CSM – 19

• To understand the methods of statistical inference, and the role that sampling distributions play in those methods.
• To be able to perform correct and meaningful statistical analyses of simple to moderate complexity.

References

1. John Vince, Foundation Mathematics for Computer Science, Springer.
2. K. Trivedi.Probability and Statistics with Reliability, Queuing, and Computer Science Applications. Wiley.
3. M. Mitzenmacher and E. Upfal.Probability and Computing: Randomized Algorithms and Probabilistic Analysis.
4. Alan Tucker, Applied Combinatorics, Wiley

Course Code	CSM102
Course Name	Advanced Data Structures
Credits	4
Pre-Requisites	UG level course in Data Structures

Total Number of Lectures:48

COURSE OBJECTIVE
• The student should be able to choose appropriate data structures, understand the ADT/libraries, and use it to design algorithms for a specific problem.
• Students should be able to understand the necessary mathematical abstraction to solve problems.
• To familiarize students with advanced paradigms and data structure used to solve algorithmic problems.
• Student should be able to come up with analysis of efficiency and proofs of correctness.

LECTURE WITH BREAKUP	NO. OF LECTURES
Unit 1 **Dictionaries:** Definition, Dictionary Abstract Data Type, Implementation of Dictionaries. **Hashing:** Review of Hashing, Hash Function, Collision Resolution Techniques in Hashing, Separate Chaining, Open Addressing, Linear Probing, Quadratic Probing, Double Hashing, Rehashing, Extendible Hashing.	7
Unit 2 **Skip Lists:** Need for Randomizing Data Structures and Algorithms, Search and Update Operations on Skip Lists, Probabilistic Analysis of Skip Lists, Deterministic Skip Lists	5
Unit 3 **Trees:** Binary Search Trees, AVL Trees, Red Black Trees, 2-3 Trees, B-Trees, Splay Trees	9
Unit 4	12
Text Processing: Sting Operations, Brute-Force Pattern Matching, The Boyer-Moore Algorithm, The Knuth-Morris-Pratt Algorithm, Standard Tries, Compressed Tries, Suffix Tries, The Huffman Coding Algorithm, The Longest Common Subsequence Problem (LCS), Applying Dynamic Programming to the LCS Problem.	
Unit 5 **Computational Geometry:** One Dimensional Range Searching, Two Dimensional Range Searching, Constructing a Priority Search Tree, Searching a Priority Search Tree, Priority Range Trees, Quadtrees, k-D Trees.	10

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Unit 6 Recent Trands in Hashing, Trees, and various computational geometry methods for effeciently solving the new evolving problem	5

COURSE OUTCOMES
After completion of course, students would be able to:
• Understand the implementation of symbol table using hashing techniques.
• Develop and analyze algorithms for red-black trees, B-trees and Splay trees.
• Develop algorithms for text processing applications.
• Identify suitable data structures and develop algorithms for computational geometry problems.

References:

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, 2nd Edition, Pearson, 2004.
2. M T Goodrich, Roberto Tamassia, Algorithm Design, John Wiley, 2002.

ELECTIVE I

Course Code	CSM103A
Course Name	Machine learning
Credits	4
Pre-Requisites	

Total Number of Lectures:48

COURSE OBJECTIVE
• To learn the concept of how to learn patterns and concepts from data without being explicitly programmed in various IOT nodes.
• To design and analyse various machine learning algorithms and techniques with a modern outlook focusing on recent advances.
• Explore supervised and unsupervised learning paradigms of machine learning.
• To explore Deep learning technique and various feature extraction strategies.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: **Supervised Learning (Regression/Classification)** • Basic methods: Distance-based methods, Nearest-Neighbours, Decision Trees, Naive Bayes	10
• Linear models: Linear Regression, Logistic Regression, Generalized Linear Models • Support Vector Machines, Nonlinearity and Kernel Methods • Beyond Binary Classification: Multi-class/Structured Outputs, Ranking	
Unit 2: **Unsupervised Learning** • Clustering: K-means/Kernel K-means • Dimensionality Reduction: PCA and kernel PCA • Matrix Factorization and Matrix Completion • Generative Models (mixture models and latent factor models)	7
Unit 3 Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods (Boosting, Bagging, Random Forests)	6
Unit 4 Sparse Modeling and Estimation, Modeling Sequence/Time-Series Data, Deep Learning and Feature Representation Learning	9
Unit 5 Scalable Machine Learning (Online and Distributed Learning) A selection from some other advanced topics, e.g., Semi-supervised Learning, Active Learning, Reinforcement Learning, Inference in Graphical Models, Introduction to Bayesian Learning and Inference	9
Unit 6: Recent trends in various learning techniques of machine learning and classification methods for IOT applications. Various models for IOT applications.	5

COURSE OUTCOMES
After completion of course, students would be able to:
• Extract features that can be used for a particular machine learning approach in various IOT applications.

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Unit 5: **Routing protocols:** Introduction, MANET protocols **Routing protocols for WSN**: Resource-aware routing, Data-centric, Geographic Routing, Broadcast, Multicast **Opportunistic Routing Analysis**: Analysis of opportunistic routing (Markov Chain) Advanced topics in wireless sensor networks.	10
Unit 6: **ADVANCED TOPICS** Recent development in WSN standards, software applications.	4

COURSE OUTCOMES
After completion of course, students would be able to:
• Describe and explain radio standards and communication protocols for wireless sensor networks.
• Explain the function of the node architecture and use of sensors for various applications.
• Be familiar with architectures, functions and performance of wireless sensor networks systems and platforms.

References:

1. W. Dargie and C. Poellabauer, "Fundamentals of Wireless Sensor Networks –Theory and Practice", Wiley 2010
2. KazemSohraby, Daniel Minoli and TaiebZnati, "wireless sensor networks -Technology, Protocols, and Applications", Wiley Interscience 2007
3. Takahiro Hara,Vladimir I. Zadorozhny, and Erik Buchmann, "Wireless Sensor Network Technologies for the Information Explosion Era", springer 2010

Course Code	CSM103C
Course Name	Introduction to Intelligent Systems
Credits	4
Pre-Requisites	Data Structures and Data Management or Data Structures

Total Number of Lectures: 48

COURSE OBJECTIVE
• The aim of the course is to introduce to the field of Artificial Intelligence (AI) with emphasis on its use to solve real world problems for which solutions are difficult to express using the traditional algorithmic approach. It explores the essential theory behind methodologies for developing systems that demonstrate intelligent behaviour including dealing with uncertainty,

learning from experience and following problem solving strategies found in nature.	
LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Biological foundations to intelligent systems I: Artificial neural networks, Back-propagation networks, Radial basis function networks, and recurrent networks.	9
Unit 2: Biological foundations to intelligent systems II: Fuzzy logic, knowledge Representation and inference mechanism, genetic algorithm, and fuzzy neural networks.	6
Unit 3: Search Methods Basic concepts of graph and tree search. Three simple search methods: breadth-first search, depth-first search, iterative deepening search. Heuristic search methods: best-first search, admissible evaluation functions, hill-climbing search. Optimisation and search such as stochastic annealing and genetic algorithm.	7
Unit 4: Knowledge representation and logical inference Issues in knowledge representation. Structured representation, such as frames, and scripts, semantic networks and conceptual graphs. Formal logic and logical inference. Knowledge-based systems structures, its basic components. Ideas of Blackboard architectures.	9
Unit 5: Reasoning under uncertainty and Learning Techniques on uncertainty reasoning such as Bayesian reasoning, Certainty factors and Dempster-Shafer Theory of Evidential reasoning, A study of different learning and evolutionary algorithms, such as statistical learning and induction learning.	7
Unit 6: Recent trends in Fuzzy logic, Knowledge Representation	5

COURSE OUTCOMES
After completion of course, students would be:
• Able to Demonstrate knowledge of the fundamental principles of intelligent systems and would be able to analyse and compare the relative merits of a variety of AI problem solving techniques.

References:

1. Luger G.F. and Stubblefield W.A. (2008). Artificial Intelligence: Structures and strategies for Complex Problem Solving. Addison Wesley, 6th edition.
2. Russell S. and Norvig P. (2009). Artificial Intelligence: A Modern Approach. Prentice-Hall, 3rd edition.

Course Code	CSM103D
Course Name	Human and Computer Interection
Credits	4
Pre-Requisites	

Total Number of Lectures: 48

COURSE OBJECTIVE

- Learn the foundations of Human Computer Interaction
- Be familiar with the design technologies for individuals and persons with disabilities
- Be aware of mobile Human Computer interaction.

- Learn the guidelines for user interface.

LECTURE WITH BREAKUP	NO. OF LECTURES
Unit 1: Human: I/O channels – Memory – Reasoning and problem solving; The computer: Devices – Memory – processing and networks; Interaction: Models – frameworks – Ergonomics – styles – elements – interactivity- Paradigms.	9
Unit 2: Interactive Design basics – process – scenarios – navigation – screen design – Iteration and prototyping. HCI in software process – software life cycle – usability engineering – Prototyping in practice – design rationale. Design rules – principles, standards, guidelines, rules. Evaluation Techniques – Universal Design.	12
Unit 3: Cognitive models –Socio-Organizational issues and stake holder requirements –Communication and collaboration models-Hypertext, Multimedia and WWW.	8
Unit 4: Mobile Ecosystem: Platforms, Application frameworks- Types of Mobile Applications: Widgets, Applications, Games- Mobile Information Architecture, Mobile 2.0, Mobile Design: Elements of Mobile Design, Tools.	8
Unit 5: Designing Web Interfaces – Drag & Drop, Direct Selection, Contextual Tools, Overlays, Inlays and Virtual Pages, Process Flow. Case Studies.	8
Unit 6: Recent Trends: Speech Recognition and Translation, Multimodal System	3

COURSE OUTCOMES
After completion of course, students would be:
• Understand the structure of models and theries of human computer interaction and vision.\ • Design an interactive web interface on the basis of models studied.

References:

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, "Human Computer Interaction", 3rd Edition, Pearson Education, 2004 (UNIT I , II & III)
2. Brian Fling, "Mobile Design and Development", First Edition , O®Reilly Media Inc., 2009 (UNIT – IV)
3. Bill Scott and Theresa Neil, "Designing Web Interfaces", First Edition, O®Reilly, 2009.(UNIT-V)

Course Code	CSM 103E
Course Name	Image Processing
Credits	4

Pre-Requisites	Mathematics

LECTURE WITH BREAKUP	NO. OF LECTURES
UNIT 1: DIGITAL IMAGE FUNDAMENTALS Introduction – Digital Image Representation – Fundamental steps in Digital Image Processing – Components; Elements of Visual Perception – Light and Electromagnetic Spectrum – Image Acquisition – Image Sampling and Quantization – Relationships between pixels.	8
UNIT 2: IMAGE ENHANCEMENT Spatial Domain: Gray level transformations – Histogram processing – Basics of Spatial Filtering–Smoothing and Sharpening Spatial Filtering Frequency Domain: Introduction to Fourier Transform – Properties of The Two Dimensional Fourier Transform, Discrete Fourier Transform, Discrete Cosine & Sine Transform. Enhancement in the frequency domain - Low pass filtering, High pass filtering.	10
UNIT 3: IMAGE RESTORATION Degradation Model, Discrete Formulation, Algebraic Approach to Restoration - Unconstrained & Constrained; Constrained Least Square Filtering – Geometric Transformation – Spatial Transformation, Gray Level Interpolation.	8
UNIT 4: IMAGE SEGMENTATION AND REPRESENTATION Point Detection, Line Detection, Edge detection, Combined detection, Edge Linking & Boundary Detection – Local Processing, Global Processing via The Hough Transform; Thresholding - Foundation, Simple Global Thresholding, Optimal Thresholding Segmentation – Detection of Discontinuities – Edge Linking and Boundary detection – Region based segmentation;	8
UNIT 5: IMAGE MORPHOLOGY Preliminaries, dilation, erosion, open and closing, hit or miss transformation, basic morphologic algorithms.	6

BOOKS:

1. Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing", Pearson Education, Third Edition, 2010.
2. W.K.Pratt, Digital Image Processing ,3/e Edn., John Wiley & sons, Inc. 2006.
3. Bhabatosh Chanda, Dwejesh Dutta Majumder, "Digital Image Processing and analysis", PHI Learning Pvt. Ltd., Second Edition, 2011.

REFERENCES:

1. Fundamentals of Digital Image Processing, Jain, PHI
2. Image Processing, Analysis & Machine Vision, Sonka, VIKAS

ELECTIVE II

Course Code	CSM104A
Course Name	Information Theory and Coding
Credits	4
Pre-Requisites	Probability Theory, Computer Networks

Total Number of Lectures: 48

COURSE OBJECTIVE
• The objective of this course is to provide an insight to information coding techniques, error correction mechanism. Various compression techniques for text, video and image are covered for thorough knowledge of efficient information conveying systems.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Information and entropy information measures, Shannon's concept of Information. Channel coding, channel mutual information capacity (BW),	8
Unit 2: Theorem for discrete memory less channel, information capacity theorem, Error detecting and error correcting codes,	9
Unit 3: Types of codes: block codes, Hamming and Lee metrics, description of linear block codes, parity check Codes, cyclic code, Masking techniques,	8
Unit 4: Compression: loss less and lossy, Huffman codes, LZW algorithm, Binary Image compression schemes, run length encoding, CCITT group 3 1-DCompression, CCITT group 3 2D compression, CCITT group 4 2DCompression.	10
Unit 5: Convolutional codes, sequential decoding. Video image Compression: CITT H 261 Video coding algorithm, audio (speech) Compression. Cryptography and cipher.	9
Unit 6: Case study of CCITT group 3 1-DCompression, CCITT group 3 2D compression.	4

COURSE OUTCOMES
After completion of course, students would be:
• The aim of this course is to introduce the principles and applications of information theory.
• The course will study how information is measured in terms of probability and entropy.
• The students learn coding schemes, including error correcting codes, The Fourier perspective; and extensions to wavelets, complexity, compression, and efficient coding of audio-visual information.

References:

1. Fundamentals in information theory and coding, Monica Borda,Springer.
2. Communication Systems: Analog and digital, Singh and Sapre, TataMcGraw Hill.
3. Multimedia Communications Fred Halsall.
4. Information Theory, Coding and Cryptography R Bose.
5. Multimedia system Design Prabhat K Andleigh and Kiran Thakrar.

Course Code	CSM104B
Course Name	Data Preparation and Analysis
Credits	4
Pre-Requisites	

Total Number of Lectures: 48

COURSE OBJECTIVE	
• To prepare the data for analysis and develop meaningful Data Visualizations	
LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit1: **Data Gathering and Preparation:** Data formats, parsing and transformation, Scalability and real-time issues	9
Unit2: **Data Cleaning:** Consistency checking, Heterogeneous and missing data, Data Transformation and segmentation	11
Unit3: **Exploratory Analysis:** Descriptive and comparative statistics, Clustering and association, Hypothesis generation	13
Unit4: **Visualization:** Designing visualizations, Time series, Geolocated data, Correlations and connections, Hierarchies and networks, interactivity	15

COURSE OUTCOMES
After completion of course, students would be:
• Able to extract the data for performing the Analysis.

References:

1. Making sense of Data : A practical Guide to Exploratory Data Analysis and Data Mining, by Glenn J. Myatt

Course Code	CSM104C
Course Name	Cloud Computing
Credits	4
Pre-Requisites	

Total Number of Lectures: 48

COURSE OBJECTIVE
• The student will also learn how to apply trust-based security model to real-world security problems.
• An overview of the concepts, processes, and best practices needed to successfully secure information within Cloud infrastructures.
• Students will learn the basic Cloud types and delivery models and develop an understanding of the risk and compliance responsibilities and Challenges for each Cloud type and service delivery model.

LECTURE WITH BREAKUP	NO. OF LECTURES
Unit 1: **Introduction to Cloud Computing** Online Social Networks and Applications, Cloud introduction and overview, Different clouds, Risks, Novel applications of cloud computing	4
Unit 2: **Cloud Computing Architecture** Requirements, Introduction Cloud computing architecture, On Demand Computing Virtualization at the infrastructure level, Security in Cloud computing environments, CPU Virtualization, A discussion on Hypervisors Storage Virtualization Cloud Computing Defined, The SPI Framework for Cloud Computing, The Traditional Software Model, The Cloud Services Delivery Model **Cloud Deployment Models** Key Drivers to Adopting the Cloud, The Impact of Cloud Computing on Users, Governance in the Cloud, Barriers to Cloud Computing Adoption in the Enterprise	11
Unit 3: **Security Issues in Cloud Computing** Infrastructure Security, Infrastructure Security: The Network Level, The Host Level, The Application Level, Data Security and Storage, Aspects of Data Security, Data Security Mitigation Provider Data and Its Security **Identity and Access Management** Trust Boundaries and IAM, IAM Challenges, Relevant IAM Standards and Protocols for Cloud Services, IAM Practices in the Cloud, Cloud Authorization Management	10
Unit 4: **Security Management in the Cloud** Security Management Standards, Security Management in the Cloud, Availability Management: SaaS, PaaS, IaaS **Privacy Issues** Privacy Issues, Data Life Cycle, Key Privacy Concerns in the Cloud, Protecting Privacy, Changes to Privacy Risk Management and Compliance in Relation to Cloud Computing, Legal and Regulatory Implications, U.S. Laws and Regulations, International Laws and Regulations	11
Unit 5: **Audit and Compliance** Internal Policy Compliance, Governance, Risk, and Compliance (GRC), Regulatory/External Compliance, Cloud Security Alliance, Auditing the Cloud for Compliance, Security-as-a-Cloud	8

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Unit 6: **ADVANCED TOPICS** Recent devlopments in hybrid cloud and cloud security.	4

COURSE OUTCOMES
After completion of course, students would be able to:
• Identify security aspects of each cloud model
• Develop a risk-management strategy for moving to the Cloud
• Implement a public cloud instance using a public cloud service provider
• Apply trust-based security model to different layer

References:

1. Cloud Computing Explained: Implementation Handbook for Enterprises, John Rhoton, Publication Date: November 2, 2009
2. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance (Theory in Practice), Tim Mather, ISBN-10: 0596802765,O'Reilly Media, September 2009

Course Code	CSM104D
Course Name	GPU Computing
Credits	4
Pre-Requisites	

Total Number of Lectures: 48

RSE OBJECTIVE	
• To learn parallel programming with Graphics Processing Units (GPUs).	
LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: **Introduction**: History, Graphics Processors, Graphics Processing Units, GPGPUs. Clock speeds, CPU / GPU comparisons, Heterogeneity, Accelerators, Parallel programming, CUDA OpenCL / OpenACC, Hello World Computation Kernels, Launch parameters, Thread hierarchy, Warps / Wavefronts, Thread blocks / Workgroups, Streaming multiprocessors, 1D / 2D / 3D thread mapping, Device properties, Simple Programs	13
Unit 2: **Memory**: Memory hierarchy, DRAM / global, local / shared, private / local, textures, Constant Memory, Pointers, Parameter Passing, Arrays and dynamic Memory, Multi-dimensional Arrays, Memory Allocation, Memory copying across devices, Programs with matrices, Performance evaluation with different Memories	7

Unit 3: **Synchronization**: Memory Consistency, Barriers (local versus global), Atomics, Memory fence. Prefix sum, Reduction. Programs for concurrent Data Structures such as Worklists, Linked-lists. Synchronization across CPU and GPU **Functions**: Device functions, Host functions, Kernels functions, Using libraries (such as Thrust), and developing libraries.	10
Unit 4: **Support**: Debugging GPU Programs. Profiling, Profile tools, Performance aspects **Streams**: Asynchronous processing, tasks, Task-dependence, Overlapped data transfers, Default Stream, Synchronization with streams. Events, Event-based-Synchronization - Overlapping data transfer and kernel execution, pitfalls.	8
Unit 5: **Case Studies**: Image Processing, Graph algorithms, Simulations, Deep Learning	5
Unit 6: **Advanced topics**: Dynamic parallelism, Unified Virtual Memory, Multi-GPU processing, Peer access, Heterogeneous processing	5

COURSE OUTCOMES
After completion of course, students would be:
• Students would learn concepts in parallel programming, implementation of programs on GPUs, debugging and profiling parallel programs.

References:

1. Programming Massively Parallel Processors: A Hands-on Approach; David Kirk, Wen-mei Hwu; Morgan Kaufman; 2010 (ISBN: 978-0123814722)
2. CUDA Programming: A Developer's Guide to Parallel Computing with GPUs; Shane Cook; Morgan Kaufman; 2012 (ISBN: 978-0124159334)

Course Code	CSM104E
Course Name	Pattern Recognition
Credit	4
Pre-requisite	Linear algebra and Statistics

LECTURE WITH BREAKUP	**NO. OF LECTURES**
UNIT -1 **Introduction to pattern recognition** Basic concepts- Definitions, data sets for Pattern Recognition, Structure of a typical pattern recognition system. Different Paradigms of Pattern Recognition. Representations of Patterns and Classes. Metric and non-metric proximity measures	6
UNIT -2 **Probabilistic models** Methods for parameter estimation-Maximum-Likelihood (ML) estimation-Maximum a posteriori (MAP) estimation-Bayesian estimation-Gaussian mixture model (Both unimodal-and multimodal distribution)-Expectation-maximization method.	5
UNIT -3	4

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Features selection Feature vectors - Feature spaces - Different approaches to Feature Selection-Filter, Wrapper and Embedded. Sequential Feature Selection.	
UNIT -4 **Features extraction** Principal Component Analysis (PCA), Kernel PCA, CCA.	3
UNIT -5 Pattern classification using Statistical classifiers - Bayes' and Naïve Bayes classifier - Classification performance measures – Risk and error probabilities. Linear Discriminant Function, Mahalanobis Distance, K-NN Classifier, Fisher's LDA, Single Layer Perceptron, Multi-layer Perceptron, Training set, test set; standardization and normalization	12
UNIT -6 Basics of Clustering; similarity and dissimilarity measures ; clustering criteria. Different distance functions and similarity measures. K-means algorithm, K-medoids, DBSCAN.	8

Text books

1. Pattern Classification, R.O.Duda, P.E.Hart and D.G.Stork, John Wiley, 2001
2. Pattern Recognition and Machine Learning, C.M.Bishop, Springer, 2006

Reference books

1. Peter Flach, Machine Learning. Cambridge University Press, 2012.
2. Pattern Recognition, S.Theodoridis and K.Koutroumbas, 4th Ed., Academic Press, 2009
3. Statistical pattern Recognition; K. Fukunaga; Academic Press, 2000.

Course Code	CSM105
Course Name	Research Methodology and IPR
Credits	4
Pre-Requisites	Numerical Analysis

Teaching Scheme Lectures: 1hrs/week	

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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.

Syllabus Contents:

Unit 1: 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 2: Effective literature studies approaches, analysis

Plagiarism, Research ethics,

Unit 3: 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 4: Nature of Intellectual Property: Patents, Designs, Trade and Copyright. 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 5: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Unit 6: 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.

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Course Code	CSM192
Course Name	**Advanced Data Structures Lab**
Credits	3
Pre-Requisites	

Total Number of Lab:12

COURSE OBJECTIVE
• The student should be able to choose appropriate data structures, understand the ADT/libraries, and use it to design algorithms for a specific problem.
• Students should be able to understand the necessary mathematical abstraction to solve problems.
• To familiarize students with advanced paradigms and data structure used to solve algorithmic problems.
• Student should be able to come up with analysis of efficiency and proofs of correctness.

LABORATORY	NO. OF LABORATORY
• Assignments on the application of array data structure to sort a set of elements using different sorting methods (e.g., bubble sort, insertion sort, selection sort) • Assignments on the application of array data structure to search an element in a set of elements using different searching methods (e.g., linear search, binary search) • Implementation of stack and queue using array and linked list data structures • Assignments on the implementation of binary tree using array and linked list and traversal of the tree • Implementation of hashing where collision resolution is done using open addressing method • Implementation of KMP algorithm for pattern matching • Application of one/ two data structures in real life applications	12

COURSE OUTCOMES
After completion of course, students would be able to:
• Understand the implementation of symbol table using hashing techniques.
• Develop and analyze algorithms for red-black trees, B-trees and Splay trees.
• Develop algorithms for text processing applications.
• Identify suitable data structures and develop algorithms for computational geometry problems.

References:

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, 2nd Edition, Pearson, 2004.
2. M T Goodrich, Roberto Tamassia, Algorithm Design, John Wiley, 2002.

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Course Code	CSM193A
Course Name	Machine learning Lab
Credits	3
Pre-Requisites	

Total Number of Lab:12

COURSE OBJECTIVE
• To learn the concept of how to learn patterns and concepts from data without being explicitly programmed in various IOT nodes.
• To design and analyse various machine learning algorithms and techniques with a modern outlook focusing on recent advances.
• Explore supervised and unsupervised learning paradigms of machine learning.
• To explore Deep learning technique and various feature extraction strategies.

LABORATORY	NO. OF LABORATORY
• Softwares: Matlab/R/Python, Weka • Implementation of Clustering, Classification and Regression Algorithms • Linear and Non Linear Classification using Neural Network • SVM toolboxes: SVMlight, SVMtorch etc • Deep Learning platforms: Tensorflow/Caffe/Theano, implementation of popular architectures related to CNN, RNN, LSTM, Auto-encoder etc • Implementation of Time Series clustering and alignment algorithms	12

COURSE OUTCOMES
After completion of course, students would be able to:
• Extract features that can be used for a particular machine learning approach in various IOT applications.
• To compare and contrast pros and cons of various machine learning techniques and to get an insight of when to apply a particular machine learning approach.
• To mathematically analyse various machine learning approaches and paradigms.

References:

1. R.P. Deng, R Programming for Data Science, (https://leanpub.com/rprogramming)

2. J. Verzani, Using R for Introductory Statistics, Chapman & Hall/CRC .

3. H. Wickham, Advanced R, Chapman & Hall/CRC.

4. P.K. Janert, Data Analysis with Open Source Tools: A Hands-On Guide for Programmers and Data Scientists, O' Reilly Dan Van Boxel, Hands-On Deep Learning with TensorFlow

5. Geron A., Hands-on Machine Learning with Scikit-learn and Tensorflow, O'Reilly

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Course Code	CSM193B
Course Name	**Wireless Sensor Networks Lab**
Credits	3
Pre-Requisites	

Total Number of Lab:12

COURSE OBJECTIVE
• Architect sensor networks for various application setups.
• Devise appropriate data dissemination protocols and model links cost.
• Understanding of the fundamental concepts of wireless sensor networks and have a basic knowledge of the various protocols at various layers.
• Evaluate the performance of sensor networks and identify bottlenecks.

LABORATORY	**NO. OF LABORATORY**
• Network Simulator (NS) • Installation of Network Simulator ns 2 • Familiarization with ns 2 • Learn programming in OTCL • Setup wired and wireless networks using existing protocols in OTCL • Observe the variation in the network performance of wireless ad hoc networks for various routing protocols • Observe the variation in the network performance of vehicular ad hoc networks for various routing protocols • Real time network simulator Qualnet • Building a prototype sensor network: The instructor will make available some sensor hardware and wireless interfaces. Students will be permitted to work individually or form groups of 2-5 members, and propose an application. The group is expected to develop the protocols and software and demonstrates a working prototype network that suits the picked application. Students are required to justify all design decisions made and compile that and all learned lessons in a professionally written project report. • Investigating an open research problem in the context of wireless sensor networks: For this arrangement a students can work alone or with at most one additional classmate. The students are expected to survey the literature, propose a solution and validate the performance. Students are to prepare a well-written paper that describes the problem, details and justifies the solution and discusses the volition results.	12

COURSE OUTCOMES
After completion of course, students would be able to:
• Describe and explain radio standards and communication protocols for wireless sensor networks.
• Explain the function of the node architecture and use of sensors for various applications.
• Be familiar with architectures, functions and performance of wireless sensor networks systems and platforms.

References:

1. W. Dargie and C. Poellabauer, "Fundamentals of Wireless Sensor Networks –Theory and Practice", Wiley 2010

2. KazemSohraby, Daniel Minoli and TaiebZnati, "wireless sensor networks -Technology, Protocols, and Applications", Wiley Interscience 2007

3. Takahiro Hara,Vladimir I. Zadorozhny, and Erik Buchmann, "Wireless Sensor Network Technologies for the Information Explosion Era", springer 2010

Course Code	CSM193C
Course Name	**Introduction to Intelligent Systems Lab**
Credits	3
Pre-Requisites	

Total Number of Lab:12

COURSE OBJECTIVE
• The aim of the course is to introduce to the field of Artificial Intelligence (AI) with emphasis on its use to solve real world problems for which solutions are difficult to express using the traditional algorithmic approach. It explores the essential theory behind methodologies for developing systems that demonstrate intelligent behaviour including dealing with uncertainty, learning from experience and following problem solving strategies found in nature.

LABORATORY	**NO. OF LABORATORY**
In this laboratory students will be familiarized with PROLOG/ LISP language. • Introduction to PROLOG facts & rules with the help of a simple family tree: how the goals are given in PROLOG; some simple queries on the family tree formation of recursive definition; how PROLOG executes the goals; simple assignments • how PROLOG deals with problems with numbers – integers, real; with some examples Introduction to LIST structure: how PROLOG implements LIST; some simple assignments on LIST • some more complex assignments on LIST. Introduction to Accumulator – simple assignments • Introduction to CUT with simple assignments; implementation of sorting algorithms • implementation of graph search algorithms like DFS, BFS; Some application of BFS. DFS • Implementation of some well known puzzles, like 8-queens problem, Towers-of-Hanoi problem, Missionaries & Cannibals problem etc. • Introduction to LISP • Some simple assignments on LISP	12

COURSE OUTCOMES
After completion of course, students would be:
• Able to Demonstrate knowledge of the fundamental principles of intelligent systems and would be able to analyse and compare the relative merits of a variety of AI problem solving techniques.

References:

1. Luger G.F. and Stubblefield W.A. (2008). Artificial Intelligence: Structures and strategies for Complex Problem Solving. Addison Wesley, 6th edition.
2. Russell S. and Norvig P. (2009). Artificial Intelligence: A Modern Approach. Prentice-Hall, 3rd edition.

Course Code	CSM193D
Course Name	**Data Warehouse and Data Mining Lab**
Credits	3
Pre-Requisites	

Total Number of Lab:12

COURSE OBJECTIVE
• The objective of this course is to introduce data warehousing and mining techniques. Application of data mining in web mining, pattern matching and cluster analysis is included to aware students of broad data mining areas.

LABORATORY	NO. OF LABORATORY
Apriori Algorithm. FP-Growth Algorithm. K-means clustering. Linear and non linear Classification using neural network. One Hierarchical clustering algorithm. Bayesian Classification. Decision Tree. Support Vector Machines. Applications of classification for web mining. Case Study on Text Mining or any commercial application.	12

COURSE OUTCOMES
After completion of course, students would be:
• Study of different sequential pattern algorithms
• Study the technique to extract patterns from time series data and it application in realworld.
• Can extend the Graph mining algorithms to Web mining
• Help in identifying the computing framework for Big Data

References:

1. Jiawei Han and M Kamber, Data Mining Concepts and Techniques,, Second Edition, Elsevier Publication, 2011.
2. Vipin Kumar, Introduction to Data Mining - Pang-Ning Tan, Michael Steinbach, Addison Wesley, 2006.
3. G Dong and J Pei, Sequence Data Mining, Springer, 2007.

Course Code	**CSM193E**
Course Name	Image Processing
Credit	3
Pre-requisite	Basic knowledge of mathematics and programming

LABORATORY	**NO. OF Experiments**
UNIT -1 **Introduction to MATLAB and Image** Introduction to MATLAB tools for image processing. Image zooming and shrinking.	2
UNIT -2 **Image Enhancement** Power-law transformation, contrast stretching, image negative. Histogram equalization. Smoothing - Image Averaging, Median Filter. Sharpening. SOBEL, Prewitt and Laplacian. Frequency domain transformation by DFT and DCT. Low and high pass filtering by Discrete Fourier transform.	6
UNIT -3 **Image Segmentation** Image thresholding by global and optimal. Edge and Line detection by Hough transformation.	2
UNIT -4 **Morphology** Image erosion and dilation. Image opening and closing.	2

Text books.

1. Digital Image Processing, Gonzalves,Pearson
2. Digital Image Processing, Jahne, Springer India

Reference books.

1.Digital Image Processing & Analysis,Chanda & Majumder,PHI
2.Fundamentals of Digital Image Processing, Jain, PHI
3.Image Processing, Analysis & Machine Vision, Sonka, VIKAS

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Semester II

Program Core

Course Code	CSM201
Course Name	Advanced Algorithms
Credits	4
Pre-Requisites	UG level course in Algorithm Design and Analysis

Total Number of Lectures:48

COURSE OBJECTIVE
• Introduce students to the advanced methods of designing and analyzing algorithms.
• The student should be able to choose appropriate algorithms and use it for a specific problem.
• To familiarize students with basic paradigms and data structures used to solve advanced algorithmic problems.
• Students should be able to understand different classes of problems concerning their computation difficulties.
• To introduce the students to recent developments in the area of algorithmic design.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit1 **Sorting:** Review of various sorting algorithms, topological sorting **Graph:** Definitions and Elementary Algorithms: Shortest path by BFS, shortest path in edge-weighted case (Dijkasra's), depth-first search and computation of strongly connected components, emphasis on correctness proof of the algorithm and time/space analysis, example of amortized analysis.	6
Unit 2 **Matroids:** Introduction to greedy paradigm, algorithm to compute a maximum weight maximal independent set. Application to MST. **Graph Matching:** Algorithm to compute maximum matching. Characterization of maximum matching by augmenting paths, Edmond's Blossom algorithm to compute augmenting path.	8
Unit 3 **Flow-Networks:** Maxflow-mincut theorem, Ford-Fulkerson Method to compute maximum flow, Edmond-Karp maximum-flow algorithm. **Matrix Computations:** Strassen's algorithm and introduction to divide and conquer paradigm, inverse of a triangular matrix, relation between the time complexities of basic matrix operations, LUP-decomposition.	9
Unit 4 **Shortest Path in Graphs:** Floyd-Warshall algorithm and introduction to dynamic programming paradigm. More examples of dynamic programming. **Modulo Representation of integers/polynomials:** Chinese Remainder Theorem, Conversion between base-representation and modulo-representation. Extension to polynomials. Application: Interpolation problem. **Discrete Fourier Transform (DFT):** In complex field, DFT in modulo ring. Fast Fourier Transform algorithm. Schonhage-Strassen Integer Multiplication algorithm	10

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Unit 5 **Linear Programming:** Geometry of the feasibility region and Simplex algorithm **NP-completeness:** Examples, proof of NP-hardness and NP-completeness. **One or more of the following topics based on time and interest** Approximation algorithms, Randomized Algorithms, Interior Point Method,	10
Advanced Number Theoretic Algorithm	
Unit 6 Recent Trends in problem solving paradigms using recent searching and sorting techniques by applying recently proposed data structures.	5
COURSE OUTCOMES	
After completion of course, students would be able to:	
• Analyze the complexity/performance of different algorithms.	
• Determine the appropriate data structure for solving a particular set of problems.	
• Categorize the different problems in various classes according to their complexity.	
• Students should have an insight of recent activities in the field of the advanced data structure.	

References:

1. "Introduction to Algorithms" by Cormen, Leiserson, Rivest, Stein.
2. "The Design and Analysis of Computer Algorithms" by Aho, Hopcroft, Ullman.
3. "Algorithm Design" by Kleinberg and Tardos.

Course Code	CSM202
Course Name	Soft Computing
Credits	4
Pre-Requisites	Basic knowledge of mathematics

Total Number of Lectures:48

COURSE OBJECTIVE	
• To introduce soft computing concepts and techniques and foster their abilities in designing appropriate technique for a given scenario.	
• To implement soft computing based solutions for real-world problems.	
• To give students knowledge of non-traditional technologies and fundamentals of artificial neural networks, fuzzy sets, fuzzy logic, genetic algorithms.	
• To provide studentan hand-on experience on MATLAB to implement various strategies.	
LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1 **INTRODUCTION TO SOFT COMPUTING AND NEURAL NETWORKS:** Evolution of Computing: Soft Computing Constituents, From Conventional AI to Computational Intelligence: Machine Learning Basics	7
Unit 2 **FUZZY LOGIC:** Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Relations, Membership Functions: Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert Systems, Fuzzy Decision Making.	8

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Unit 3 **NEURAL NETWORKS:** Machine Learning Using Neural Network, Adaptive Networks, Feed forward Networks, Supervised Learning Neural Networks, Radial Basis Function Networks : Reinforcement Learning, Unsupervised Learning Neural Networks, Adaptive Resonance architectures, Advances in Neural networks	10
Unit 4 **GENETIC ALGORITHMS:** Introduction to Genetic Algorithms (GA), Applications of GA in Machine Learning : Machine Learning Approach to Knowledge Acquisition.	5
Unit 5	13
Matlab/Python Lib: Introduction to Matlab/Python, Arrays and array operations, Functions and Files, Study of neural network toolbox and fuzzy logic toolbox, Simple implementation of Artificial Neural Network and Fuzzy Logic	
Unit 6 Recent Trands in deep learning, various classifiers, neural networks and genetic algorithm. Implementation of recently proposed soft computing techniques.	5
COURSE OUTCOMES	
After completion of course, students would be able to:	
• Identify and describe soft computing techniques and their roles in building intelligent machines	
• Apply fuzzy logic and reasoning to handle uncertainty and solve various engineering problems.	
• Apply genetic algorithms to combinatorial optimization problems.	
• Evaluate and compare solutions by various soft computing approaches for a given problem.	

References:

1. Jyh:Shing Roger Jang, Chuen:Tsai Sun, EijiMizutani, Neuro:Fuzzy and Soft Computing , Prentice:Hall of India, 2003.
2. George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic:Theory and Applications , Prentice Hall, 1995.
3. MATLAB Toolkit Manual

ELECTIVE III

Course Code	CSM203A
Course Name	Advanced Wireless and Mobile Networks
Credits	4
Pre-Requisites	Computer Networks

Total Number of Lectures: 48

COURSE OBJECTIVE
• The students should get familiar with the wireless/mobile market and the future needs and challenges.

• To get familiar with key concepts of wireless networks, standards, technologies and their basic operations
• To learn how to design and analyse various medium access
• To learn how to evaluate MAC and network protocols using network simulation software tools.
• The students should get familiar with the wireless/mobile market and the future needs and challenges.

LECTURE WITH BREAKUP	NO. OF LECTURES
Unit 1: **INTRODUCTION:** Wireless Networking Trends, Key Wireless Physical Layer Concepts, Multiple Access Technologies -CDMA, FDMA, TDMA, Spread Spectrum technologies, Frequency reuse, Radio Propagation and Modelling, Challenges in Mobile Computing: Resource poorness, Bandwidth, energy etc. **WIRELESS LOCAL AREA NETWORKS:** IEEE 802.11 Wireless LANs Physical & MAC layer, 802.11 MAC Modes (DCF & PCF) IEEE 802.11 standards, Architecture & protocols, Infrastructure vs. Adhoc Modes, Hidden Node & Exposed Terminal Problem, Problems, Fading Effects in Indoor and outdoor WLANs, WLAN Deployment issues	11
Unit 2: **WIRELESS CELLULAR NETWORKS:** 1G and 2G, 2.5G, 3G, and 4G, Mobile IPv4, Mobile IPv6, TCP over Wireless Networks, Cellular architecture, Frequency reuse, Channel assignment strategies, Handoff strategies, Interference and system capacity, Improving coverage and capacity in cellular systems, Spread spectrum Technologies.	10
Unit 3: WiMAX (Physical layer, Media access control, Mobility and Networking), IEEE 802.22 Wireless Regional Area Networks, IEEE 802.21 Media Independent Handover Overview **WIRELESS SENSOR NETWORKS** Introduction, Application, Physical, MAC layer and Network Layer, Power Management, Tiny OS Overview.	8
Unit 4: **WIRELESS PANs** Bluetooth AND Zigbee, Introduction to Wireless Sensors,.	4
Unit 5: **SECURITY** Security in wireless Networks Vulnerabilities, Security techniques, Wi-Fi Security, DoS in wireless communication.	10
Unit 6: **ADVANCED TOPICS** IEEE 802.11x and IEEE 802.11i standards, Introduction to Vehicular Adhoc Networks	5

COURSE OUTCOMES
After completion of course, students would be:
• Demonstrate advanced knowledge of networking and wireless networking and understand various types of wireless networks, standards, operations and use cases.

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• Be able to design WLAN, WPAN, WWAN, Cellular based upon underlying propagation and performance analysis.
• Demonstrate knowledge of protocols used in wireless networks and learn simulating wireless networks.
• Design wireless networks exploring trade-offs between wire line and wireless links.
• Develop mobile applications to solve some of the real world problems.

References:

1. Schiller J., Mobile Communications, Addison Wesley 2000
2. Stallings W., Wireless Communications and Networks, Pearson Education 2005
3. Stojmenic Ivan, Handbook of Wireless Networks and Mobile Computing, John Wiley and Sons Inc 2002
4. Yi Bing Lin and Imrich Chlamtac, Wireless and Mobile Network Architectures, John Wiley and Sons Inc 2000
5. Pandya Raj, Mobile and Personal Communications Systems and Services, PHI 200

Course Code	CSM203B
Course Name	Data Science
Credits	4
Pre-Requisites	

Total Number of Lectures:48

COURSE OBJECTIVE
• Provide you with the knowledge and expertise to become a proficient data scientist.
• Demonstrate an understanding of statistics and machine learning concepts that are vital for data science;
• Produce Python code to statistically analyse a dataset;
• Critically evaluate data visualisations based on their design and use for communicating stories from data;

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction to core concepts and technologies: Introduction, Terminology, data science process, data science toolkit, Types of data, Example applications.	6
Unit 2: Data collection and management: Introduction, Sources of data, Data collection and APIs, Exploring and fixing data, Data storage and management, Using multiple data sources	7
Unit 3: Data analysis: Introduction, Terminology and concepts, Introduction to statistics, Central tendencies and distributions, Variance,Distribution properties and arithmetic, Samples/CLT, Basic machine learning algorithms, Linear regression, SVM, Naive Bayes.	10

Unit 4: Data visualisation:Introduction, Types of data visualisation,Data for visualisation:Data types, Data encodings, Retinal variables, Mapping variables to encodings, Visual encodings.	11
Unit 5: Applications of Data Science,Technologies for visualisation, Bokeh (Python)	7
Unit 6: Recent trends in various data collection and analysis techniques, various visualization techniques, application development methods of used in data science.	7

COURSE OUTCOMES
On completion of the course the student should be able to
• Explain how data is collected, managed and stored for data science;
• Understand the key concepts in data science, including their real-world applications and the toolkit used by data scientists;
• Implement data collection and management scripts using MongoDB

References:

1. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline. O'Reilly.
2. Jure Leskovek, Anand Rajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge University Press.

Course Code	CSM203C
Course Name	Digital Forensics
Credits	4
Pre-Requisites	Cybercrime and Information Warfare, Computer Networks

Total Number of Lectures: 48

COURSE OBJECTIVE
• Provides an in-depth study of the rapidly changing and fascinating field of computer forensics.
• Combines both the technical expertise and the knowledge required to investigate, detect and prevent digital crimes.
• Knowledge on digital forensics legislations, digital crime, forensics processes and procedures, data acquisition and validation, e-discovery tools
• E-evidence collection and preservation, investigating operating systems and file systems, network forensics, art of steganography and mobile device forensics

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: **Digital Forensics Science:** Forensics science, computer forensics, and digital forensics. **Computer Crime:** Criminalistics as it relates to the investigative process, analysis of cyber-criminalistics area, holistic approach to cyber-forensics	9

Unit 2: **Cyber Crime Scene Analysis:** Discuss the various court orders etc., methods to search and seizure electronic evidence, retrieved and un-retrieved communications, Discuss the importance of understanding what court documents would be required for a criminal investigation.	8
Unit 3: **Evidence Management & Presentation:** Create and manage shared folders using operating system, importance of the forensic mindset, define the workload of law enforcement, Explain what the normal case would look like, Define who should be notified of a crime, parts of gathering evidence, Define and apply probable cause.	9
Unit 4: **Computer Forensics:** Prepare a case, Begin an investigation, Understand computer forensics workstations and software, Conduct an investigation, Complete a case, Critique a case, **Network Forensics:** open-source security tools for network forensic analysis, requirements for preservation of network data.	10
Unit 5: **Mobile Forensics:** mobile forensics techniques, mobile forensics tools. **Legal Aspects of Digital Forensics:** IT Act 2000, amendment of IT Act 2008.	8
Unit 6: Recent trends in mobile forensic technique and methods to search and seizure electronic evidence	4

COURSE OUTCOMES
After completion of course, students would be able to:
• Understand relevant legislation and codes of ethics
• Computer forensics and digital detective and various processes, policies and procedures
• E-discovery, guidelines and standards, E-evidence, tools and environment.
• Email and web forensics and network forensics

References:

1. John Sammons, The Basics of Digital Forensics, Elsevier

2. John Vacca, Computer Forensics: Computer Crime Scene Investigation, Laxmi Publications

Course Code	CSM203D
Course Name	Distributed Systems
Credits	4
Pre-Requisites	Database Management Systems

Total Number of Lectures: 48

COURSE OBJECTIVE
• To introduce the fundamental concepts and issues of managing large volume of shared data in a parallel and distributed environment, and to provide insight into related research problems.

LECTURE WITH BREAKUP	NO. OF LECTURES
Unit 1: **INTRODUCTION** Distributed data processing; What is a DDBS; Advantages and disadvantages of DDBS; Problem areas; Overview of database and computer network concepts **DISTRIBUTED DATABASE MANAGEMENT SYSTEM ARCHITECTURE** Transparencies in a distributed DBMS; Distributed DBMS architecture; Global directory issues	8
Unit 2: **DISTRIBUTED DATABASE DESIGN** Alternative design strategies; Distributed design issues; Fragmentation; Data allocation **SEMANTICS DATA CONTROL** View management; Data security; Semantic Integrity Control **QUERY PROCESSING ISSUES** Objectives of query processing; Characterization of query processors; Layers of query processing; Query decomposition; Localization of distributed data	11
Unit 3: **DISTRIBUTED QUERY OPTIMIZATION** Factors governing query optimization; Centralized query optimization; Ordering of fragment queries; Distributed query optimization algorithms **TRANSACTION MANAGEMENT** The transaction concept; Goals of transaction management; Characteristics of transactions; Taxonomy of transaction models **CONCURRENCY CONTROL** Concurrency control in centralized database systems; Concurrency control in DDBSs; Distributed concurrency control algorithms; Deadlock management	11
Unit 4: **RELIABILITY** Reliability issues in DDBSs; Types of failures; Reliability techniques; Commit protocols; Recovery protocols	8
Unit 5: **PARALLEL DATABASE SYSTEMS** Parallel architectures; parallel query processing and optimization; load balancing	6
Unit 6:	4
ADVANCED TOPICS Mobile Databases, Distributed Object Management, Multi-databases	

COURSE OUTCOMES
After completion of course, students would be:
• Design trends in distributed systems.
• Apply network virtualization.
• Apply remote method invocation and objects.

References:

1. Principles of Distributed Database Systems, M.T. Ozsu and P. Valduriez, Prentice-Hall, 1991.
2. Distributed Database Systems, D. Bell and J. Grimson, Addison-Wesley, 1992.

ELECTIVE IV

Course Code	CSM204A
Course Name	Security in Computing
Credits	4
Pre-Requisites	Computer Networks, Web Programming

Total Number of Lectures:48

COURSE OBJECTIVE
• To learn the basics of security and various types of security issues.
• To study different cryptography techniques available and various security attacks.
• Explore network security and how they are implemented in real world.
• To get an insight of various issues of Web security and biometric authentication.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Data security: Review of cryptography. Examples RSA, DES, ECC.	6
Unit 2: Authentication, non-repudiation and message integrity. Digital signatures and certificates. Protocols using cryptography (example Kerberos). Attacks on protocols	9
Unit 3 Network security: Firewalls, Proxy-Servers, Network intrusion detection. Transport security: Mechanisms of TLS, SSL, IPSec.	9
Unit 4 Web security – SQL injection, XSS, etc. Software security and buffer overflow. Malware types and case studies.	11
Access Control, firewalls and host/network intrusion detection.	
Unit 5 Other topics: Biometric authentication, Secure E-Commerce (ex. SET), Smart Cards, Security in Wireless Communication.	8
Unit 6: recent trends in IOT security, IDS and Biometric.	5

COURSE OUTCOMES
After completion of course, students would be able to:

• To have an understanding of basics of security and issues related to it.
• Understanding of biometric techniques available and how they are used in today's world.
• Security issues in web and how to tackle them.
• Learn mechanisms for transport and network security

References:

1. W. R. Cheswick and S. M. Bellovin. Firewalls and Internet Security. Addison Wesley, 1994.
2. W. Stallings. Cryptography and Network Security. Prentice Hall, 1999.
3. B. Schneier. Applied Cryptography. Wiley, 1999.

Course Code	CSM204B
Course Name	Data Warehousing and Data Mining
Credits	4
Pre-Requisites	Databases, Probability

Total Number of Lectures: 48

COURSE OBJECTIVE
• The objective of this course is to introduce data warehousing and mining techniques. Application of data mining in web mining, pattern matching and cluster analysis is included to aware students of broad data mining areas.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Introduction to Data Warehousing; Data Mining: Mining frequent patterns, association and correlations; Sequential Pattern Mining concepts, primitives, scalable methods;	7
Unit 2: Classification and prediction; Cluster Analysis – Types of Data in Cluster Analysis, Partitioning methods, Hierarchical Methods; Transactional Patterns and other temporal based frequent patterns,	8
Unit 3: Mining Time series Data, Periodicity Analysis for time related sequence data, Trend analysis, Similarity search in Time-series analysis;	8
Unit 4: Mining Data Streams, Methodologies for stream data processing and stream data systems, Frequent pattern mining in stream data, Sequential Pattern Mining in Data Streams, Classification of dynamic data streams, Class Imbalance Problem; Graph Mining; Social Network Analysis;	11
Unit 5: Web Mining, Mining the web page layout structure, mining web link structure, mining multimedia data on the web, Automatic classification of web documents and web usage mining; Distributed Data Mining.	9
Unit 6: Recent trends in Distributed Warehousing and Data Mining, Class Imbalance Problem; Graph Mining; Social Network Analysis	5

COURSE OUTCOMES
After completion of course, students would be:

• Study of different sequential pattern algorithms
• Study the technique to extract patterns from time series data and it application in real world.
• Can extend the Graph mining algorithms to Web mining
• Help in identifying the computing framework for Big Data

References:

1. Jiawei Han and M Kamber, Data Mining Concepts and Techniques,, Second Edition, Elsevier Publication, 2011.
2. Vipin Kumar, Introduction to Data Mining - Pang-Ning Tan, Michael Steinbach, Addison Wesley, 2006.
3. G Dong and J Pei, Sequence Data Mining, Springer, 2007.

Course Code	CSM204C
Course Name	Quantum Computing
Credits	4
Pre-Requisites	Linear Algebra, Theory of Computation

Total Number of Lectures: 48

COURSE OBJECTIVE
• The course will provide an insight of basic of quantum physics from a computer scientist's perspective, and how it describes reality and understand the philosophical implications of quantum computing

LECTURE WITH BREAKUP	**NO. OF**

	LECTURES
Unit 1: Qubit & Quantum States: The Qubit, Vector Spaces. Linear Combination Of Vectors, Uniqueness of a spanning set, basis & dimensions, inner Products, orthonormality, gram-schmidt orthogonalization, bra-ket formalism, the Cauchy-schwarez and triangle Inequalities.	8
Unit 2: Matrices & Operators: Observables, The Pauli Operators, Outer Products, The Closure Relation, Representation of operators using matrices, outer products & matrix representation, matrix representation of operators in two dimensional spaces, Pauli Matrix, Hermitian unitary and normal operator, Eigen values & Eigen Vectors, Spectral Decomposition, Trace of an operator, important properties of Trace, Expectation Value of Operator, Projection Operator, Positive Operators,	8
Unit 3: Commutator Algebra, Heisenberg uncertainty principle, polar decomposition &singular values, Postulates of Quantum Mechanics.	7
Unit 4: Tensor Products: Representing Composite States in Quantum Mechanics, Computing inner products, Tensor products of column vectors, operators and tensor products of Matrices. Density Operator: Density Operator of Pure & Mix state, Key Properties, Characterizing Mixed State, Practical Trace & Reduce Density Operator, Density Operator & Bloch Vector.	12
Unit 5: Quantum Measurement Theory: Distinguishing Quantum states & Measures, Projective Measurements, Measurement on Composite systems, Generalized Measurements, Positive Operator- Valued Measures.	8
Unit 6: Recent trends in Quantum Computing Research, Quantum Computing Applications of Genetic Programming.	5

COURSE OUTCOMES
After completion of course, students would have:
• knowledge of Vector spaces, Matrices, Quantum state, Density operator and Quantum Measurement theory.

References:

1. Quantum Computing without Magic by Zdzislaw Meglicki
2. Quantum Computing Explained By DAVID Mc MAHON
3. Quantum Computer Science By Marco Lanzagorta, Jeffrey Uhlmann
4. An Introduction to Quantum Computing Phillip Kaye, Raymond Laflamme, Michele Mosca.

Course Code	CSM204D
Course Name	Computer Vision
Credits	4
Pre-Requisites	Linear algebra, vector calculus, Data structures and Programming.

Total Number of Lectures: 48

COURSE OBJECTIVE
• Be familiar with both the theoretical and practical aspects of computing with images.
• Have described the foundation of image formation, measurement, and analysis.
• Understand the geometric relationships between 2D images and the 3D world.
• Grasp the principles of state-of-the-art deep neural networks.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Overview, computer imaging systems, lenses, Image formation and sensing, Image analysis, pre-processing and Binary image analysis	8
Unit 2: Edge detection, Edge detection performance, Hough transform, corner detection	9
Unit 3: Segmentation, Morphological filtering, Fourier transform	9
Unit 4: Feature extraction, shape, histogram, color, spectral, texture, using CVIPtools, Feature analysis, feature vectors, distance /similarity measures, data pre-Processing	9
Unit 5: Pattern Analysis: Clustering: K-Means, K-Medoids, Mixture of Gaussians Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA, and Non-parametric methods.	9
Unit 6: Recent trends inActivity Recognition, computational photography, Biometrics.	4

COURSE OUTCOMES
After completion of course, students would be able to:
• Developed the practical skills necessary to build computer vision applications.
• To have gained exposure to object and scene recognition and categorization from images.

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1. Computer Vision: Algorithms and Applications by Richard Szeliski.
2. Deep Learning, by Goodfellow, Bengio, and Courville.
3. Dictionary of Computer Vision and Image Processing, by Fisher et al.

OPEN ELECTIVE

Lecture: - 3 h/week

Course Code	CSM205A
Course Name	**Business Analytics**

Credits **Prerequisites**	

Total Number of Lectures: 48

Course objective
1. Understand the role of business analytics within an organization. 2. Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization. 3. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making. 4. To become familiar with processes needed to develop, report, and analyze business data. 5. Use decision-making tools/Operations research techniques. 6. Mange business process using analytical and management tools. 7. Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit1: Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.	9

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Unit 2: Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.	8
Unit 3: Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.	9
Unit 4:	
Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.	10
Unit 5: Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.	8
Unit 6: Recent Trends in : Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.	4

COURSE OUTCOMES	
1.	Students will demonstrate knowledge of data analytics.
2.	Students will demonstrate the ability of think critically in making decisions based on data and deep analytics.
3.	Students will demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.
4.	Students will demonstrate the ability to translate data into clear, actionable insights.

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1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

OPEN ELECTIVES

Course Code	CSM205B
Course Name	**Industrial Safety**

Credits **Prerequisites**	

Total Number of Lectures: 48

Teaching scheme Lecture: - 3 h/week

Unit-I: Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

Unit-II: Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

Unit-III: Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and

applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

Unit-IV: Fault tracing: Fault tracing-concept and importance, decision treeconcept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic,automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

Unit-V: Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine

tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

Reference:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

OPEN ELECTIVES

Course Code	CSM205C
Course Name	Optimization Techniques
Credits	4
Pre-Requisites	Linear Algebra and Numerical Methods

Total Number of Lectures: 48

COURSE OBJECTIVE
The objective of this course is to provide insight to the mathematical formulation of real world problems. To optimize these mathematical problems using nature based algorithms. And the solution is useful specially for NP-Hard problems.

LECTURE WITH BREAKUP	**NO. OF LECTURES**
Unit 1: Engineering application of Optimization, Formulation of design problems as mathematical programming problems.	7
Unit 2: General Structure of Optimization Algorithms, Constraints, The Feasible Region.	7
Unit 3: Branches of Mathematical Programming: Optimization using calculus, Graphical Optimization, Linear Programming, Quadratic Programming, Integer Programming, Semi Definite Programming.	11
Unit 4: Optimization Algorithms like Genetic Optimization, Particle Swarm Optimization, Ant Colony Optimization etc.	12
Unit 5: Real life Problems and their mathematical formulation as standard programming problems.	6
Unit 6: Recent trends: Applications of ant colony optimization, genetics and linear and quadratic programming in real world applications.	5

COURSE OUTCOMES

After completion of course, students would be:
• Formulate optimization problems.
• Understand and apply the concept of optimality criteria for various types of optimization problems.
• Solve various constrained and unconstrained problems in Single variable as well as multivariable.
• Apply the methods of optimization in real life situation.

References:

1. Laurence A. Wolsey (1998). Integer programming. Wiley. ISBN 978-0-471-28366-9.
2. Practical Optimization Algorithms and EngineeringApplications Andreas Antoniou.
3. An Introduction to Optimization Edwin K., P. Chong & Stanislaw h. Zak.
4. Dimitris Bertsimas; Robert Weismantel (2005). Optimization over integers. Dynamic Ideas. ISBN 978-0-9759146-2-5.
5. John K. Karlof (2006). Integer programming: theory and practice.CRC Press. ISBN 978-0-8493- 1914-3.
6. H. Paul Williams (2009). Logic and Integer Programming. Springer. ISBN 978-0-387-92279-9.
7. Michael Jünger; Thomas M. Liebling; Denis Naddef; George Nemhauser; William R. Pulleyblank; Gerhard Reinelt; Giovanni Rinaldi; Laurence A. Wolsey, eds. (2009). 50 Years of Integer Programming 1958-2008: From the Early Years to the State-of-the- Art. Springer. ISBN 978-3- 540-68274-5.
8. Der-San Chen; Robert G. Batson; Yu Dang (2010). Applied Integer Programming: Modeling and Solution. John Wiley and Sons. ISBN 978-0-470-37306-4.

Open Elective

Course Code	CSM205D
Course Name	**Cost Management of Engineering Projects**
Credits	
Prerequisites	

Total Number of Lectures: 48

Teaching scheme Lecture: - 3 h/week

Introduction and Overview of the Strategic Cost Management Process

Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

Project: meaning, Different types, why to manage, cost overruns centres, various

stages of project execution: conception to commissioning. Project execution as conglomeration of technical and non- technical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process

Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

References:

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

CSM206	Audit Course I
CSM291	Advanced Algorithms Lab
CSM292	Soft Computing Lab
CSM281	Mini Project with Seminar

Course Code	CSM291
Course Name	Advanced Algorithms Lab
Credits	3
Pre-Requisites	

Total Number of Lab:12

COURSE OBJECTIVE
• Introduce students to the advanced methods of designing and analyzing algorithms.
• The student should be able to choose appropriate algorithms and use it for a specific problem.
• To familiarize students with basic paradigms and data structures used to solve advanced algorithmic problems.
• Students should be able to understand different classes of problems concerning their computation difficulties.
• To introduce the students to recent developments in the area of algorithmic design.

LABORATORY	NO. OF LABORATORY
• Divide and Conquer: Find Maximum and Minimum element from a array of integer using Divide and Conquer approach • Divide and Conquer: Implement Quick Sort using Divide and Conquer approach. Check the running time for different positions of pivot elements. Implement the randomized version of quick sort • Dynamic Programming: Find the minimum number of scalar multiplication needed for chain of Matrices • Implement Single Source shortest Path for a graph (Dijkstra and Bellman Ford Algorithm) • Dynamic Programming: Implement all pair Shortest path for a graph (Floyd-Warshall Algorithm) • Greedy method: implement fractional Knapsack Problem, MST by Prim's algorithm • Greedy method: Implement MST by Kruskal's algorithm by using Union operation on Disjoint data Structures. • Graph Traversal Algorithm: Implement Depth First Search (DFS), application of DFS (do topological sorting, identify strongly connected components) • Implement KMP algorithm for string matching • Implement Ford-Fulkerson algorithm to get maximum flow of a given flow network.	12

COURSE OUTCOMES
After completion of course, students would be able to:
• Analyze the complexity/performance of different algorithms.
• Determine the appropriate data structure for solving a particular set of problems.
• Categorize the different problems in various classes according to their complexity.
• Students should have an insight of recent activities in the field of the advanced data structure.

References:

1. "Introduction to Algorithms" by Cormen, Leiserson, Rivest, Stein.
2. "The Design and Analysis of Computer Algorithms" by Aho, Hopcroft, Ullman.
3. "Algorithm Design" by Kleinberg and Tardos.

Course Code	CSM292
Course Name	**Soft Computing Lab**
Credits	3
Pre-Requisites	

Total Number of Lab:12

COURSE OBJECTIVE
• To understand the mathematical fundamentals that is prerequisites for a variety of courses like Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems, Bioinformatics, Machine learning.
• To develop the understanding of the mathematical and logical basis to many modern techniques in information technology like machine learning, programming language design, and concurrency.
• To study various sampling and classification problems.

LABORATORY	**NO. OF LABORATORY**
• Introduction to Matlab/Python, Arrays and array operations, Functions and Files. Familiarization with a few ML Tools such as Excel, WEKA, R, Python and TensorFlow • Study of neural network toolbox and fuzzy logic toolbox. • Simple implementation of Artificial Neural Network and Fuzzy Logic • Implementation of latest soft computing techniques using one of the above tools. • Regression (single and Multiple Variables) linear and non-liner; • Logistic regression • Classifiers: K-NN, Naïve Bayes Classifier, Perceptron, Multi Layer Perceptron • Clustering Algorithms: K-Means , DB-Scan • Applications of ANN and SVM using ML tools	12

COURSE OUTCOMES
After completion of course, students would be:
• An understanding of fundamental concepts and methods of machine learning and its applications.
• An ability to analyze and evaluate simple algorithms for pattern classification.
• An ability to design simple algorithms for pattern classification, code them with Python programming language and test them with benchmark data sets.
• An understanding of fundamental concepts and methods of machine learning and its applications.

References:

1. Jyh:Shing Roger Jang, Chuen:Tsai Sun, EijiMizutani, Neuro: Fuzzy and Soft Computing , Prentice: Hall of India, 2003.
2. George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications ,

Prentice Hall, 1995.

3. MATLAB Toolkit Manual ISBN 978-0-8493- 1914-3.
4. H. Paul Williams (2009). Logic and Integer Programming. Springer. ISBN 978-0-387-92279-9.
5. Michael Jünger; Thomas M. Liebling; Denis Naddef; George Nemhauser; William R. Pulleyblank; Gerhard Reinelt; Giovanni Rinaldi; Laurence A. Wolsey, eds. (2009). 50 Years of Integer Programming 1958-2008: From the Early Years to the State-of-the- Art. Springer. ISBN 978-3- 540-68274-5.
6. Der-San Chen; Robert G. Batson; Yu Dang (2010). Applied Integer Programming: Modeling and Solution. John Wiley and Sons. ISBN 978-0-470-37306-4.

Semester III

	Subject
CSM301	Audit Course II
CSM391	Project Part-I

Semester IV

	Subject
CSM491	Comprehensive Viva Voce
CSM492	Project Part-II

Audit course I & II

1. English for Research Paper Writing
2. Disaster Management
3. Sanskrit for Technical Knowledge
4. Value Education
5. Constitution of India
6. Pedagogy Studies
7. Stress Management by Yoga
8. Personality Development through Life Enlightenment Skills.

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