Computer Science, Springer – Verlag
2. Mark de Berg, Otfried Cheong, Marc van Kreveld, Mark Overmars “Computational Geometry, Algorithms & Applications” Springer.
3. Herbert Edelsbrunner, “Algorithms in Combinatorial Geometry”, EATCS Monographs on Theoretical Computer Science, Springer – Verlag.
4. Art Gallery Theorems, Joseph O’ Rourke, Oxford Press.
5. Joseph O’ Rourke, “Computational Geometry in C”, Cambridge University Press.

COURSE PLAN

Module	Contents	No. of hours
I	Geometric Preliminaries, Data Structures for geometric problems: DCEL(Doubly Connected Edge List), Quad trees, Kd-trees and BSP (Binary Space Partition) trees.	**6**
II	Geometric Searching - Planar Straight Line Graph (PSLG), Point Location Problem, Location of a point in a planar subdivision, Plane Sweep Technique-applications- line segment intersection using plane sweep, Slab method, Regularization of PSLG, Monotone polygons , Range Searching using Kd-trees.	**10**
III	Convex Hulls, Convex Hull Algorithms in the Plane -- Graham's Scan Algorithm, Jarvi's March, Divide and Conquer Algorithm, Quick Hull Algorithm. Triangulation— Polygon Triangulation.	**8**
IV	Art Gallery Theorem, Fisk's proof of Art Gallery theorem. Post Office Problem - Voronoi Diagrams- Properties , computing Voronoi diagram, Applications in the plane , Delaunay Triangulation.	**8**
V	Introduction to Visibility Problems-- Definition of direct visibility, Point visibility and Edge visibility, Algorithm for computing point visible region inside a polygon	**7**
VI	Kernel of a simple polygon , Linear time algorithm for computing Kernel. Visibility graph, Shortest path for a point Robot	**6**
	Total Hours	**45**

Course No	Course Name	Category	L	T	P	Credit
CS1P62D	SEMANTIC WEB TECHNOLOGY	PEC	3	0	0	3

COURSE OVERVIEW:

The course enables students to get an insight into the principles, practices and applications of Semantic Web Technology.

COURSE OUTCOMES

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

CO 1	Identify technologies related to Semantic Web
CO 2	Explain RDF schema in semantic web technology
CO 3	Summarize formal semantics used in semantic web technology
CO 4	Demonstrate process domains using ontology and associated tools.

SYLLABUS

Introduction to Semantic Web and semantic web technologies-XML review, First order Logic, RDF-overview, elements of RDF, basic syntax, advanced features – Relationship between doubling core, XML and RDF

RDF schema, syntax and semantics, examples Web ontology language (OWL)-Syntax and semantics, reasoning power, flavours of OWL, OWL2 standard.

Formal semantics-description Logic, model theoretic semantics of OWL, automated reasoning.

Ontology Rules and Queries-combining OWL and DL, SPARQL, Query examples, conjuctive queries.

Ontology Engineering-Requirement Analysis, Ontology creation, quality assurance, Modular ontology

Software tools-protégé, Jena, Applications

REFERENCES

1. Liyang Yu, Introduction to the Semantic Web and Semantic Web Services, Chapman & hall/CRC, 2007.
2. Pascal Hitzler, MarkusKrötzsch, Sebastian Rudolph, Foundations of Semantic Web Technologies, Chapman & hall/CRC, 2010.
3. Peter Szeredi, GergelyLukacsy, TamasBenko, Zsolt Nagy, The Semantic Web Explained The Technology and Mathematics behind Web 3.0, Cambridge University Press, 2014.
4. Dean Allemang, James Hendler, “Semantic Web for the Working Ontologist: Effective Modeling in RDFS and OWL”, Morgan Kaufmann, 2008.
5. David Wood, Marsha Zaidman, Luke Ruth, Michael Hausenblas, Linked Data, Manning Publication Company, 2014.

COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Semantic Web and semantic web technologies XML review, First order Logic	**5**
II	RDF: overview, elements of RDF, basic syntax, advanced features – Relationship between doubling core, XML and RDF	**8**
III	RDF schema, syntax and semantics, examples. Web ontology language (OWL): Syntax an semantics, reasoning power (informal treatment only), flavours of OWL, OWL2 standard.	**10**
IV	Formal semantics: description Logic, model theoretic semantics of OWL, automated reasoning.	**10**
V	Ontology Rules and Queries: combining OWL and DL, SPARQL, Query examples, conjuctive queries Ontology Engineering: Requirement Analysis, Ontology creation, quality assurance, Modular ontology.	**8**
VI	Software tools: protégé, Jena Applications	**4**
	Total Hours	**45**

Course No	Course Name	Category	L	T	P	Credit
CS1P62E	IMAGE PROCESSING	PEC	2	1	0	3

COURSE OVERVIEW:

The course enables students to learn various image processing techniques. It covers image transformations, image processing algorithms and image analysis in real life applications.

COURSE OUTCOMES

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

CO 1	Explain fundamentals of image processing.
CO 2	Identify mathematical transforms necessary for image processing.
CO 3	Apply various image processing algorithms.
CO 4	Make use of various features in image analysis.

SYLLABUS

Introduction – Digital Image representation, History, Fundamental Steps in Image Processing, Applications, Elements of digital image processing systems. Image Acquisition-sampling, Quantization, Convolution, Image transforms

Basic relationship between pixels, Image geometry, Image transforms - introduction to Fourier transform – discrete Fourier transform, Properties of 2D Fourier transform, Other separable image transforms - hoteling transform

Image reconstruction from projections, Image compression - image compression models - elements of information theory, Error-free compression - lossy compression, Image compression standards

Image enhancement - point processing, spatial filtering - frequency domain, Image Restoration-Degradation Model Diagonalization of circulant and block circulant matrices, Inverse filtering - least mean square filter

Point Detection in Images, Line Detection in Images, Edge Detection in Images Image Segmentation

REFERENCES

1. A.K. Jain, “Fundamentals Of Digital Image Processing”, Prentice Hall Of India, 1989.
2. R. C. Gonzalez, R. E. Woods, “Digital Image Processing”, Pearson Education, 4th edition, 2018.
3. M. Tekalp, “Digital Video Processing”, Prentice-Hall. 4. Bovik, “Handbook of Image & Video Processing”, Academic Press, 2000
4. W. K. Pratt, “Digital Image Processing”, Prentice Hall, 2013
5. Rosenfeld, A. C. Kak, “Digital Picture Processing”, vols. 1 and 2, Academic press, 1982.

COURSE PLAN

Module	Contents	No. of hours
I	Introduction –Digital Image representation, History, Fundamental Steps in Image Processing, Applications, Elements of digital image processing systems. Image Acquisition-Digitization (Sampling and Quantization), Sampling Theorem, Fourier Transform (in Discrete domain and Time Domain), Sampling-Convolution (Time domain, Discrete domain), convoluting a sampled image example, Nyquist Rate), Quantization	**7**
II	Basic relationship between pixels, Image geometry, Image transforms - introduction to Fourier transform – discrete Fourier transform, Properties of 2D Fourier transform, Other separable image transforms - hoteling transform, Case study	**7**
III	Image reconstruction from projections - basics of projection Parallel beam and fan beam projection - method of generating projections Fourier slice theorem, Filtered back projection algorithms, Case study	**8**
IV	Image compression - image compression models - elements of information theory, Error-free compression - lossy compression, Image compression standards, Case study	**9**
V	Image enhancement - point processing, spatial filtering - frequency domain, Image Restoration-Degradation Model Diagonalization of circulant and block circulant matrices, Inverse filtering - least mean square filter, Case study	**10**
VI	Point Detection in Images, Line Detection in Images, Edge Detection in Images Image Segmentation, Case study	**4**
	Total Hours	**45**

Course No	Course Name	Category	L	T	P	Credit
CS1P63A	MACHINE LEARNING	PEC	2	1	0	3

COURSE OVERVIEW:

The goal of this course is to understand and implement algorithms of machine learning to solve real world problems.

COURSE OUTCOMES:

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

CO 1	Explain traditional and new methods of machine learning
CO 2	Illustrate the working of classifier models for various applications
CO 3	Develop machine learning models for prediction, regression, clustering.
CO 4	Implement machine learning algorithms

SYLLABUS

Introduction to learning, Machine learning, supervised learning, unsupervised learning, semi-supervised learning, Applications, Similarity measures, Dimensionality reduction techniques.

Classification, Classifier performance, Decision trees, Information Gain, Gain Ratio, Gini Index, ID3 Algorithm, C 4.5 algorithm, Bayes Theorem, Naive Bayesian Classification.

Support Vector Machines, Maximum margin hyperplanes, Kernel Trick Association Learning, A priority Algorithm, Eclat Algorithm, FP Growth Algorithm. Ensemble Methods, Real world Application

Artificial Neural Networks, learning perception model, Multilayer feed forward network, back propagation. Deep Neural Networks. Case study

Unsupervised learning, Clustering, Distance measures in algorithmic methods, Multiphase Hierarchical clustering using clustering feature trees. Introduction Reinforcement learning. Case Study

REFERENCES

1. Shai Shalev-Shwartz and Shai Ben-David, Understanding Machine Learning (3rd Edition), Cambridge University Press, 2015. ISBN 978-1107512825.
2. Trevor Hastie, Robert Tibshirani and Jerome Friedman, The Elements of Statistical Learning (ESL) (2nd Edition), Springer, 2016. ISBN 978-0387848570.
3. Ian Goodfellow, Yoshua Bengio, Aaron Courville, and Francis Bach, Deep Learning Adaptive Computation and Machine Learning series Hardcover (1st Edition), MIT Press, 2017. ISBN 978-0262035613.
4. Yuxi (Hayden) Liu, Python Machine Learning by Example Paperback Import (1st Edition), Packt Publishing, 2017. ASIN: B01MT7ATL5.
5. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning (ESL) (1st Edition), Springer, 2009. ISBN 978-0387848587.
6. Kevin Murphy, Machine Learning: A Probabilistic Perspective (MLAPP) (1st Edition), MIT Press, 2012. ISBN 978-0262018029.

COURSE PLAN

Module	Contents	No. of hours
I	Introduction to learning, types of learning, role of learning, Machine learning, supervised learning, unsupervised learning, semi-supervised learning, Applications of machine learning. Types of data, attributes, types- nominal, ordinal, interval, ratio, Measuring the central tendency-Mean, Median, Mode, Measuring the dispersion of data- Range, Quartiles, Variance, Standard Deviation, Measuring Data Similarity and Dissimilarity between nominal, binary, ordinal attributes, Euclidian, Manhattan distance, Cosine similarity.	**7**
II	Chi-square test, Correlation Coefficient for Numeric data, Dimensionality reduction techniques- Principal Component Analysis, Attribute Subset Selection, Parametric data reduction, Histograms. Classification- Concepts, Decision trees, Information Gain, Gain Ratio, Gini Index, ID3 Algorithm, C 4.5 algorithm	**7**
III	Bayes Theorem, Naive Bayesian Classification, Metrics for evaluating Classifier performance- Accuracy, Error rate, Precision, Recall. Artificial Neural Networks- basics, learning perception model, Multi-layer feed forward network, back propagation	**8**
IV	Association Learning, Basics of Association, A priority Algorithm, Eclat Algorithm, FP Growth Algorithm. Stochastic Process, Markov Process, Hidden Markov Models, Forward Algorithm, Viterbi Algorithm, Baum-Welch Algorithm	**9**
V	Support Vector Machines- Maximum margin hyperplanes, Linear SVM, Non-linear SVM, Kernel Trick, Inductive Logic Programming, Case Based Reasoning, CBR Issues, Ensemble Methods –Bagging, Boosting, AdaBoost, Random Forests.	**10**
VI	Unsupervised learning- Clustering – Partitioning Method-K-Means, K-Medoids, Hierarchical Methods- Agglomerative versus Divisive clustering, Single link algorithm, Complete link algorithm, Distance measures in algorithmic methods, BIRCH- Multiphase Hierarchical clustering using clustering feature trees. Reinforcement learning. Case study	**4**
	Total Hours	**45**

Course No	Course Name	Category	L	T	P	Credit
CS1P63B	ADVANCED GRAPH THEORY	PEC	3	0	0	3

COURSE OVERVIEW

The goal of this course is to impart deeper understanding in advanced concepts in graph theory and their practical applications.

COURSE OUTCOMES

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

CO 1	Explain the advanced concepts of Graph Theory.
CO 2	Apply the concepts of Metrics, Convexity and Distance sequences on graphs.
CO 3	Apply the concepts of Eulerian digraphs and hamiltonicity.
CO 4	Explain the concepts of Polynomial Algorithms and NP completeness.
CO 5	Apply the concepts of colouring and network flows in graphs.
CO 6	Apply Graph Theory concepts in practical scenarios.

SYLLABUS

Graphs, Graph Classes, Tree and its properties, Graph operations. Graph Connectivity, Bridges, Vertex connectivity and edge connectivity, Properties of n-connected graphs.

Metrics on Graphs, Self-centered Graphs, The Center and Edge connectivity, Convexity, Symmetry, Distance sequences.

Digraphs, Acyclic Digraphs, Matrices: The Adjacency Matrix - The incidence Matrix - The Distance Matrix.

Eulerian Digraphs, Tournaments, Graph Hamiltonicity, Connectivity and Hamiltonicity, Graph operations, Generations of Hamiltonicity.

Polynomial Algorithms and NP completeness, Maximum Matchings, Minimum Independent Set Problem, Minimum Vertex Cover Problem – Graph coloring, Networks Theorem

REFERENCES

1. Franco P. Preparata, Michael Ian Shamos, "Computational Geometry- An Introduction", Texts and Monographs in Computer Science , Springer – Verlag
2. Mark de Berg, Otfried Cheong, Marc van Kreveld, Mark Overmars " Computational Geometry, Algorithms & Applications" Springer.
3. Herbert Edelsbrunner, "Algorithms in Combinatorial Geometry", EATCS Monographs on Theoretical Computer Science, Springer – Verlag.
4. Art Gallery Theorems, Joseph O' Rourke, Oxford Press. Joseph O' Rourke, " Computational Geometry in C", Cambridge University Press.

COURSE PLAN

Module	Contents	No. of hours
I	Graphs, Connectivity and Hamiltonicity: Graphs: Graphs as models Paths and connectedness- Cut nodes and Blocks- Graph classes and graph operations. Connectivity: Connectivity and edge connectivity - Menger's theorem - Properties of n-connected graphs-Circulants	**6**
II	Hamiltonicity: Necessary or sufficient conditions- Connectivity and Hamiltonicity- Graph operations and Hamiltonicity - Generations of Hamiltonicity. Centers: The Center and Edge connectivity- Self Central Graphs - The Median – Central Paths- Other Generalized Centers	**7**
III	Extremal Distance Problems: Radius- Small Diameter- Diameter- Long paths and Long Cycles. Distance sequences: The Eccentric Sequence -Distance Sequences - Distribution - Path Sequence - Other Sequences.	**9**
IV	Matrices: The Adjacency Matrix - The incidence Matrix - The Distance Matrix. Convexity: Closure Invariants-Metrics on Graphs – Geodetic Graphs-Distance Heredity Graphs. Symmetry: Groups- Symmetric Graphs - Distance Symmetry.	**8**
V	Digraphs: Digraphs and connectedness - Acyclic Digraphs – Matrices and Eulerian Digraphs- Long paths in Digraphs- Tournaments. Graph Algorithms: Polynomial Algorithms and NP completeness – Path Algorithms and Spanning Trees.	**8**
VI	Centers - Maximum Matchings - Two NP-Complete Problems. Networks: The Max- Flow Min-Cut Theorem - Minimum Spanning Trees - Traveling Salesman Problem - Shortest Paths - Centers – Critical Path Method	**7**
	Total Hours	**45**

Course No	Course Name	Category	L	T	P	Credit
CS1P63C	CYBER LAWS AND ETHICS	PEC	3	0	0	3

COURSE OVERVIEW:

The goal of this course is to expose the students to Intellectual property rights, Computer contracts and Cyber Laws in India. It deals with Cyber crimes, IT Act 2000, and how Cyber laws enable e-commerce and counter Cyber crimes. It also addresses the role of international organizations and the ethical issues in today's computer based environment.

COURSE OUTCOMES

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

CO 1	Explain Intellectual Property Rights and computer contracts
CO 2	Explain the different forms of computer crimes
CO 3	Apply the provisions of the IT Act to e-commerce and e-governance
CO 4	Apply the different sections of the IT Act to offences in the cyber world
CO 5	Analyse the ethical issues in the computer based environment

SYLLABUS

Intellectual Property Rights, Computer contracts and licences.

Computer crimes - different forms, Cyber laws in India, IT Act 2000, provisions to facilitate e-commerce and e-governance, handling of Offences under IT Act, protection of IPR in Cyber space in India,

International cyber laws and organisations, Ethical issues in computer security.

REFERENCES

1. D. Bainbridge, Introduction to Information Technology Law, 6/e, Pearson Education, 2007.
2. Harish Chander, Cyber Laws and IT Protection, PHI Learning Private Limited, 2012.
3. P. Duggal, Cyber law: the Indian Perspective, Saakshar Law Publications, Delhi, 2005.
4. C. P. Fleeger and S. L. Fleeger, Security in Computing, 3/e, Pearson Education, 2003.

COURSE PLAN

Module	Contents	No. of hours
I	Intellectual property rights, computer software copyrights, copyright in databases and electronic publishing, trade secrets, patent laws, trademarks, industrial designs, international implications of IPR	**6**
II	Computer contracts, liability for defective hardware and software, Contract for writing software, License agreements, Website development contracts, Electronic contracts and torts, Liability of ISP's.	**7**
III	Computer crime, computer frauds, hacking, unauthorized modification of information, piracy, cyber harassment. Cyber stalking, cyber defamation. Domain names and cybersquatting.	**9**
IV	Cyber law in India, IT Act 2000- Objectives, Provisions under IT Act, Authentication of electronic records, Digital signature	**8**
V	Offences under the IT Act 2000: sections 65 to 74, Case studies, Positive aspects and grey areas of the IT Act. Protection of IPR in Cyber space in India: copyright, patents, IPR's needing protection	**8**
VI	International organizations to regulate e-commerce and cyber crimes, COE convention on cyber crimes. Ethical issues in computer security, Case studies	**7**
	Total Hours	**45**

Course No	Course Name	Category	L	T	P	Credit
CS1P63D	PRINCIPLES OF INFORMATION SECURITY	PEC	2	1	0	3

COURSE OVERVIEW

Goal of this course is to understand the founding principles of Information security and various vulnerabilities. Also, to familiarize with network security concepts.

COURSE OUTCOMES:

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

CO 1	Conceptual understanding of the principles of information security, its significance and the domain specific security issues.
CO 2	Gather in depth knowledge in vulnerability possibilities.
CO 3	Explain the relevance of security in various domains.
CO 4	Explain the threats prevailing in an information system and to design a security system based on security policies and models.

SYLLABUS

Computer Security Concepts (CIA) and its case studies, Security Models as basis for OS security, Introduction to DB Security, Access Control in OS, Access control mechanisms.

Attacks, Threats, Software vulnerabilities, Phishing, Buffer and stack overflow, Heap overflow, OS command injection, Malwares such as Virus, Worms and Trojans, Mobile Malwares, Worm Propagation models, Topological worms, Case study of any Network Attacks.

Cryptography Topics: Introduction, El-Gamal encryption, Authentication, Dictionary attack, Kerberos, Biometric Authentication

Network Security – IPsec, IP and IPv6, IPsec Protocols, IPSec cookies, TCP/IP vulnerabilities, Internet Key Exchange Protocols, Packet Sniffing, Detecting Sniffers on your network, IP Spoofing, ARP Poisoning, UDP Hijacking.

Denial of Service, Firewalls, Intrusion Detection System Using SNORT, Overview of Wireless Security.

REFERENCES

1. Bernard Menezes, "Network security and Cryptography", Cengage Learning India, 2010.
2. Behrouz A. Forouzan, "Cryptography and Network Security", Special Indian Edition, Tata McGraw Hill, 2007
3. William Stallings, "Cryptography and Network Security: Principles and Practice", 6/e Pearson Education, 2013.
4. Ingemar J. Cox, Matthew L. Miller, Jeffrey A. Bloom, Jessica Fridrich, Ton Kalker,"Digital Watermarking and Steganography", 2/e, Morgan Kaufmann, 2008.
5. Dieter Gollmann. "Computer Security", John Wiley and Sons Ltd., 2006.
6. Whitman and Mattord, "Principles of Information Security", Cengage Learning, 2006.
7. D. Bainbridge, "Introduction to Computer Law", 5/e, Pearson Education, 2004.

COURSE PLAN

Module	Contents	No. of hours
I	Security Models as basis for OS security, Access Control in OS Discretionary Access control, Mandatory Access control and Role-based access control, Introduction to DB Security Laws and ethics, Intellectual property rights - Copyright law, Patent law, Copyright basics and Implications of software copyright law	**6**
II	Software vulnerabilities- Phishing, Buffer and stack overflow, Heap overflow. Mobile Malware, Viruses, Worms and Trojans Internet scanning worms, Worm Propagation models, Topological worms- E-mail worms, P2P worms.	**7**
III	Cryptography Topics: Cryptographic hash- SHA1, Collision resistance, Birthday attack, Message Authentication code, Digital signature, Discrete Logarithm- Diffie Hellman Key exchange Protocol, Attacks	**9**
IV	El-Gamal encryption- Signature Scheme, One way and Mutual authentication, Dictionary attack Needham Schroeder protocol, Kerberos basics, Biometrics for authentication.	**8**
V	Network security topics: Network layer security – IPSec – overview, IP and IPv6, IPSec Protocols: AH and ESP, Tunnel Mode and transport mode. Internet Key exchange Protocol- IPSec cookies.	**8**
VI	Transport layer security -SSL, SSL Record Layer Protocol. DoS and DDos attacks-SYN flooding, DDoS Attack Detection and prevention, Session Hijacking and ARP spoofing, firewalls- Types, Practical issues, RFID and E-passport, electronic payment, web services security	**7**
	Total Hours	**45**

Course No	Course Name	Category	L	T	P	Credit
CS1P68B	NETWORK AND OS LABORATORY	PCC	0	0	2	1

COURSE OVERVIEW

The course aims to offer students an experience on linux commands and implementing different scheduling, routing and cryptographic algorithms.

COURSE OUTCOMES

After the completion of the course the student will be able to:

CO 1	Implement different advanced linux commands.
CO 2	Implement inter process communication techniques.
CO 3	Implement scheduling algorithms.
CO 4	Implement routing algorithms to find the shortest path.
CO5	Implement cryptographic algorithms to perform encryption and decryption.

SYLLABUS

1) linux Commands
2) Shell Programming
3) Dining philosopher Problem, Producer Consumer problem, Binary Search Implementation using shell scripting, quick sort implementation using shell scripting, Message queue, Kernel compilation, System call implementation, Scheduling Algorithms.
4) Inter-Process Communication
5) Setting up servers
6) System Administration
7) Routing Algorithms
8) Encryption and Decryption Algorithms

REFERENCES

1. Larry L. Peterson, Bruce S. Davie, “Computer Networks – A Systems Approach”, Elsevier Fourth Edition, 2008.
2. Operating Systems Concepts, 9th Edition- Silberschatz, Galvin, Gagne

COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Linux-booting-login-simple commands	1
II	Wild card characters- grep- pipe-tee-command substitution-shell variablessubshells- filters head, tail. cut, paste, sort, uniq, nl, join	1
III	Editors-Vi and Emacs	1
IV	Communication commands-mail, talk,write, cron…	1
V	Process related commands-ps, kill, nohup, nice, time, archiving, tar-gzip-rpm	1
VI	Shell Programming Commands -Shell variables, read, echo, command line arguments, &&, !!, if, while, case, for, until, test, set, shift, trap	4
VII	Implement the following: Dining philosopher Problem, Producer Consumer problem, Binary Search Implementation using shell scripting, quick sort implementation using shell scripting, Message queue, Kernel compilation, System call implementation, Scheduling Algorithms.	8
VIII	Develop application using Inter-Process Communication (using shared memory, pipes or message queues).	2
IX	System Administration-Booting, init, runlevels.	1
X	Setting up servers-DHCP, DNS, NFS, Apache, Samba	2
XI	Implement Dijkstra's algorithm to compute the shortest path through a graph.	2
XII	Implement distance vector routing algorithm.	2
XIII	Implement encryption and decryption using DES algorithm	2
XIV	Implement encryption and decryption using RSA algorithm.	2
	Total Hours	**30**

COURSE NO	COURSE NAME	Category	L	T	P	CREDITS
CS1P69B	MINI PROJECT	PWS	0	0	4	2

COURSE OVERVIEW

To make students Design and develop a system or application in the area of their specialization.

Approach:

The student shall present two seminars and submit a report. The first seminar shall highlight the topic, objectives, methodology, design and expected results. The second seminar is the presentation of the work/ hardware implementation.

Expected Outcome:

Upon successful completion of the mini project, the student should be able to

1. Identify and solve various problems associated with designing and implementing a system or application.
2. Test the designed system or application.

SEMESTER - III SYLLABUS

Course No	Course Name	Category	L	T	P	Credit
CS1P71A	COMPLEXITY THEORY	PEC	3	0	0	3

COURSE OVERVIEW

Goal of this course is to introduce the fundamental time and space related complexity classes. It also deals with randomized computation and associated complexity classes, parallel computation and associated complexity classes. This course also helps to explore various NP complete problems. It helps to bring a better understanding on the importance of complexity theory in cryptography.

COURSE OUTCOMES

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

CO 1	Explain the fundamental time and space related complexity classes.
CO 2	Apply randomized computation and explain associated complexity classes.
CO 3	Discuss various NP complete problems.
CO 4	Apply parallel computation and explain associated complexity classes.
CO 5	Apply complexity theory in cryptography.

SYLLABUS

Review of time and space related complexity classes, Space complexity, NP complete, NP and Co-NP.

Randomized algorithms – complexity classes – RP, ZPP, PP, BPP – branching program – random sources.

Cryptography – one-way functions – trapdoor functions – cryptography and complexity –randomized cryptography – interactive proofs – zero knowledge.

Approximability – Approximation algorithms – Approximation and complexity – L-reductions – class MAXSNP, MAXSNP completeness – non-approximability.

Parallel computation – parallel algorithms – parallel models of computation – class NC, P-completeness – RNC algorithms.

REFERENCES

1. Christos H. Papadimitriou, “Computational Complexity”, Addison-Wesley Publishing Company Inc, 1994.
2. Michael Sipser, “Introduction to the Theory of Computation”, Thompson Course Technology, 2/e, 2006.
3. Dexter C. Kozen, “Theory of Computation”, Springer, 2006.
4. Vazirani V., “Approximation Algorithms”, Springer, 1/e, 2004.

COURSE PLAN

Module	Contents	No. of hours
I	Review of time and space related complexity classes – hierarchy theorem – reachability method, Space complexity – class L, NL, Co-NL, NL completeness.	**6**
II	NP complete problems – problems in NP – variants of satisfiability – graph theoretic problems – sets and numbers, NP and Co-NP – function problems.	**6**
III	Randomized computation – randomized algorithms – complexity classes – RP, ZPP, PP, BPP – branching program – random sources.	**8**
IV	Cryptography – one-way functions – trapdoor functions – cryptography and complexity – randomized cryptography – interactive proofs – zeroknowledge.	**8**
V	Approximability – Approximation algorithms – Approximation and complexity – L-reductions – class MAXSNP, MAXSNP completeness – non-approximability	**6**
VI	Parallel computation – parallel algorithms – parallel models of computation – class NC, P-completeness – RNC algorithms.	**8**
	Total Hours	42

Course No	Course Name	Category	L	T	P	Credit
CS1P71B	DISTRIBUTED ALGORITHMS	PEC	3	0	0	3

COURSE OVERVIEW

Goal of this course is to provide an understanding of basic distributed algorithms. It covers distributed algorithms in large computer networks to multiprocessor shared-memory systems.

COURSE OUTCOMES

At the end of the course students will be able to :-

CO 1	Explain various synchronous algorithms and consensus problems.
CO 2	Explain various asynchronous shared memory algorithms.
CO 3	Identify resource allocation problems and apply various asynchronous network algorithms.
CO 4	Apply partially synchronous algorithms.

SYLLABUS

Synchronous Network Algorithm: Synchronous Network Model, Leader election in asynchronous ring, Algorithms in General Synchronous Networks.

Distributed consensus with link failures, Deterministic coordinated attack problem, Distributed consensus with process failures, Algorithm for Byzantine failure. Asynchronous Algorithms.

Asynchronous Shared Memory Algorithms: Asynchronous Shared Memory Model, Mutual Exclusion, Dijkstra's Mutual Exclusion algorithm, Lock out free Mutual Exclusion algorithms.

Resource allocation, The problem, Nonexistence of Symmetric Dining Philosophers Algorithm, Left Dining Philosophers Algorithm, Drinking Philosophers Problem, Consensus, Agreement using Read/Write shared memory. Asynchronous Network Algorithms.

Partially Synchronous Algorithms: System model, MMT Timed automata, General Timed automata, Basic Definitions and operations, Transforming MMT automata into General Timed Automata.

REFERENCES

1. Nancy Lynch, “Distributed Algorithms”, Morgan Kaufmann, 1996.
2. Vijay K. Garg, “Elements of Distributed Computing”, John Wiley, 2006.
3. S. Mullender, “Distributed Systems”, Addison-Wesley, 1993.
4. Gerard Tel, “Introduction to Distributed Algorithms”, Cambridge Univ. Press, 2000.

COURSE PLAN

Module	Contents	No. of hours
I	Synchronous Network Algorithm: Synchronous Network Model, Leader election in a synchronous ring, Algorithms in General Synchronous Networks – Flooding algorithm – Breadth First Search – Shortest Paths – Minimum Spanning Tree – Maximal Independent Set.	7
II	Distributed consensus with link failures – Deterministic coordinated attack problem, Distributed consensus with process failures – Algorithm for Byzantine failure. Asynchronous Algorithms: Asynchronous System model – I/O automata – Operations on automata – Fairness – Inputs and outputs for problems – Properties and proof methods.	8
III	Asynchronous Shared Memory Algorithms: Asynchronous Shared Memory Model, Mutual Exclusion – Dijkstra's Mutual Exclusion algorithm– Lock out free Mutual Exclusion algorithms, Mutual Exclusion using Read–Modify – Write Variables – TicketME algorithm.	7
IV	Resource allocation – The problem – Nonexistence of Symmetric Dining Philosophers Algorithm – Left Dining Philosophers Algorithm, Drinking Philosophers Problem, Consensus – Agreement using Read/Write shared memory.	7
V	Asynchronous Network Algorithms: Asynchronous Network Model, Basic asynchronous network algorithms – Leader election – Spanning Tree construction – BFS – Shortest path –Minimum Spanning Tree, Synchronizers – The Local synchronizer – The safe synchronizer – Implementations – Applications.	8
VI	Partially Synchronous Algorithms: System model – MMT Timed automata General Timed automata – Basic Definitions and operations – Transforming MMT automata into General Timed Automata, Mutual Exclusion with partial synchrony – The problem – Single-Register algorithm.	8
	Total Hours	**45**

Course No	Course Name	Category	L	T	P	Credit

CS1P71C	ADVANCED COMPUTER GRAPHICS	PEC	3	0	0	3

COURSE OVERVIEW

The goal of this course is to introduce geometric modelling and modelling transformations, to learn different techniques for representing solids, visible surface determination algorithms and concepts of global illumination modelling using advanced Ray tracing algorithms and Radiosity methods.

COURSE OUTCOMES:

After the completion of the course the student will be able to:

CO 1	Explain geometric modelling and modelling transformations.
CO 2	Analyse different techniques for representing Solids.
CO 3	Compare visible surface determination algorithms.
CO 4	Analyse concepts of global illumination modelling using advanced Ray tracing algorithms and Radiosity methods.
CO 5	Describe computer assisted animation and image manipulation.
CO 6	Apply appropriate mathematical models to solve computer graphics problems.

SYLLABUS

Geometric modelling: Hierarchy in Geometric models- Defining and Displaying structures, Modelling - Transformations

Interaction-Optimizing display of hierarchical models- Limitations of SPHIGS- User Interface Software- User Interface Management systems

Solid Modelling- Visible surface determination algorithms- Illumination and Shading.

Image manipulation and storage- Advanced geometric and raster transforms- Animation: Conventional and computer assisted animation- Methods of controlling animation, -Multiprocessor Graphics System

REFERENCES

1. James D. Foley, Andries van Dam, Steven K. Feiner and F. Hughes John, “Computer Graphics, principles and Practice in C”, 2/e, Pearson Education.
2. Donald Hearn and M. Pauline Baker, “ Computer Graphics”, Prentice Hall India
3. Alan Watt , “ 3D Computer Graphics”, Addison Wesley

COURSE PLAN

Module	Contents	No. of hours
I	Geometric modelling: Hierarchy in Geometric models, relationship between model, application program and Graphical System, Defining and Displaying structures, Modelling Transformations, Hierarchical structure networks, Appearance attribute handling in hierarchy, Screen updating and rendering modes.	**8**
II	Interaction, Output features, Implementation issues, Optimizing display of hierarchical models, Limitations of SPHIGS. User Interface Software: Basic interaction handling models, Window management, Output handling in window systems, Input handling in window systems, User Interface Management systems.	**7**
III	Solid Modelling: Regularized Boolean set of operations, Sweep representations, Boundary representations, Boolean Set Operations, Spatial Partitioning representations, Octrees, Constructive Solid Geometry, Comparisons of representations.	8
IV	Visible surface determination algorithms: Scan line algorithm, Area subdivision algorithm, visible surface ray tracing. Illumination and shading: Illumination models, diffuse reflection and Specular reflection, illumination models, Shading models for polygons. Global illumination algorithms. Recursive ray tracing and distributed ray tracing. Radiosity methods, Combining radiosity and ray tracing.	**8**
V	Image manipulation and storage: Geometric transformation of images, Filtering, Multipass transforms, Generation of transformed image with filtering, Image Compositing, Mechanism for image geometric and raster transforms: Clipping- clipping polygon against rectangles and other polygons.	7
VI	Animation: Conventional and computer assisted animation, Methods of controlling animation. Advanced Raster graphics architecture: Display processor system, Standard graphics pipeline, Multiprocessor Graphics System, Graphics Programming using OPENGL	7
	Total Hours	**45**

Course No	Course Name	Category	L	T	P	Credit
CS1P71D	ADHOC AND SENSOR NETWORKS	PEC	3	0	0	3

COURSE OVERVIEW

Goal of this course is to impart a deeper understanding of Wireless Sensor Networks (WSN) - learn the concepts and principles behind WSN – design and implementation of wireless network and sensor nodes – provide an insight to the issues involved in wireless network security.

COURSE OUTCOMES

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

CO 1	Explain the standards, concepts, network architectures and applications of ad hoc and wireless sensor networks.
CO 2	Analyze the protocol design issues of ad hoc and sensor networks
CO 3	Design routing protocols for ad hoc and wireless sensor networks with respect to some protocol design issues
CO 4	Analyze the QoS related performance measurements of ad hoc and sensor networks.
CO 5	Explain the security issues in Wireless Sensor Networks.

SYLLABUS

Fundamentals of wireless communication, characteristics of wireless channels, modulation techniques, multiple access techniques, wireless LANs, PANs, WANs, and MANs, Wireless Internet. Introduction to adhoc/sensor networks, advantages of ad-hoc/sensor network, issues in adhoc wireless networks, sensor network architecture, data dissemination and gathering.

MAC Protocols, issues, design goals, classification, S-MAC, IEEE 802.15.4. Routing Protocols : Issues, classification, QoS and Energy Management, Issues and, classifications, QoS frameworks, need for energy management, classification, Security in Ad-hoc wireless Networks.

REFERENCES

1. C. Siva Ram Murthy, B. S. Manoj, "AdHoc Wireless Networks ", Pearson Education, 2008.
2. Feng Zhao, LeonidesGuibas, "Wireless Sensor Networks ", Elsevier Publications, 2004.
3. Carlos De Morais Cordeiro, Dharma Prakash Agrawal "Ad Hoc & Sensor Networks: Theory and Applications", World Scientific Publishing Company, 2006.
4. Jochen Schiller, "Mobile Communications ", 2/e, Pearson Education, 2003.
5. William Stallings, "Wireless Communications and Networks ", Pearson Education, 2004.

COURSE PLAN

Module	Contents	No. of hours
I	Introduction: Fundamentals of wireless communication technology, the electro-magnetic spectrum, radio propagation mechanisms, characteristics of wireless channels. Modulation techniques, Multiple access techniques, wireless LANs-Fundamentals of WLANS, IEEE 802.11 Standard, PANs-Bluetooth, WANs-cellular concept, cellular architecture, and MANs-IEEE 802.16 Standard, Wireless Internet – Introduction, Mobile Ip.	**9**
II	Introduction to adhoc/sensor networks: Key definitions of adhoc/ sensor networks, unique constraints and challenges, advantages of adhoc/sensor network, driving applications, issues in adhoc wireless networks, issues in design of sensor network, sensor network architecture, data dissemination and gathering.	**5**
III	MAC Protocols: Issues in designing MAC protocols for adhoc wireless networks, design goals, classification of MAC protocols. MAC protocols for sensor network, location discovery, S-MAC.	**8**
IV	Routing Protocols: Issues in designing a routing protocol. Classification of routing protocols, Destination Sequenced Distance Vector routing protocol, Dynamic Source Routing Protocol.	**6**
V	QoS: Concept, Issues, and challenges in providing QoS. QoS – Classifications, MAC layer solutions, QoS frameworks for Ad-hoc Wireless networks- QoS Models, QoS Resource Reservation signalling, INSIGNIA, INORA, SWAN.	10
VI	Energy Management - need for energy management, classification. Security in Ad-hoc wireless networks- Network security Requirements, issues, and challenges in security provisioning Network Security Attacks.	7
	Total Hours	**45**

Course No	Course Name	Category	L	T	P	Credit
CS1P72A	Principles of Network Security	PEC	3	0	0	3

COURSE OVERVIEW:

In this course, student will learn the fundamental principles of computer and network security by studying attacks on computer systems, network, and the Web. Students will learn how those attacks work and how to prevent and detect them. Students can enhance their understanding of the principles, and be able to apply those principles to solve real problems.

COURSE OUTCOMES

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

CO 1	Identify security vulnerabilities in a networked system
CO 2	Apply network security algorithms and principles at different layers in typical networked environment
CO 3	Examine various IP security and intrusion detection mechanisms

SYLLABUS

DES, Cryptographic Hash functions, Digital signatures. Wireless LAN protocol architecture. IP Security , Internet Key Exchange. Modes of operation, Security policy, Email Architecture, SSL Architecture. Symmetric Key Agreement. Statistical anomaly detection.

REFERENCES

(a) Text books

a. Charlie Kaufman, Radia Perlman and Mike Speciner, Network Security: PRIVATE Communication in a PUBLIC World, Second Edition, Prentice Hall, 2002.
b. Eric Rescoria, “SSL and TLS: Designing and Building Secure Systems, Addison Wesley Professional, 2000.
c. Stephen Kent, Charles Lynn, Joanne Mikkelson, and Karen Seo, Secure Border Gateway Protocol (S-BGP)-Real World Performance and Deployment Issues, NDSS, 2000.

COURSE PLAN

Module	Contents	No. of hours
I	DES, Strength of DES, Principles of public key crypto systems, The RSA algorithm, Cryptographic Hash functions- Applications, Requirements, Secure Hash Algorithm (SHA), Digital signatures- Elgamal Digital Signature Scheme, Schnorr Digital Signature Scheme, Digital Signature Standard.	**7**
II	Wireless LAN protocol architecture, Wireless LAN security, IEEE 802.11i Phases of operation- Discovery, Authentication, Key management, Protected data transfer. Wireless Application Protocol (WAP).	**7**
III	IP Security, Modes of operation, Protocols -Authentication Header (AH), Encapsulating Security Payload(ESP), Security Associations, Security policy, Internet Key Exchange – Diffie-Hellman key exchange, Attacks, IKE phases- Main mode, Aggressive and Quick mode	**7**
IV	Email Architecture, Security, PGP-authentication, confidentiality, PGP Certificates and public keys, Trust model in PGP, Key Revocation, PGP packets, S/MIME- MIME, S/MIME data content types Secure Socket Layer, SSL Architecture, key exchange algorithms, Sessions and connections, Protocols –Handshake protocol, Change cipher Spec protocol, Record protocol, Alert protocol, Transport layer security, HTTPS, SSH.	**7**
V	Symmetric Key Agreement- Diffie-Hellman Key exchange, Station to Station Key exchange, Distribution of public keys, X.509 certificates, Public Key Infrastructure, Remote user authentication, Remote user authentication using symmetric key encryption Kerberos- version 4 message exchanges, improvements in version 5, Zero Knowledge Protocols – Fiat-Shamir protocol, Feige-Fiat Shamir Protocol..	8
VI	Statistical anomaly detection, Rule based Intrusion detection, distributed intrusion detection, Password Management- password protection, password selection strategies Malicious software- types, virus, worms, distributed denial of service, Firewalls -types of firewalls	9
	Total Hours	45

Course No	Course Name	Category	L	T	P	Credit
CS1P72B	FUZZY SET THEORY AND APPLICATIONS	PEC	3	0	0	3

COURSE OVERVIEW

The course helps students to understand Fuzzy Set Theory and the basis of fuzzy logic and its applications such as fuzzy control and fuzzy decision making.

COURSE OUTCOMES

After the completion of the course the student will be able to:

CO 1	Examine the Set Theory problems.
CO 2	Interpret the systems which include fuzzines within the scope of fuzzy set theory.
CO 3	Combine the information of decision theory and the information of fuzzy set theory.
CO 4	Improve the proof techniques of Fuzzy Set Theory.
CO 5	Solve problems that include uncertainty with using Fuzzy Set Theory

SYLLABUS

Introduction – crisp sets an overview – the notion of fuzzy sets – Basic concepts of fuzzy sets – classical logic an overview – Fuzzy logic. Operations on fuzzy sets - fuzzy complement – fuzzy union – fuzzy intersection – combinations of operations – general aggregation operations

Crisp and fuzzy relations – binary relations – binary relations on a single set–equivalence and similarity relations.

Compatibility or tolerance relations– orderings – Membership functions – methods of generation – defuzzification methods.

General discussion – belief and plausibility measures – probability measures– possibility and necessity measures – relationship among classes of fuzzy measures.

Classical logic: An overview – fuzzy logic – fuzzy rule based systems – fuzzy decision making

Fuzzy logic in database and information systems – Fuzzy pattern recognition – Fuzzy control systems

REFERENCES

1. Timothy J Ross, Fuzzy Logic with Engineering Applications, Wiley Publications.
2. George J Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, PHI.
3. H J Zimmerman, Fuzzy Set Theory and its Applications, Kluwer Academic Publishers.

COURSE PLAN

Module	Contents	No. of hours
I	Introduction – crisp sets an overview – the notion of fuzzy sets – Basic concepts of fuzzy sets – classical logic an overview – Fuzzy logic. Operations on fuzzy sets - fuzzy complement – fuzzy union – fuzzy intersection – combinations of operations – general aggregation operations	**6**
II	Crisp and fuzzy relations – binary relations – binary relations on a single set–equivalence and similarity relations.	**6**
III	Compatibility or tolerance relations– orderings – Membership functions – methods of generation – defuzzification methods.	8
IV	General discussion – belief and plausibility measures – probability measures– possibility and necessity measures – relationship among classes of fuzzy measures.	**7**
V	Classical logic: An overview – fuzzy logic – fuzzy rule based systems – fuzzy decision making	9
VI	Fuzzy logic in database and information systems – Fuzzy pattern recognition – Fuzzy control systems	9
	Total Hours	45

Course No	Course Name	Category	L	T	P	Credit
CS1P72C	DECISION SUPPORT SYSTEMS	PEC	3	0	0	3

COURSE OVERVIEW

The course gives an insight into the theory and applications of various types of DSS.

COURSE OUTCOMES

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

CO 1	Explain the concept of information systems
CO 2	Identify different models used for making decisions
CO 3	Explain different representation of knowledge management system
CO 4	Explain the concept of Business Intelligence

SYLLABUS

Introduction, Concepts of Data, Information, Information Systems & End Users. Systems Concepts. Building Information System: System Analysis and Design PS, OAS, MIS, DSS, EIS, ES.

Decision Making, DSS Configurations, DSS Characteristics and Capabilities. Components of DSS, DSS Classifications DSS Modeling-Static and Dynamic Models, Making Decisions in Groups: Group Decision Support System (GDSS), Tools for Indirect and Indirect Support of Decision Making.

From GDSS to GSS Knowledge Management System: Definition and types of Knowledge, Framework for Knowledge Management Knowledge Representation Techniques: Rules, Frames, Semantic Networks.

Introduction to Business Intelligence; Characteristics of Business Intelligence, Towards Competitive Intelligence, Successful BI Implementation, Structure and Components of BI, Future trends.

REFERENCES

1. Turban, Efrain, “Decision Support & Business Intelligent Systems”, 8/e, Pearson Education
2. Marakas, George.M, “Decision Support Systems in the 21st Century”, Pearson Education
3. Mallach, Efrem G., “ Decision Support & Data Warehouse Systems”, Tata McGraw-Hill
4. Keen,Peter G.W, “Decision Support System and Organizational Perspective”, AddisonWesley
5. Theierauff, Robert J., “Decision Support System for Effective Planning”, Prentice Hall, 1982.
6. Krober,Donald W., and Hugh J. Watson, “Computer Based Information System”, New York,1984.
7. Andrew P. Sage, “Decision Support System Engineering”, John Wiley & Sons, New York,1991.
8. Leod. Raymond Me JR, “Management Information Systems”, 5/e, Macmillian Publishing Company, 1993.

COURSE PLAN

Module	Contents	No. of hours
I	Introduction, Concepts of Data, Information, Information Systems & End Users. Systems Concepts: Open System, Closed System; Information Systems and Systems Concept. Building Information System: System Analysis and Design – Systems Development Cycle (Identification of Requirements, Feasibility Study, System Analysis, Design And Implementation), Prototyping Evolution of Information Systems: PS,OAS,MIS,DSS,EIS,ES	**7**
II	Decision Making: Introduction and Definitions, Simons Decision Making Model, How Decisions are Supported, DSS Configurations, DSS Characteristics and Capabilities. Components of DSS, DSS Classifications DSS Modeling-Static and Dynamic Models, Certainty, Uncertainty, and Risk, Sensitivity Analysis, What-IF, and Goal Seeking	**7**
III	Making Decisions in Groups: Group Decision Support System(GDSS),Characteristics, Process, Benefits, and Dysfunctions, Supporting Group work with Computerized Systems, Tools for Indirect and Indirect Support of DecisionMaking, From GDSS to GSS Knowledge Management System: Definition and types of Knowledge, Frame work for Knowledge Management Knowledge Representation Techniques: Rules, Frames, Semantic Networks	**8**
IV	Introduction to Business Intelligence: Origins and Drivers of Business Intelligence, General Process of Intelligence Creation and Use, Characteristics of Business Intelligence, Towards Competitive Intelligence, Successful BI Implementation, Structure and Components of BI, Future trends.	8
V	Data Warehousing Definitions and Concepts, Types of Data warehouse. Business Analytics-Online Analytical Processing (OLAP), Reporting and Queries, Multidimensionality.	7
VI	Knowledge Discovery in Databases (KDD), framework of KDD. Data Mining Concepts and Applications, Framework of data mining, Text Mining, Web Mining Usage, Benefits, and Success of Business Analytics**.**	8
	Total Hours	45

Course No	Course Name	Category	L	T	P	Credit
CS1P72D	ADVANCED SOFTWARE PROJECT MANAGEMENT	PEC	3	0	0	3

COURSE OVERVIEW

The goal of this course is to familiarize the students with the advanced concepts and methods for software project management. It includes the different stages of pre-project activities as well as the main activities of planning and execution of the project.

COURSE OUTCOMES

After the completion of the course the student will be able to:

CO 1	Explain the criteria for planning a software project to achieve successful completion
CO 2	Analyze the options for process implementation
CO 3	Apply the techniques for cost estimation, activity planning, risk analysis and resource allocation
CO 4	Apply progress monitoring and resource management tools
CO 5	Apply quality assurance and configuration management methods

SYLLABUS

Software project management concepts: Stakeholders, Issues and problems; Planning a software project: defining scope and objectives, Work breakdown Structure; Methods of Project evaluation: Strategic and Technical assessment, Cost benefit analysis, risk evaluation;
Selection of Process model: different life cycle models; Software effort estimation: Effort estimation techniques, Algorithmic methods; Activity planning: Network planning models, critical path, slack and float;
Risk analysis and risk management: Risk identification, assessment, mitigation and monitoring; Resource allocation: allocating and scheduling of resources, cost variance, time - cost tradeoff ;
Project tracking and control: measurement of progress, status report, change control; Contract management: types, stages and terms of contract; People management: recruitment, motivation, group behaviour, leadership, organisational structures;
Software quality assurance: Planning for quality, defect analysis and prevention, statistical process control, quality standards and models, quality audit.

REFERENCES:

1. Bob Hughes,MikeCotterell,RajibMall,"Software Project Management",6/e,2017,McGraw Hill
2. Roger S. Pressman,"Software Engineering: A practitioner's Approach",7/e, 2010,McGraw Hill
3. Robert T. Futrell, Donald F. Shafer, and Linda I. Shafer, "Quality Software Project Management", 2002, Pearson Education Asia.
4. Ramesh Gopalaswamy, "Managing Global Software Projects", 2003, Tata McGraw Hill.
5. Pankaj Jalote, "Software Project Management in Practice", 2002, Pearson Education

COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Software Project Management: Stakeholders; Software product, process, resources, quality, and cost;Objectives, issues, and problems relating to software projects. Project Planning: Defining scope and objectives; Work breakdown structure; Time, cost, and resource estimation.Case studies	**6**
II	Project Evaluation: Strategic assessment; Technical assessment; Cost benefit analysis; Risk evaluation. Choice of process model: Rapid application development; Waterfall model; V-process model; Spiral model; Prototyping; Incremental delivery, Agile methods. Case studies.	**6**
III	Software Effort Estimation: Effort estimation techniques; Algorithmic methods; Function point analysis; COCOMO model. Case studies. Activity Planning: Network planning models; Critical path; Slack and float.	**7**
IV	Risk Analysis and Management: Risk Identification; Risk assessment; Riskk mitigation, monitoring, and management. Resource Allocation: project resources; Allocating and scheduling resources; cost of resources; Cost variance; time-cost tradeoff. Case studies.	**8**
V	Project Tracking and Control: Measurement of physical and financial progress; Status reports; Change control. Contract Management: Outsourcing; Types of contracts; Stages and Terms of contract; Contract monitoring; Managing People and Organizing Teams: Recruitment; Motivation; Group behaviour; Leadership Mini and leadership styles; forms of organizational structures.	**9**
VI	Software Quality Assurance: Planning for quality; Product versus process quality; Defect analysis and prevention; Statistical process control; Pareto analysis; Causal analysis; Quality standards and Models; Quality audit. Configuration Management: CM Process; Change control; Configuration audit; Status reporting .	**9**
	Total Hours	**45**

COURSE NO	COURSE NAME	CATEGORY	L	T	P	CREDITS
CS7192	SEMINAR II	SE	0	0	2	1

COURSE OVERVIEW

To make students

1. Identify the current topics in the specific stream.

2. Collect the recent publications related to the identified topics.

3. Do a detailed study of a selected topic based on current journals, published papers and books.

4. Present a seminar on the selected topic on which a detailed study has been done. 5. Improve the writing and presentation skills.

Approach:

Students shall make a presentation for 20-25 minutes based on the detailed study of the topic and submit a report based on the study.

Expected Outcome:

Upon successful completion of the seminar, the student should be able to

1. Get good exposure in the current topics in the specific stream.
2. Improve the writing and presentation skills.
3. Explore domains of interest so as to pursue the course project..

COURSE NO	COURSE NAME	CATEGORY	L	T	P	CREDITS
CS7193	PROJECT(PHASE I)	PR	0	0	12	6

COURSE OVERVIEW

To make students

1. Do an original and independent study on the area of specialization.

2. Explore in depth a subject of his/her own choice.

3. Start the preliminary background studies towards the project by conducting literature survey in the relevant field.

4. Broadly identify the area of the project work, familiarize with the tools required for the design and analysis of the project.

5. Plan the experimental platform, if any, required for project work.

Approach:

The student has to present two seminars and submit an interim Project report. The first seminar would highlight the topic, objectives, methodology and expected results. The first seminar shall be conducted in the first half of this semester. The second seminar is the presentation of the interim project report of the work completed and scope of the work which has to be accomplished in the fourth semester.

Expected Outcome:

Upon successful completion of the project phase 1, the student should be able to

1. Identify the topic, objectives and methodology to carry out the project.

2. Finalize the project plan for their course project.

SEMESTER IV SYLLUBUS

COURSE NO	COURSE NAME	CATEGORY	L	T	P	CREDIT S
CS7194	PROJECT(PHASE II)	PR	0	0	23	12

COURSE OVERVIEW

To continue and complete the project work identified in project phase 1.

Approach:

There shall be two seminars (a mid-term evaluation on the progress of the work and pre submission seminar to assess the quality and quantum of the work). At least one technical paper has to be prepared for possible publication in journals / conferences based on their project work.

Expected Outcome:

Upon successful completion of the project phase II, the student should be able to

1. Get a good exposure to a domain of interest.

2. Get a good domain and experience to pursue future research activities.