M.Tech (COMPUTER SCIENCE)
Department of CSE, JNTUHCEH
COURSE STRUCTURE
(Applicable for the Batch admitted from the Academic Year 2021-22 onwards)

I SEMESTER

S.No	Course Code	Subject	L	T	P	Credits
1.	PC 1	Advanced Data Structures & Algorithms	3	0	0	3
2.	PC 2	Mathematical Foundations of Computer Science	3	0	0	3
3.	PE I	Program Elective-I	3	0	0	3
4.	PE II	Program Elective-II	3	0	0	3
5.	Laboratory 1	Advanced Data Structures and Algorithms Lab	0	0	4	2
6.	Laboratory 2	Program Elective-I Lab	0	0	4	2
7.	MLC	Research Methodologies and IPR	2	0	0	2
8.	Audit I	Audit Course -I	2	0	0	0
TOTAL			**16**	**0**	**8**	**18**

Program Elective - I

1. Social Media Mining
2. High Performance Computing
3. Image and Video Processing

Program Elective - II

1. Cloud Computing Security
2. Video Analytics
3. Quantum Computing

II SEMESTER

S.No	Course Code	Subject	L	T	P	Credits
1.	PC 3	Randomized Algorithms	3	0	0	3
2.	PC 4	Advanced Computer Networks	3	0	0	3
3.	PE III	Program Elective-III	3	0	0	3
4.	PE IV	Program Elective-IV	3	0	0	3
5.	Laboratory 3	Randomized Algorithms Lab	0	0	4	2
6.	Laboratory 4	Advanced Computer Networks Lab	0	0	4	2
7.	MLC	Technical Seminar	2	0	0	2
8.	Audit II	Audit Course -II	2	0	0	0
TOTAL			**16**	**0**	**8**	**18**

Program Elective - III

1. Fog Computing
2. Robotic Process Automation
3. Federated Machine Learning

Program Elective - IV

1. Spatial and Multimedia Database
2. Augmented Reality and Virtual Reality
3. Reinforcement Learning

III SEMESTER

S.No	Code	Subject	L	T	P	Credits
1.	PE V	Program Elective-V	3	0	0	3
2.	OEC	Open Elective	3	0	0	3
3.	PW	PROJECT/ DISSERTATION PHASE - I	0	0	20	10
TOTAL CREDITS			**6**	**0**	**20**	**16**

Program Elective - V

1. Predictive Analytics
2. Digital Forensics
3. Data Visualization

IV SEMESTER

S.No	Group	Subject	L	T	P	Credits
1.	PW	PROJECT/ DISSERTATION PHASE - II	0	0	32	16
TOTAL CREDITS			**0**	**0**	**32**	**16**

Open Elective (Offered by **CSE** Department)

1. Data Analytics
2. Data Visualization
3. Machine Learning

Audit Course I & II

1. English for Research Paper Writing.
2. Disaster Management.
3. Sanskrit for Technical Knowledge.
4. Value Education.
5. Indian Constitution.
6. Pedagogy Studies.
7. Stress Management by yoga.
8. Personality Development Through Life Enlightenment Skills.
9. Research Methodology & IPR

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L	T	P	C
3	0	0	3

Advanced Data Structure and Algorithms

Prerequisites

1. A course on "Data Structures"

Objectives

1. Introduces the heap data structures such as leftist heaps, binomial heaps, fibonacci and min-max heaps
2. Introduces a variety of data structures such as disjoint sets, hash tables, search structures and digital search structures

Outcomes

1. Ability to select the data structures that efficiently model the information in a problem
2. Ability to understand how the choice of data structures impact the performance of programs
3. Can Design programs using a variety of data structures, including hash tables, search structures and digital search structures

UNIT - I

Heap Structures

Introduction, Min-Max Heaps, Leftist trees, Binomial Heaps, Fibonacci heaps.

UNIT - II

Hashing and Collisions

Introduction, Hash Tables, Hash Functions, different Hash Functions:- Division Method, Multiplication Method, Mid-Square Method, Folding Method, Collisions

UNIT - III

Search Structures

OBST, AVL trees, Red-Black trees, Splay trees,

Multiway Search Trees

B-trees., 2-3 trees

UNIT - IV

Digital Search Structures

Digital Search trees, Binary tries and Patricia, Multiway Tries, Suffix trees, Standard Tries, Compressed Tries

Pattern matching

Introduction, Brute force, the Boyer –Moore algorithm, Knuth-Morris-Pratt algorithm, Naïve String ,Harspool, Rabin Karp

UNIT - V

Dynamic programming, graph algorithms: DFS, BFS, topological sorting, shortest path algorithms, network flow problems. String algorithms, suffix trees, geometric algorithms.

Textbooks:

1. Fundamentals of data structures in C++ Sahni, Horowitz, Mehatha, Universities Press.
2. Introduction to Algorithms, TH Cormen, PHI

References:

1. Design methods and analysis of Algorithms, SK Basu, PHI.
2. Data Structures & Algorithm Analysis in C++, Mark Allen Weiss, Pearson Education.
3. Fundamentals of Computer Algorithms, Ellis Horowitz, SartajSahni, Sanguthevar Rajasekaran, 2nd Edition, Universities Press.

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MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE

Pre-requisites

1. No prerequisites
2. An understanding of Mathematics in general is sufficient.

Objectives

1. Introduces the elementary discrete mathematics for computer science and engineering.
2. Topics include formal logic notation, methods of proof, induction, sets, relations, graph theory, permutations and combinations, counting principles; recurrence relations and generating functions.

Outcomes

1. Ability to understand and construct precise mathematical proofs
2. Ability to use logic and set theory to formulate precise statements
3. Ability to analyze and solve counting problems on finite and discrete structures
4. Ability to describe and manipulate sequences
5. Ability to apply graph theory in solving computing problems

UNIT - I

The Foundations: Logic and Proofs

Propositional Logic, Applications of Propositional Logic, Propositional Equivalence, Predicates and Quantifiers, Nested Quantifiers, Rules of Inference, Introduction to Proofs,Proof Methods and Strategy.

UNIT - II

Basic Structures, Sets, Functions, Sequences, Sums, Matrices and Relations

Sets, Functions , Sequences & Summations, Cardinality of Sets and Matrices Relations**,** Relations and Their Properties, n-ary Relations and Their Applications, Representing Relations, Closures of Relations, Equivalence Relations, Partial Orderings.

UNIT - III

Algorithms, Induction and Recursion

Algorithms, The Growth of Functions, Complexity of Algorithms.

Induction and Recursion

Mathematical Induction, Strong Induction and Well-Ordering, Recursive Definitions and Structural Induction, Recursive Algorithms, Program Correctness.

UNIT - IV

Discrete Probability and Advanced Counting Techniques

An Introduction to Discrete Probability . Probability Theory, Bayes' Theorem, Expected Value and Variance.

Advanced Counting Techniques

Recurrence Relations, Solving Linear Recurrence Relations, Divide-and-Conquer Algorithms and Recurrence Relations, Generating Functions, Inclusion-Exclusion, Applications of Inclusion-Exclusion.

UNIT-V

Graphs

Graphs and Graph Models, Graph Terminology and Special Types of Graphs, Representing Graphs and Graph Isomorphism, Connectivity, Euler and Hamilton Paths, Shortest-Path Problems, Planar Graphs, Graph Coloring.

Trees

Introduction to Trees, Applications of Trees, Tree Traversal, Spanning Trees, MinimumSpanning Trees.

Textbook:

1. Discrete Mathematics and Its Applications with Combinatorics and Graph Theory-Kenneth H Rosen, 7th Edition, TMH.

References:

1. Discrete Mathematical Structures with Applications to Computer Science-J.P.Tremblay and R. Manohar, TMH,
2. Discrete Mathematics for Computer Scientists & Mathematicians: Joe L. Mott,Abraham Kandel, Teodore P. Baker, 2nd ed. , Pearson Education.
3. Discrete Mathematics- Richard Johnsonbaugh, 7Th Edtn., Pearson Education.
4. Discrete Mathematics with Graph Theory- Edgar G. Goodaire, Michael M. Parmenter.
5. Discrete and Combinatorial Mathematics - an applied introduction: Ralph.P. Grimald,5th edition , Pearson Education,.

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SOCIAL MEDIA MINING
(Program Elective – I)

Prerequisites: Data Analytics

Objectives
1. The purpose of this course is to provide the students with knowledge of social media mining principles and techniques.
2. This course is also designed to give an exposure of the frontiers of social media mining (Face book, twitter)
3. To introduce new technology for data analytics
4. To introduce community Analysis
5. To introduce various Recommendation algorithms
6. To Introduce Behavior analysis

Outcomes
1. Ability to understand social media and its data.
2. Ability to apply mining technologies on twitter, facebook, LinkdIn and Google.
3. Ability to learn about community
4. Ability to apply various Recommendation Algorithms
5. Ability to analyze the Behavior of people

UNIT - I
Social media mining, Fundamentals, new challenges, key concepts, Good Data vs Bad Data, understanding sentiments, Sentiment Analysis, Classification, supervised social media mining, unsupervised social media mining, human sensors under honest signals.

UNIT - II
Recommendation in Social Media, Challenges, Classical Recommendation Algorithms, Recommendation Using Social Context, Evaluating Recommendations

UNIT - III
Mining Twitter: Exploring Trending Topics, Discovering What People Are Talking About, Mining Face book: Analyzing Fan Pages, Examining Friendships, Mining LinkedIn: Faceting Job Titles, Clustering Colleagues, Mining Google+: Computing Document Similarity, Extracting Collocations

UNIT - IV
Community Analysis: Community Detection, Community Evolution, Community Evaluation Recommendation in social media: Challenges, Classical Recommendation Algorithms, Recommendation Using Social Context, Evaluating Recommendations,

UNIT - V
Behavior Analytics: Individual Behavior, Collective Behavior

Textbooks
1. Mining the Social WebData Mining Face book, Twitter, LinkedIn, Google+, GitHub, and More By Matthew A. , 2nd Edition,Russell Publisher: O'Reilly Media.
2. Social Media Mining, An Introduction By Reza Zafarani, Mohammad Ali Abbasi, Huan Liu.

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HIGH PERFORMANCE COMPUTING
(Program Elective – I)

Prerequisites

1. A Course on "Computer Organization & Architecture"
2. Operating Systems and Basic Programming

Objectives

1. To understand the Grid, Cluster computing platforms
2. To learn various distributed and parallel computing architecture
3. To learn different computing technologies

Outcomes

1. Understanding the concepts in grid, cluster and pervasive computing
2. Ability to set up cluster and run parallel applications
3. Ability to understand the cluster projects and cluster OS
4. Understanding the core concepts of pervasive computing

UNIT - I

Grid Computing: Data & Computational Grids, The concept of Virtual Organizations, Grid Architecture, Grid Architecture and Its Relations to Various Distributed Technologies. The Grid Computing Road Map. **The Grid Computing Toolkit:** GLOBUS GT3 Toolkit.

UNIT - II

Introduction to Parallel Computing - Programming Using the Message-Passing **Paradigm** - **Programming Shared -** Address Space Platforms

UNIT – III

Cluster Computing at a Glance: Introduction, Scalable Parallel Computer Architectures, A Cluster Computer and its Architecture, Towards Low Cost Parallel Computing and Motivations, A Cluster Computer and its Architecture, Cluster Classifications, Commodity Components for clusters, Network Services/Communication SW, Cluster Middleware and SSI, Resource Management and Scheduling (RMS), Programming Environments and Tools, Cluster Applications

Cluster Setup & Its Administration: Introduction, Setting up the cluster, Example Cluster System – Beowulf;

UNIT – IV

Lightweight Messaging Systems: Introduction, Latency Bandwidth Evaluation of Communication performance, Traditional Communication Mechanisms for clusters, Lightweight Communication Mechanisms

Job and Resource Management Systems: Need of Job management, Components and Architecture.

Scheduling Parallel Jobs on Clusters: Introduction, Rigid Jobs with process migration, Malleable Jobs with Dynamic Parallelism, Communication-Based Co-scheduling, Batch Scheduling. **Cluster Operating Systems:** COMPaS

UNIT – V

Pervasive Computing Concepts & Scenarios: Pervasive Computing, Pervasive Computing Infrastructure, **Device Technology:** Hardware, Human – Machine Interfaces, Biometrics, Operating Systems. Java for Pervasive Devices.

Device Connectivity: Protocols, Security, Device Management.

Textbooks:

1. Grid Computing, J. Joseph & C. Fellenstien, Pearson Education
2. Introduction to Parallel Computing, Second Edition, Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar Publisher: Addison Wesley
3. High Performance Cluster Computing, Raj kumar Buyya, pearson Education.
4. Pervasive Computing, J. Burkhardt et.al, Pearson Education

References:

1. The Grid 2: Blue Print for a New Computing Infrastructure, Ian Foster and Carl Kesselman, 2nd Edition, The Elsevier Series.
2. A networking approach to Grid Computing, Minoli , Wiley

M.Tech CS I Semester

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IMAGE AND VIDEO PROCESSING
(Program Elective – I)

Unit I:
Digital image fundamentals: A simple image formation model, Image sampling and quantization, Some basic relationships between pixels, Basic intensity transformation functions, Sampling and fourier transform of sampled functions, The discrete fourier transform of one variable, Extensions to functions of two variables(2-D discrete fourier transform, Properties of 2-D DFT and IDFT, 2-D Discrete Convolution Theorem

Unit II:
Image Enhancement(spatial domain): Histogram processing, Fundamentals of spatial filtering, Smoothing spatial filters, Sharpening spatial filters, The Laplacian-use of second order derivative for image sharpening, The Gradient-use of first order derivative for image sharpening
Image Enhancement(frequency domain): Basics of filtering in frequency domain, Image smoothing using lowpass frequency domain filters, Image sharpening using highpass filters

Unit III:
Image restoration: Noise Models, Restoration in the presence of noise only – Spatial filters, Periodic noise reduction using Frequency domain filtering, Estimating the degradation function, inverse filtering, Minimum Least square error filtering, constrained least square filters
Wavelet and Multiresolution processing: Matrix-based transform, Walsh-Hadamard Transform, Slant transform, Haar transform

Unit IV:
Image compression: Lossy and lossless compression schemes: Huffman coding, Run-length coding, Arithmetic coding, Block transform coding, JPEG
Image Morphology: Fundamental operations, Morphological Algorithms
Image segmentation: Point, Line and Edge detection, Canny edge detection, Hough Transform, Edge linking, Thresholding, Region-based segmentation, Pixel-based segmentation.

Unit V:
Feature Extraction: Boundary preprocessing, Boundary feature descriptor, Region feature descriptor, Principal components as feature descriptor, Whole image feature
Video Processing: Video Formats, Video Enhancement and Restoration, Video Segmentation

Textbooks:
1. Digital Image Processing, R. C. Gonzalez and R. E. woods, Pearson Education.
2. Handbook of Image and Video Processing, AL Bovik, Academic Press.

References:
1. Digital Image Processing and Analysis, B. Chanda and D. Dutta Mazumdar, PHI.
2. Digital Image Processing, W. K. Pratt, Wiley-Interscience.
3. Fundamentals of Digital Image Processing, A. K. Jain, Pearson India Education.
4. Pattern Classification and Scene Analysis, R. O. Duda and P. E. Hart, Wiley.

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CLOUD COMPUTING SECURITY
(Program Elective – II)

Objectives
1. Guiding Security design principles for Cloud Computing
2. Be able to understand the legal, security, forensics, personal & data privacy issues within Cloud environment
3. Understand the concepts and guiding principles for designing and implementing appropriate safeguards and countermeasures for Cloud based IT services

Outcomes
1. Approaches to designing cloud services that meets essential Cloud infrastructure characteristics on demand computing, shared resources, elasticity and measuring usage.
2. Design security architectures that assures secure isolation of physical and logical infrastructures
3. Understand the industry security standards, regulatory mandates, audit policies and compliance requirements for Cloud based infrastructures.

UNIT - I
Introduction to cloud – Basic Concepts and Terminology – Concepts and Models of cloud computing – Cloud delivery and deployment models.
UNIT - II
Cloud enablers and security – Internet, Broadband, Data centre and virtualization technologies
UNIT - III
Web and Multitenant services – Cloud security,
UNIT - IV
Agent threats: Cloud infrastructure mechanisms, Specialized cloud mechanisms,
UNIT - V
Cloud Management and Cloud Security. AWS, Azure and Google case study

Textbooks:
1. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, T. Mather, S. Kumaraswamy, S. Latif, O'Reilly Series, 2009.
2. Cloud Computing: Concepts, Technology & Architecture, T. Erl, R. Puttini, Z. Mahmood Prentice Hall, 2013.

References:
1. The Google file system. In Proceedings of the nineteenth ACM symposium on Operating systems principles (SOSP '03). ACM, New York, NY, USA, 29-43.
2. MapReduce: simplified data processing on large clusters. Commun. ACM 51, 1, 107-113, 2008.
3. Controlling data in the cloud: outsourcing computation without outsourcing control. In Proceedings of the 2009 ACM workshop on Cloud computing security (CCSW '09). ACM, New York, NY, USA, 85-90, 2009.

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VIDEO ANALYTICS
(Program Elective – II)

Objectives:

1. To know the fundamental concepts of big data and analytics
2. To learn various techniques for mining data streams
3. To acquire the knowledge of extracting information from surveillance videos.
4. To learn Event Modelling for different applications.
5. To understand the models used for recognition of objects in videos.

Course Outcomes:

1. Understand the basics of video- signals and systems.
2. Able to estimate motion in a video
3. Able to detect the objects and track them
4. Recognize activity and analyze behavior
5. Evaluate face recognition technologies

UNIT I

INTRODUCTION

Multi dimensional signals and systems: signals, transforms, systems, sampling theorem**.**

Digital Images and Video: human visual system and color, digital video, 3D video, digital-video applications, image and video quality.

UNIT II

MOTION ESTIMATION

Image formation, motion models, 2D apparent motion estimation,differential methods, matching methods, non-linear optimization methods, transform domain methods, 3D motion and structure estimation.

UNIT III

VIDEO ANALYTICS

Introduction- Video Basics - Fundamentals for Video Surveillance- Scene Artifacts- Object Detection and Tracking: Adaptive Background Modelling and Subtraction- Pedestrian Detection and TrackingVehicle Detection and Tracking- Articulated Human Motion Tracking in Low-Dimensional Latent Spaces.

UNIT IV

BEHAVIOURAL ANALYSIS & ACTIVITY RECOGNITION

Event Modelling- Behavioural Analysis- Human Activity Recognition-Complex Activity RecognitionActivity modelling using 3D shape, Video summarization, shape based activity models-Suspicious Activity Detection.

UNIT V HUMAN FACE RECOGNITION & GAIT ANALYSIS

Introduction: Overview of Recognition algorithms – Human Recognition using Face: Face Recognition from still images, Face Recognition from video, Evaluation of Face Recognition Technologies- Human Recognition using gait: HMM Framework for Gait Recognition, View Invariant Gait Recognition, Role of Shape and Dynamics in Gait Recognition

Textbooks:

1. A.MuratTekalp, “Digital Video Processing”, second edition, Pearson, 2015
2. Rama Chellappa, Amit K.Roy-Chowdhury, Kevin Zhou.S, “Recognition of Humans and their Activities using Video”, Morgan&Claypool Publishers, 2005.
3. Yunqian Ma, Gang Qian, “Intelligent Video Surveillance: Systems and Technology”, CRC Press (Taylor and Francis Group), 2009.

References:

1. Richard Szeliski, “Computer Vision: Algorithms and Applications”, Springer, 2011.
2. Yao Wang, JornOstermann and Ya-Qin Zhang, “Video Processing and Communications”, Prentice Hall, 2001.
3. Thierry Bouwmans, FatihPorikli, Benjamin Höferlin and Antoine Vacavant, “Background Modeling and Foreground Detection for Video Surveillance: Traditional and Recent Approaches, Implementations, Benchmarking and Evaluation”, CRC Press, Taylor and Francis Group, 2014.
4. Md. Atiqur Rahman Ahad, “Computer Vision and Action Recognition-A Guide for Image Processing and Computer Vision Community for Action Understanding”, Atlantis Press, 2011.

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3	0	0	3

QUANTUM COMPUTING

(Program Elective – II)

Unit I

History of Quantum Computing : Importance of Mathematics, Physics and Biology.
Introduction to Quantum Computing : Bits Vs Qubits, Classical Vs Quantum logical operations

Unit II

Background Mathematics : Basics of Linear Algebra, Hilbert space, Probabilities and measurements.
Background Physics : Paul's exclusion Principle, Superposition, Entanglement and super-symmetry, density operators and correlation, basics of quantum mechanics, Measurements in bases other than computational basis.
Background Biology : Basic concepts of Genomics and Proteomics (Central Dogma)

Unit III

Qubit : Physical implementations of Qubit.
Qubit as a quantum unit of information. The Bloch sphere

Quantum Circuits : single qubit gates, multiple qubit gates, designing the quantum circuits. Bell states.

Unit IV

Quantum Algorithms: Classical computation on quantum computers. Relationship between quantum and classical complexity classes. Deutsch’s algorithm, Deutsch’s-Jozsa algorithm, Shor’s factorization algorithm, Grover’s search algorithm.

Unit V

Noise and error correction : Graph states and codes, Quantum error correction, fault-tolerant computation.
Quantum Information and Cryptography : Comparison between classical and quantum information theory. Quantum Cryptography, Quantum teleportation

Textbooks:

1. Quantum Computing for Computer Scientists by Noson S. Yanofsky and Mirco A. Mannucci
2. Nielsen M. A., Quantum Computation and Quantum Information, Cambridge

References :

Benenti G., Casati G. and Strini G., Principles of Quantum Computation and Information, Vol. I: Basic Concepts, Vol II: Basic Tools and Special Topics, World Scientific.
Pittenger A. O., An Introduction to Quantum Computing Algorithms

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0	0	4	2

ADVANCED DATA STRUCTURES AND ALGORITHMS LAB

Prerequisites

1. A course on Computer Programming & Data Structures"

Objectives

1. Introduces the basic concepts of Abstract Data Types.
2. Reviews basic data structures such as stacks and queues.
3. Introduces a variety of data structures such as hash tables, search trees, tries, heaps, graphs, and B-trees.
4. Introduces sorting and pattern matching algorithms

Outcomes

1. Ability to select the data structures that efficiently model the information in a problem.
2. Ability to assess efficiency trade-offs among different data structure implementations or combinations.
3. Implement and know the application of algorithms for sorting and pattern matching.
4. Design programs using a variety of data structures, including hash tables, binary and general tree structures, search trees, tries, heaps, graphs, and B-trees.

List of Programs

1. Write a program to perform the following operations:
a) Insert an element into a binary search tree.
b) Delete an element from a binary search tree.
c) Search for a key element in a binary search tree.

2. Write a program for implementing the following sorting methods:
a) Merge sort b) Heap sort c) Quick sort

3. Write a program to perform the following operations:
a) Insert an element into a B- tree.
b) Delete an element from a B- tree.
c) Search for a key element in a B- tree.

4. Write a program to perform the following operations:
a) Insert an element into a Min-Max heap
b) Delete an element from a Min-Max heap
c) Search for a key element in a Min-Max heap

5. Write a program to perform the following operations:
a) Insert an element into a AVL tree.
b) Delete an element from a AVL search tree.
c) Search for a key element in a AVL search tree.

6. Write a program to perform the following operations:
a) Insert an element into a Red-Black tree.
b) Delete an element from a Red-Black tree.
c) Search for a key element in a Red-Black tree.

7. Write a program to implement all the functions of a dictionary using hashing.

8. Write a program for implementing Knuth-Morris-Pratt pattern matching algorithm.

9. Write a program for implementing Brute Force pattern matching algorithm.

10. Write a program for implementing Boyer pattern matching algorithm

11. Write a program for implementing Shortest path algorithm

12. Write a program for implementing graph traversal DFS and BFS

13. Write a program for implementing String algorithms

14. Write a program for implementing geometric algorithms.

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HIGH PERFORMANCE COMPUTING LAB

1. Practice Basic commands, System Commands and Networking commands of Linux.
2. Explore the details with a sample implementation of Grid Service using Globus GT3 Toolkit
3. Design a parallel program to implement synchronization between producer – consumer processes using pthread APIs
4. Design a parallel program to implement BFS Algorithm using OpenMP
5. Design a parallel program to calculate pi using MPI programming
6. Establish Beowulf Cluster using two computers. Apply basic configurations and customize it.

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0	0	4	2

IMAGE AND VIDEO PROCESSING LAB
(Using Python/matlab)

1. Perform basic operations on images like addition, subtraction etc.
2. Plot the histogram of an image and perform histogram equalization
3. Perform image restoration
4. Perform image compression using lossy technique
5. Perform image compression using lossless technique
6. Implement segmentation algorithm
7. Calculate boundary features of an image
8. Calculate regional features of an image
9. Perform video enhancement
10. Perform video segmentation

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L	T	P	C
2	0	0	2

RESEARCH METHODOLOGY AND IPR

Course Objectives:

- To understand the research problem
- To know the literature studies, plagiarism and ethics
- To get the knowledge about technical writing
- To analyze the nature of intellectual property rights and new developments
- To know the patent rights

Course Outcomes: At the end of this course, students will be able to

- Understand research problem formulation.
- Analyze research related information
- Follow research ethics
- Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
- Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
- Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

UNIT-I:

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.

Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT-II:

Effective literature studies approaches, analysis, Plagiarism, Research ethics

UNIT-III:

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT-IV:

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Copyleft and Creative Commons Licensing. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT-V:

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

TEXT BOOKS:

1. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students’”
2. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”

REFERENCES:

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

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L	T	P	C
3	0	0	3

RANDOMIZED ALGORITHMS

UNIT I

Review of Basic Probability, Polynomial Identity Testing, Schwartz-Zippel Lemma , Reduction from Perfect Bipartite Matching to PIT, Randomized Quick sort, Markov, Chebyshev, and Chernoff bounds

Tossing coins, coupon collector problem, birthday paradox, Balls and bins, Two-point sampling, Randomized rounding: Multi-commodity flow

UNIT II

Introduction to Markov chain, randomized algorithm for 2SAT, stationary distribution, Irreducible and aperiodic Markov chain, fundamental theorem of Markov chain (statement only), coupling, Random walk, Metropolis Algorithm, Mixing time of Random Walk on Cycles, Proof of the fundamental Theorem of Markov chains

UNIT III

Finishing proof of the fundamental Theorem of Markov chains, hitting time, commute time, cover time, Monte Carlo Method, FPRAS for DNF Counting, FPRAS for Independent Set Counting using Monte Carlo Method, Overview of Path Coupling, Introduction to Probabilistic Methods

UNIT IV

Probabilistic method -- method of expectation, alteration; Lovasz Local Lemma and its application, Method of Conditional Expectation for De-randomization, Introduction to Universal Hash Family, Perfect Hashing, Cuckoo Hashing, Bloom Filter, Count Min Sketch, Construction of Universal Hash Family, Nearest Neighbor Search (NNS), Point Location in Equal Balls (PLEB), Locality Sensitive Hashing (LSH), Johnson Linden Strauss Lemma

UNIT V

Sub-Gaussian Random Variables, Introduction to Probabilistic Tree Embedding, Probabilistic Tree Embedding, buy at Bulk Network Design, Martingale: Definition, Doob's Martingale, Stopping Time Theorem (without proof), Wald's equation, Azuma-Hoeffding Inequality, McDiarmid's Inequality, Applications, Problem Solving Session.

Textbooks:

1. Randomized Algorithms: Rajeev Motwani, Prabhakar Raghavan
2. Probability and Computing: Randomization and Probabilistic Techniques in Algorithms and Data Analysis by Eli Upfal and Michael Mitzenmacher.

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ADVANCED COMPUTER NETWORKS

Prerequisites:
1. Data Communication, Basic Networking Principles

Objective:
1. This course aims to provide advanced background on relevant computer networking topics to have a comprehensive and deep knowledge in computer networks.

Outcomes:
1. Understanding of holistic approach to computer networking
2. Ability to understand the computer networks and their application
3. Ability to design simulation concepts related to packet forwarding in networks

UNIT - I
Review of Computer Networks, Devices and the Internet: Internet, Network edge, Network core, Access Networks and Physical media, ISPs and Internet Backbones, Delay and Loss in Packet-Switched Networks, Networking and Internet - Foundation of Networking Protocols: 5-layer TCP/IP Model, 7-Layer OSI Model, Internet Protocols and Addressing. Multiplexers, Modems and Internet Access Devices, Switching and Routing Devices, Router Structure. The Link Layer and Local Area Networks-Link Layer, Introduction and Services, Error- Detection and Error-Correction techniques, Multiple Access Protocols, Link Layer Addressing, Ethernet, Interconnections: Hubs and Switches, PPP: The Point-to-Point Protocol, Link Virtualization

UNIT - II
Data-link protocols: Ethernet, Token Ring and Wireless (802.11). Wireless Networks and Mobile IP: Infrastructure of Wireless Networks, Wireless LAN Technologies, IEEE 802.11 Wireless Standard, Cellular Networks, Mobile IP, Wireless Mesh Networks (WMNs), Multiple access schemes
Routing and Internetworking: Network–Layer Routing, Least-Cost-Path algorithms, Non- Least-Cost-Path algorithms, Intra-domain Routing Protocols, Inter-domain Routing Protocols, Congestion Control at Network Layer.

UNIT - III
Logical Addressing: IPv4 Addresses, IPv6 Addresses - Internet Protocol: Internetworking, IPv4, IPv6, Transition from IPv4 to IPv6 – Multicasting Techniques and Protocols: Basic Definitions and Techniques, Intra-domain Multicast Protocols, Inter-domain Multicast Protocols, Node-Level Multicast algorithms

UNIT - IV
Transport and Application Layer Protocols: Client-Server and Peer-To-Peer Application Communication, Protocols on the transport layer, reliable communication. Routing packets through a LAN and WAN. Transport Layer, Transmission Control Protocol (TCP), User Datagram Protocol (UDP), Mobile Transport Protocols, TCP Congestion Control. Principles of Network Applications,

UNIT - V
The Web and HTTP, File Transfer: FTP, Electronic Mail in the Internet, Domain Name System (DNS), P2P File Sharing, Socket Programming with TCP and UDP, Building a Simple Web Server Creating simulated networks and passing packets through them using different routing techniques. Installing and using network monitoring tools.

Textbooks:

1. Computer Networking: A Top-Down Approach, James F. Kuros and Keith W. Ross, Pearson, 6th Edition, 2012.
2. Computer Networks and Internets, Duglas E. Comer, 6th Edition, Pearson.

References:

1. A Practical Guide to Advanced Networking , Jeffrey S. Beasley and Piyasat Nilkaew, Pearson, 3rd Edition,2012
2. Computer Networks , Andrew S. Tanenbaum, David J. Wetherall,Prentice Hall.

M.Tech CS I Semester

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FOG COMPUTING
(Program Elective-III)

Objectives:

- Learn principles and paradigms of fog computing, edge computing
- Optimization problems in fog and edge computing
- Know data management, security and privacy issues in fog computing
- Explore various applications of fog computing.

Course Outcomes:

1. Understand the basics of fog computing
2. Compare fog with cloud, edge computing
3. Discuss the significance of middleware for fog computing
4. Understand optimization problems.
5. Handle data management, security and privacy issues in fog computing

UNIT-I

Fog Computing: Concepts, Principles and Related Paradigms:- Introduction, Fog Computing and its related technologies, Fog Computing Issues-Security and Privacy, Fog Network Topology and Location Awareness of Nodes, Interoperability and Other Issues. Cloud Paradigm Versus Fog Computing, Fog Computing Versus Edge Computing, Fog Computing Reference Architecture, Fog Computing Application Scenarios, Future of Fog Computing.

Dichotomy of Fog Computing in the Realm of Cloud Computing: Exploring the Emerging Dimensions:- Key Tenets of Cloud Computing, Cloud Versus Fog Computing, Promise of Cloud and Fog Computing, Platform Design in Cloud and Fog Computing, Issues in Cloud and Fog Computing, Legal Dimensions of Cloud and Fog Computing

UNIT-II

Fog Computing in a Developing World Context - How Fog Computing works, Characteristics of Fog Computing, Factors Affecting the Adoption of Fog Computing, Technology Adoption Theories, Technological Factors.

Edge and Fog: A Survey, Use Cases, and Future Challenges – Edge computing architecture, fog computing architecture, Illustrative use cases, future challenges

UNIT-III

Middleware for Fog and Edge Computing - Need for Fog and Edge Computing Middleware, Design Goals, State-of-the-Art Middleware Infrastructures, System Model, Proposed Architecture, Case Study Example, Future Research Directions.

Optimization Problems in Fog and Edge Computing - The Case for Optimization in Fog Computing, Formal Modeling Framework for Fog Computing, Optimization Opportunities along the Fog Architecture, optimization techniques

UNIT-IV

Data Management in Fog Computing:- Introduction-Structure of Data Management in fog computing, Background- data management in fog computing, Fog Data Management, Future Research and Direction-Security, Defining the Level of Data Computation and Storage

Security and Privacy Issues in Fog Computing :-Trust in IoT, Authentication, Authorization, Privacy ,Web Semantics and Trust Management for Fog Computing, Discussion-Authentication ,Authorization.

UNIT-V

Applications and Issues:

Exploiting Fog Computing in Health Monitoring, Smart Surveillance Video Stream Processing at the Edge for Real-Time Human Objects Tracking, Fog Computing Model for Evolving Smart Transportation Applications

Text Books:

1. Zaigham Mahmood, Fog Computing- Concepts, Frameworks and Technologies, Springer,2015

2. Fog and Edge Computing: Principles and Paradigms,Rajkumar Buyya, Satish Narayana Srirama, January 2019
3. Fog Computing: Theory and Practice, Assad Abbas (Editor), Samee U. Khan (Editor), Albert Y. Zomaya-Wiley Series-April 2020

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ROBOTIC PROCESS AUTOMATION
(Program Elective-III)

Unit I

Introduction to Robotic Process Automation & Bot Creation
Introduction to RPA and Use cases – Automation Anywhere Enterprise Platform – Advanced features and capabilities – Ways to create Bots

Unit II

Web Control Room and Client
Introduction - Features Panel - Dashboard (Home, Bots, Devices, Audit, Workload, Insights) - Features Panel – Activity (View Tasks in Progress and Scheduled Tasks) - Bots (View Bots Uploaded and Credentials)

Unit III

Devices (View Development and Runtime Clients and Device Pools) - Workload (Queues and SLA Calculator) - Audit Log (View Activities Logged which are associated with Web CR) - Administration (Configure Settings, Users, Roles, License and Migration) - Demo of Exposed API's – Conclusion – Client introduction and Conclusion.

Unit IV

Bot Creator
Introduction – Recorders – Smart Recorders – Web Recorders – Screen Recorders - Task Editor – Variables - Command Library – Loop Command – Excel Command – Database Command - String Operation Command - XML Command

Unit V

Terminal Emulator Command - PDF Integration Command - FTP Command - PGP Command - Object Cloning Command - Error Handling Command - Manage Windows Control Command - Workflow Designer - Report Designer

Textbooks:

1. Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool - UiPath: Create Software robots. with the leading RPA tool – UiPath Kindle Edition

References:

1. Robotic Process Automation A Complete Guide - 2020 Edition Kindle Edition

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FEDERATED MACHINE LEARNING
(Program Elective-III)

Prerequisites

The prerequisite knowledge for this course includes machine learning, basic computer systems and basic programming skills.

Course Objectives

- Understand the key concepts and issues behind Federated Learning
- Get familiar with key theoretical results of Federated Learning

Course Outcomes

Students will attain the following on completion of the course:

- Knowledge of the basic concepts, architecture and applications of FL.
- Understanding of new research and application trends in FL.

Unit - I

Introduction: Motivation, Federated Learning as a Solution, The Definition of Federated Learning, Categories of Federated Learning, Current Development in Federated Learning, Research Issues in Federated Learning, Open-Source Projects, Standardization Efforts, The Federated AI Ecosystem

Background: Privacy-Preserving Machine Learning, PPML and Secure ML, Threat and Security Models, Privacy Threat Models, Adversary and Security Models, Privacy Preservation Techniques, Secure Multi-Party Computation, Homomorphic Encryption, Differential Privacy

Unit - II

Distributed Machine Learning: Introduction to DML, The Definition of DML, DML Platforms, Scalability-Motivated DML, Large-Scale Machine Learning, Scalability-Oriented DML Schemes, Privacy-Motivated DML, Privacy-Preserving Decision Trees, Privacy-Preserving Techniques, Privacy-Preserving DML Schemes, Privacy-Preserving Gradient Descent, Vanilla Federated Learning, Privacy-Preserving Methods

Unit - III

Horizontal Federated Learning: The Definition of HFL, Architecture of HFL, The Client-Server Architecture, The Peer-to-Peer Architecture, Global Model Evaluation, The Federated Averaging Algorithm, Federated Optimization, The FedAvg Algorithm, The Secured FedAvg Algorithm, Improvement of the FedAvg Algorithm, Communication Efficiency, Client Selection

Vertical Federated Learning: The Definition of VFL, Architecture of VFL, Algorithms of VFL, Secure Federated Linear Regression, Secure Federated Tree-Boosting

Unit - IV

Federated Transfer Learning: Heterogeneous Federated Learning, Federated Transfer Learning, The FTL Framework, Additively Homomorphic Encryption, The FTL Training Process, The FTL Prediction Process, Security Analysis, Secret Sharing-Based FTL

Incentive Mechanism Design for Federated Learning: Paying for Contributions, Profit-Sharing Games, Reverse Auctions, A Fairness-Aware Profit Sharing Framework,Modeling Contribution, Modeling Cost, Modeling Regret, Modeling Temporal Regret, The Policy Orchestrator, Computing Payoff Weightage

Unit - V

Federated Learning for Vision, Language, and Recommendation: Federated Learning for Computer Vision, Federated CV, Federated Learning for NLP, Federated NLP, Federated Learning for Recommendation Systems, Recommendation Model, Federated Recommendation System

Federated Reinforcement Learning:

Introduction to Reinforcement Learning, Policy, Reward, Value Function, Model of the Environment, RL Background Example, Reinforcement Learning Algorithms, Distributed Reinforcement Learning, Asynchronous Distributed Reinforcement Learning, Synchronous Distributed Reinforcement Learning, Federated Reinforcement Learning, Background and Categorization

Textbooks:

1. Federated Learning, Qiang Yang, Yang Liu, Yong Cheng, Yan Kang, Tianjian Chen, and Han Yu Synthesis Lectures on Artificial Intelligence and Machine Learning 2019

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SPATIAL AND MULTIMEDIA DATABASE
(Program Elective-IV)

UNIT I:

Introduction to Spatial Databases: Overview, beneficiaries, GIA and SDBMS, users, Space taxonomy, query language, query processing, query optimization.
Spatial Concepts and Data Models: Models of Spatial information, three step database design, Extending the ER model with spatial concept, object oriented data modeling.
Spatial Query Languages.

UNIT II:

Spatial Storage and Indexing: Storage-disks and files, spatial indexing, TR*, spatial join index.
Query processing and optimization – Evaluation of Spatial operations, query optimization, Analysis of Spatial index structures, distributed and parallel spatial database system.
Multidimensional Data Structures: k-d Trees, Point Quadtrees, The MX-Quadtree, R-Trees, comparison of Different Data Structures.

UNIT III:

Image Databases : Raw Images, Compressed Image Representations, Image Processing: Segmentation, Similarity-Based Retrieval, Alternative Image DB Paradigms, Representing Image DBs with Relations, Representing Image DBs with R-Trees, Retrieving Images By Spatial Layout, Implementations.
Text/Document Databases : Precision and Recall, Stop Lists, Word Stems, and Frequency Tables, Latent Semantic Indexing, TV-Trees, Other Retrieval Techniques

UNIT IV:

Video Databases : Organizing Content of a Single Video, Querying Content of Video Libraries, Video Segmentation, video Standards
Audio Databases : A General Model of Audio Data, Capturing Audio Content through Discrete Transformation, Indexing Audio Data
Multimedia Databases : Design and Architecture of a Multimedia Database, Organizing Multimedia Data Based on The Principle of Uniformity, Media Abstractions, Query Languages for Retrieving Multimedia Data, Indexing SMDSs with Enhanced Inverted Indices, Query Relaxation/Expansion.

UNIT V:

Creating Distributed Multimedia Presentations: Objects in Multimedia Presentations, Specifying Multimedia Documents with Temporal Constraints, Efficient Solution of Temporal Presentation Constraints, Spatial Constraints.
Distributed Media Servers: Distributed multimedia server architecture, distributed retrieval plans, optimal distributed retrieval plans.

Textbooks:

1. Shashi Shekhar, Sanjiv Chawla ,Spatial Databases-A Tour, Pearson Education.
2. V.S. Subrahmanian , Principles of Multimedia Database Systems, Morgan Kauffman.

References:

1. Multimedia Databases: An object relational approach, Lynne Dunckley, Pearson Education.
2. Multimedia Database Systems, Prabhakaram, Springer.

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AUGMENTED REALITY AND VIRTUAL REALITY
(Program Elective-IV)

Unit I

Introduction of Virtual Reality: Fundamental Concept and Components of Virtual Reality. Primary Features and Present Development on Virtual Reality.

Multiple Models of Input and Output Interface in Virtual Reality: Input -- Tracker, Sensor, Digital Glove, Movement Capture, Video-based Input, 3D Menus & 3DScanner etc. Output -- Visual /Auditory / Haptic Devices.

Unit II

Visual Computation in Virtual Reality: Fundamentals of Computer Graphics.

Software and Hardware Technology on Stereoscopic Display. Advanced Techniques in CG: Management of Large Scale Environments & Real Time Rendering.

Unit III

Interactive Techniques in Virtual Reality: Body Track, Hand Gesture, 3D Manus, Object Grasp.

Development Tools and Frameworks in Virtual Reality: Frameworks of Software Development Tools in VR. X3D Standard; Vega, MultiGen, Virtools etc.

Unit IV

Application of VR in Digital Entertainment: VR Technology in Film & TV Production. VR Technology in Physical Exercises and Games. Demonstration of Digital Entertainment by VR.

Unit V

Augmented and Mixed Reality, Taxonomy, technology and features of augmented reality, difference between AR and VR, Challenges with AR, AR systems and functionality, Augmented reality methods, visualization techniques for augmented reality, wireless displays in educational augmented reality applications, mobile projection interfaces, marker-less tracking for augmented reality, enhancing interactivity in AR environments, evaluating AR systems.

Textbooks:

1) Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition. Wiley-IEEE Press, 2003/2006.

2) Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, 2013.

References:

1) Alan Craig, William Sherman and Jeffrey Will, Developing Virtual Reality Applications, Foundations of Effective Design, Morgan Kaufmann, 2009.

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REINFORCEMENT LEARNING
(Program Elective-IV)

Unit I

Basics of probability and linear algebra, Definition of a stochastic multi-armed bandit, Definition of regret, Achieving sublinear regret, UCB algorithm, KL-UCB, Thompson Sampling.

Unit II

Markov Decision Problem, policy, and value function, Reward models (infinite discounted, total, finite horizon, and average), Episodic & continuing tasks, Bellman's optimality operator, and Value iteration & policy iteration

Unit III

The Reinforcement Learning problem, prediction and control problems, Model-based algorithm, Monte Carlo methods for prediction, and Online implementation of Monte Carlo policy evaluation

Unit IV

Bootstrapping; TD(0) algorithm; Convergence of Monte Carlo and batch TD(0) algorithms; Model-free control: Q-learning, Sarsa, Expected Sarsa.

Unit V

n-step returns; TD(λ) algorithm; Need for generalization in practice; Linear function approximation and geometric view; Linear TD(λ).
Tile coding; Control with function approximation; Policy search; Policy gradient methods; Experience replay; Fitted Q Iteration; Case studies.

Textbooks:

1. “Reinforcement learning: An introduction,” First Edition, Sutton, Richard S., and Andrew G. Barto, MIT press 2020
2. “Statistical reinforcement learning: modern machine learning approaches,” First Edition, Sugiyama, Masashi. CRC Press
2015

References:

1. “Bandit algorithms,” First Edition, Lattimore, T. and C. Szepesvári.Cambridge University Press. 2020
2. “Reinforcement Learning Algorithms: Analysis and Applications,” Boris Belousov, Hany Abdulsamad, Pascal Klink, Simone Parisi, and Jan Peters First Edition, Springer 2021
3. Alexander Zai and Brandon Brown “Deep Reinforcement Learning in Action,” First Edition, Manning Publications 2020

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RANDOMIZED ALGORITHMS LAB

1. Design and implement Monte-Carlo randomized algorithm for DNF counting
2. Design a Randomized Quick-Sort algorithm and demonstrate its complexity.
3. Design and Implement the Page rank algorithm using Random-walks
4. Design a Randomized algorithm for Polynomial and Matrix Identity Verification
5. Design and Implement an efficient algorithm for 2-SAT problem using randomized algorithm
6. Design a Randomized algorithm for Nearest Neighbor Search (NNS)

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ADVANCED COMPUTER NETWORKS LAB

Prerequisites:
Data communication, Basic networking principles

Objective:
1. Understand and analyze the existing protocols
2. Understand the use of network packet capturing tools

Outcome:
1. Ability of acquiring the practical exposure to existing protocols

Lab Experiments:
1. Implement the IP fragmentation and reassembly algorithm.
2. Implement the IP forwarding algorithm.
3. Implement the simplest sliding window protocol of TCP.
4. Connect two systems using a switch and configure private IP addresses to the systems and ping them from each other. Using Wireshark, capture packets and analyze all the header information in the packets captured.
5. Install Telnet on one of the systems connected by a switch and telnet to it from the other system. Using Wireshark, capture the packets and analyze the TCP 3-way Handshake for connection establishment and tear down.
6. Start packet capture in wireshark application and then open your web browser and type in an URL of website of your choice. How long did it take from when the HTTP GET message was sent until the HTTP OK reply was received for the webpage you visited in your web browser.

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PREDICTIVE ANALYTICS
(Program Elective – V)

Prerequisite: Data Science/ Data analytics

Course Objectives:

To learn the basics and applications of predictive analytics using different techniques

Course Outcomes:

1. Understand the processing steps for predictive analytics
2. Construct and deploy prediction models with integrity
3. Explore various techniques (machine learning/data mining, ensemble) for predictive analytics.
4. Apply predictive analytics to real world examples.

UNIT I

Introduction – types of analytics, applications of predictive analytics(TB1), overview of predictive analytics(TB2).

Setting up the problem - processing steps, business understanding, objectives, data for predictive modeling, columns as measures, target variables, measures of success for predictive models. (TB2)

UNIT II

Prediction effect, deployment of prediction model, ethics and responsibilities

The Data effect (TB1)

UNIT III

Machine Learning for prediction (TB1)

Predictive modeling – decision trees, logistic regression, neural network, kNN, Bayesian method, Regression model (TB2)

Assessing Predictive models - Batch Approach to Model Assessment, Percent Correct Classification, Rank-Ordered Approach to Model Assessment, Assessing Regression Models (TB2)

UNIT IV

Ensemble effect (TB1)

Model ensembles – motivation, wisdom of crowds, Bagging, Boosting, Random forests, stochastic gradient boosting, heterogeneous ensembles. (TB2)

UNIT V

Case studies: Survey analysis (TB2), question answering– challenges in text mining, persuasion by the numbers(TB1)

Text Books:

1. Eric Siegel, Predictive analytics- the power to predict who will Click, buy, lie, or die, John Wiley & Sons, 2013.
2. Dean Abbott, Applied Predictive Analytics - Principles and Techniques for the Professional Data Analyst, 2014.

References:

1.Trevor Hastie, Robert Tibshirani, Jerome Friedman , The Elements of Statistical Learning-Data Mining, Inference, and Prediction ,Second Edition , Springer Verlag,2009.
2. G.James,D.Witten,T.Hastie,R.Tibshirani-An introduction to statistical learning with applications in R,Springer,2013
3 E.Alpaydin, Introduction to Machine Learning, Prentice Hall Of India,2010

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DIGITAL FORENSICS
(Program Elective – V)

Objectives

1. Know the history and evaluation of digital forensics
2. Describe various types of cyber crime
3. Understand benefits of forensics
4. Implement forensics readiness plan

Outcomes

1. Interpret and appropriately apply the laws and procedures associated with identifying, acquiring, examining and presenting digital evidence.
2. Create a method for gathering, assessing and applying new and existing legislation and industry trends specific to the practice of digital forensics

UNIT - I

Computer Forensics Fundamentals

Introduction to Computer Forensics, Use of Computer Forensics in Law Enforcement, Computer Forensics Assistance to Human Resources/Employment Proceedings, Computer Forensics Services, Benefits of Professional Forensics Methodology, Steps taken by Computer Forensics Specialists Types of Computer Forensics Technology: Types of Military Computer Forensic Technology, Types of Law Enforcement — Computer Forensic Technology — Types of Business Computer Forensic Technology Computer Forensics Evidence and Capture: Data Recovery Defined — Data Back-up and Recovery — The Role of Back-up in Data Recovery — The Data-Recovery Solution.

UNIT - II

Evidence Collection and Data Seizure

Why Collect Evidence? Collection Options — Obstacles — Types of Evidence — The Rules of Evidence — Volatile Evidence — General Procedure — Collection and Archiving — Methods of Collection — Artifacts — Collection Steps — Controlling Contamination: The Chain of Custody Duplication and Preservation of Digital Evidence: Preserving the Digital Crime Scene — Computer Evidence Processing Steps — Legal Aspects of Collecting and Preserving Computer Forensic Evidence Computer Image Verification and Authentication: Special Needs of Evidential Authentication — Practical Consideration —Practical Implementation.

UNIT - III

Computer Forensics analysis and validation

Determining what data to collect and analyze, validating forensic data, addressing data-hiding techniques, performing remote acquisitions

Network Forensics

Network forensics overview, performing live acquisitions, developing standard procedures for network forensics, using network tools, examining the honeynet project.

Processing Crime and Incident Scenes

Identifying digital evidence, collecting evidence in private-sector incident scenes, processing law enforcement crime scenes, preparing for a search, securing a computer incident or crime **scene**, seizing digital evidence at the scene, storing digital evidence, obtaining a digital hash, reviewing a case

UNIT - IV

Current Computer Forensic tools

Evaluating computer forensic tool needs, computer forensics software tools, computer forensics hardware tools, validating and testing forensics software E-Mail Investigations: Exploring the role of e-mail in investigation, exploring the roles of the client and server in e-mail, investigating e-mail crimes and violations, understanding e-mail servers, using specialized e-mail forensic tools.

Cell phone and mobile device forensics

Understanding mobile device forensics, understanding acquisition procedures for cell phones and mobile devices.

UNIT - V

Working with Windows and DOS Systems

Understanding file systems, exploring Microsoft File Structures, Examining NTFS disks, Understanding whole disk encryption, windows registry, Microsoft startup tasks, MS-DOS startup tasks, virtual machines.

Textbooks:

1. Computer Forensics, Computer Crime Investigation by John R. Vacca, Firewall Media, New Delhi.
2. Computer Forensics and Investigations by Nelson, Phillips Enfinger, Steuart, CENGAGE Learning

References:

1. Real Digital Forensics by Keith J. Jones, Richard Bejtiich, Curtis W. Rose, Addison-Wesley Pearson Education
2. Forensic Compiling, A Tractitioneris Guide by Tony Sammes and Brian Jenkinson, Springer International edition.
3. Computer Evidence Collection & Presentation by Christopher L.T. Brown, Firewall Media.
4. Homeland Security, Techniques & Technologies by Jesus Mena, Firewall Media.
5. Software Forensics Collecting Evidence from the Scene of a Digital Crime by Robert M. Slade, TMH 2005
6. Windows Forensics by Chad Steel, Wiley India Edition

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DATA VISUALIZATION
(Program Elective – V)

Prerequisite: exposure to programming

Course Objectives:

- To expose to visual representation methods and techniques that increase the understanding of complex data.
- Study good design practices for visualization, tools for visualization of data from a variety of fields

Course Outcomes:

1. Articulate research-based reasons for pursuing better data visualization
2. List several options for displaying a single number and describe when each option is most suitable
3. Perform decluttering and prepare best visualizations.
4. Identify the limited options for visualizing regression and deal with correlation and regression.
5. Create visualizations depicting trends

Unit I

Foundation of data visualization – Need of visualization, choosing the chart type. (TB1)
Introduction – understand the context, exploratory vs explanatory analysis, Communication mechanism, consulting for context, Storyboarding. (TB2)
Choosing an effective visual – simple text, tables, heat map, graphs - points, lines, slopes, bars, area, other specific graph types – pie, donut, 3D. (TB2)

Unit II

Visualizing a single number, measures of variability (TB1), Visualizing comparisons (TB1)
Displaying relative performances (TB1)

Unit III

Clutter elimination - Cognitive Load, Gestalt Principles of Visual Perception, Lack of visual order, decluttering .(TB2)
Preattentive attributes – sight and memory , preattentive attributes of numbers, text, graphs, size, color, position.(TB2)

Unit IV

Designer perspective - affordances, accessibility and aesthetics (TB2), Communicating correlation and regression (TB1), Visualizing qualitative data (TB1)

Unit V

Depicting trends (TB1)
CASE STUDIES: Color considerations with a dark background, Leveraging animation in the visuals you present, Logic in order, Strategies for avoiding the spaghetti graph, Alternatives to Pies.(TB2)

Text books:

1. Stephanie D. H. Evergreen , Effective Data Visualization The Right Chart for the Right Data , SAGE publications,2017.
2. Cole Nussbaumer Knaflic ,Storytelling with data- a data visualization guide for business professionals, Wiley publications, 2015.

References:

1. Alberto Cairo, “The Functional Art: An Introduction to Information Graphics and Visualization”, New Riders, 2012
2. Nathan Yau, “Visualize This: The FlowingData Guide to Design, Visualization and Statistics”, John Wiley & Sons, 2011
3. Tamara Munzner, “Visualization Analysis and Design”, A K Peters Visualization Series, CRC Press, 2014.
4. Scott Murray,” Interactive Data Visualization for the Web”, O’Reilly, 2013.

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DATA ANALYTICS
(Open Elective)

Objectives

1. To explore the fundamental concepts of data analytics.
2. To learn the principles and methods of statistical analysis
3. Discover interesting patterns, analyze supervised and unsupervised models and estimate the accuracy of the algorithms.
4. To understand the various search methods and visualization techniques.

Outcomes

1. Understand the impact of data analytics for business decisions and strategy
2. Carry out data analysis/statistical analysis
3. To carry out standard data visualization and formal inference procedures
4. Design Data Architecture
5. Understand various Data Sources

UNIT - I

Data Management

Design Data Architecture and manage the data for analysis, understand various sources of Data like Sensors/Signals/GPS etc. Data Management, Data Quality(noise, outliers, missing values, duplicate data) and Data Processing & Processing.

UNIT - II

Data Analytics

Introduction to Analytics, Introduction to Tools and Environment, Application of Modeling in Business, Databases & Types of Data and variables, Data Modeling Techniques, Missing Imputations etc. Need for Business Modeling.

UNIT - III

Regression

Concepts, Blue property assumptions, Least Square Estimation, Variable Rationalization, and Model Building etc.

Logistic Regression: Model Theory, Model fit Statistics, Model Construction, Analytics applications to various Business Domains etc.

UNIT - IV

Object Segmentation

Regression Vs Segmentation – Supervised and Unsupervised Learning, Tree Building – Regression, Classification, Overfitting, Pruning and Complexity, Multiple Decision Trees etc. Time Series Methods: Arima, Measures of Forecast Accuracy, STL approach, Extract features from generated model as Height, Average Energy etc and Analyze for prediction

UNIT - V

Data Visualization

Pixel-Oriented Visualization Techniques, Geometric Projection Visualization Techniques, Icon-Based Visualization Techniques, Hierarchical Visualization Techniques, Visualizing Complex Data and Relations.

Textbooks:

1. Student's Handbook for Associate Analytics – II, III.
2. Data Mining Concepts and Techniques, Han, Kamber, 3rd Edition, Morgan Kaufmann Publishers.

References:

1. Introduction to Data Mining, Tan, Steinbach and Kumar, Addision Wisley, 2006.
2. Data Mining Analysis and Concepts, M. Zaki and W. Meira
3. Mining of Massive Datasets, Jure Leskovec Stanford Univ. Anand RajaramanMilliway Labs Jeffrey D Ullman Stanford Univ.

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DATA VISUALIZATION
(Open Elective)

Unit I

Value of Visualization – What is Visualization and Why do it: External representation – Interactivity – Difficulty in Validation.
Data Abstraction: Dataset types – Attribute types – Semantics.
Task Abstraction – Analyze, Produce, Search, Query.

Four levels of validation –
Validation approaches – Validation examples. Marks and Channels

Unit II

Rules of thumb – Arrange tables: Categorical regions – Spatial axis orientation – Spatial layout density. Arrange spatial data: Geometry – Scalar fields – Vector fields – Tensor fields.

Unit III

Arrange networks and trees: Connections, Matrix views –Containment. Map color: Color theory, Color maps and other channels.

Unit IV

Manipulate view: Change view over time – Select elements –Changing viewpoint – Reducing attributes. Facet into multiple views: Juxtapose and Coordinate views –

Unit V

Partition into views –
Static and Dynamic layers – Reduce items and attributes: Filter – Aggregate. Focus and context: Elide – Superimpose - Distort – Case studies

Text books:

1. Tamara Munzner, “Visualization Analysis and Design”, A K Peters Visualization Series, CRC Press, 2014.
2. Scott Murray,” Interactive Data Visualization for the Web”, O’Reilly, 2013.

References:

1. Alberto Cairo, “The Functional Art: An Introduction to Information Graphics and Visualization”, New Riders, 2012
2. Nathan Yau, “Visualize This: The FlowingData Guide to Design, Visualization and Statistics”, John Wiley & Sons, 2011

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MACHINE LEARNING
(Open Elective)

Prerequisites
1. Data Structures
2. Knowledge on statistical methods

Objectives
1. This course explains machine learning techniques such as decision tree learning, Bayesian learning etc.
2. To understand computational learning theory.
3. To study the pattern comparison techniques.

Outcomes
1. Understand the concepts of computational intelligence like machine learning
2. Ability to get the skill to apply machine learning techniques to address the real time problems in different areas
3. Understand the Neural Networks and its usage in machine learning application.

UNIT - I
Introduction - Well-posed learning problems, designing a learning system Perspectives and issues in machine learning
Concept learning and the general to specific ordering – Introduction, A concept learning task, concept learning as search, Find-S: Finding a Maximally Specific Hypothesis, Version Spaces and the Candidate Elimination algorithm, Remarks on Version Spaces and Candidate Elimination, Inductive Bias.
Decision Tree Learning – Introduction, Decision Tree Representation, Appropriate Problems for Decision Tree Learning, The Basic Decision Tree Learning Algorithm Hypothesis Space Search in Decision Tree Learning, Inductive Bias in Decision Tree Learning, Issues in Decision Tree Learning.

UNIT - II
Artificial Neural Networks Introduction, Neural Network Representation, Appropriate Problems for Neural Network Learning, Perceptions, Multilayer Networks and the Back propagation Algorithm.

Discussion on the Back Propagation Algorithm, An illustrative Example: Face Recognition Evaluation Hypotheses – Motivation, Estimation Hypothesis Accuracy, Basics of Sampling Theory, A General Approach for Deriving Confidence Intervals, Difference in Error of Two Hypotheses, Comparing Learning Algorithms.

UNIT - III
Bayesian learning - Introduction, Bayes Theorem, Bayes Theorem and Concept Learning Maximum Likelihood and Least Squared Error Hypotheses, Maximum Likelihood Hypotheses for Predicting Probabilities, Minimum Description Length Principle , Bayes Optimal Classifier, Gibs Algorithm, Naïve Bayes Classifier, An Example: Learning to Classify Text, Bayesian Belief Networks, EM Algorithm.
Computational Learning Theory – Introduction, Probably Learning an Approximately Correct Hypothesis, Sample Complexity for Finite Hypothesis Space, Sample Complexity for Infinite Hypothesis Spaces, The Mistake Bound Model of Learning.
Instance-Based Learning – Introduction, k-Nearest Neighbor Learning, Locally Weighted Regression, Radial Basis Functions, Case-Based Reasoning, Remarks on Lazy and Eager Learning.

UNIT - IV

Pattern Comparison Techniques, Temporal patterns, Dynamic Time Warping Methods, Clustering, Codebook Generation, Vector Quantization

Pattern Classification: Introduction to HMMS, Training and Testing of Discrete Hidden Markov Models and Continuous Hidden Markov Models, Viterbi Algorithm, Different Case Studies in Speech recognition and Image Processing

UNIT - V

Analytical Learning – Introduction, Learning with Perfect Domain Theories : PROLOG-EBG Remarks on Explanation-Based Learning, Explanation-Based Learning of Search Control Knowledge, Using Prior Knowledge to Alter the Search Objective, Using Prior Knowledge to Augment Search Operations.

Combining Inductive and Analytical Learning – Motivation, Inductive-Analytical Approaches to Learning, Using Prior Knowledge to Initialize the Hypothesis.

Text Books

1. Machine Learning – Tom M.Mitchell,-MGH
2. Fundamentals of Speech Recognition by Lawrence Rabiner and Biing – Hwang Juang.

Reference Books

1. Machine Learning: An Algorithmic Perspective, Stephen Marsland, Taylor & Francis

M.Tech CS III Semester

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ENGLISH FOR RESEARCH PAPER WRITING
(AUDIT COURSE-I)

Course Objectives: To help students:
1. Understand the essentials of writing skills and their level of readability
2. Learn about what to write in each section
3. Ensure qualitative presentation with linguistic accuracy.

Course Outcomes: Students will be able to:
1. Understand writing skills and level of readability
2. Write title, abstract, different sections in research paper
3. Develop the skills needed while writing a research paper

Syllabus

Unit 1 Overview of a Research Paper- Planning and Preparation- Word Order- Useful Phrases - Breaking up Long Sentences-Structuring Paragraphs and Sentences -Being Concise and Removing Redundancy -Avoiding Ambiguity

Unit 2 Essential Components of a Research Paper- Abstracts- Building Hypothesis-Research Problem - Highlight Findings- Hedging and Criticizing, Paraphrasing and Plagiarism, Chapterisation

Unit 3 Introducing Review of the Literature – Methodology - Analysis of the Data-Findings - Discussion- Conclusions-Recommendations.

Unit 4 Key skills needed for writing a Title, Abstract, and Introduction

Unit 5 Appropriate language to formulate Methodology, incorporate Results, put forth Arguments and draw Conclusions

Suggested Reading:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books) Model Curriculum of Engineering & Technology PG Courses [Volume-I]
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook .
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

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M.Tech CS III Semester

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VALUE EDUCATION
(AUDIT COURSE-I)

Course Objectives: To help the students:
1. Understand value of education and self- development
2. Imbibe good values
3. Know about the importance of character

Course outcomes: Students will be able to:
1. Acquire knowledge about self-development
2. Learn the importance of Human values
3. Develop the overall personality

Syllabus

Unit1 Values and Self-development – Social Values and Individual Attitudes. Work Ethics, Indian Vision of Humanism. Ethical Standards and Principles. Value Judgments

Unit2 Importance of Cultivating Values. Sense of Duty. Devotion, Self-reliance, Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. National Unity. Patriotism. Love for Nature, Discipline

Unit 3 Personality and Behavior Development - Soul and Scientific Attitude- Integrity and Discipline. Punctuality- Compassion and Benevolence - Positive Thinking- Composure and Equipoise- Dignity of Labour.

Unit4 Universal Brotherhood and Religious Tolerance. True Friendship. Happiness Vs Suffering- Aware of Self-destructive Habits. Association and Cooperation. Eco-friendly Consciousness

Unit5 Character and Competence – Values of Scriptures- Self-management and Good health. Science of Reincarnation. Equality, Nonviolence, Humility, Role of Women- Secular Thinking- Mind your Mind, Self-control- Non Ethnocentric Behavior

Suggested Readings

1. Chakroborty, S.K. "*Values and Ethics for organizations Theory and practice*", Oxford University Press, New Delhi. 1998.
2. Dostoyevsky, Fyodor, Constance Garnett, and Ernest J. Simmons. *Crime and Punishment*. New York: Modern Library, 1950. Print.
3. Galsworthy, John. *Justice***.** Czechia, Good Press, 2019.
4. TED Talks

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