Department of Computer Science & Engineering

Curriculum
For
M. TECH
in
Computer Science & Engineering

(Effective from 2021-22 Admission Batch)

Semester-I

Subject Code	Subject Name	L:T:P/Week	Total Credits	Contact Hours/Week
PROGRAM CORE				
CSM101	Mathematical Foundations of Computer	4:0:0	4	4
CSM102	Advanced Data Structures	4:0:0	4	4
ELECTIVE I				
CSM103A	Machine Learning	4:0:0	4	4
CSM103B	Wireless Sensor Networks	4:0:0	4	4
CSM103C	Mobile Device Programming	4:0:0	4	4
CSM103D	Digital Image Processing	4:0:0	4	4
CSM103E	Web & Internet Technologies	4:0:0	4	4
ELECTIVE II				
CSM104A	Information Theory & Coding	4:0:0	4	4
CSM104B	Cloud Computing	4:0:0	4	4
CSM104C	Distributed Systems	4:0:0	4	4
CSM104D	Advanced Computer Architecture	4:0:0	4	4
CSM104E	Pattern Recognition	4:0:0	4	4
COMPULSORY				
CSM105	Research Methodology and IPR	4:0:0	4	4
CSM106	Operations Research	4:0:0	4	4
PRACTICAL:				
CSEM192	Advanced Data Structures Lab	0:0:3	3	3
CSM193A	Machine Learning Lab	0:0:3	3	3
CSM193B	Wireless Sensor Networks Lab	0:0:3	3	3
CSM193C	Mobile Device Programming Lab	0:0:3	3	3
CSM193D	Digital Image Processing Lab	0:0:3	3	3
CSM193E	Web & Internet Technologies Lab	0:0:3	3	3
	TOTAL:	24:0:6	30	30

Semester II:

Subject Code	Subject Name	L:T:P/Week	Total Credits	Contact Hours/Week
PROGRAM CORE				
CSM201	Advanced Algorithms	4:0:0	4	4
CSM202	Soft Computing	4:0:0	4	4
ELECTIVE III				
CSM203A	Neural Networks & Deep Learning	4:0:0	4	4
CSM203B	Cryptography & Network Security	4:0:0	4	4
CSM203C	Smart Sensors and Internet of Things	4:0:0	4	4
CSM203D	Quantum Computing	4:0:0	4	4
ELECTIVE IV				
CSM204A	Data Warehouse and Data Mining	4:0:0	4	4
CSM204B	Big Data Analytics	4:0:0	4	4
CSM204C	Natural Language Processing	4:0:0	4	4
CSM204D	Computer Vision	4:0:0	4	4
OPEN ELECTIVE				
CSM205A	Entrepreneurship	4:0:0	4	4
CSM205B	Cyber Law and Ethics	4:0:0	4	4
CSM205C	Optimization Techniques	4:0:0	4	4
CSM205D	Cost Management of Engineering Projects	4:0:0	4	4
AUDIT COURSE				
CSM206	Audit Course I	2:0:0	0	2
PRACTICAL:				
CSM291	Advanced Algorithms Lab	0:0:3	3	3
CSM292	Soft Computing Lab	0:0:3	3	3
CSM281	Mini Project with Seminar	0:0:3	3	3
	TOTAL:	26:0:9	29	31

Audit Course I

1. English for Research Paper Writing
2. Disaster Management
3. Sanskrit for Technical Knowledge
4. Value Education

Semester III:

Subject Code	Subject Name	L:T:P/Week	Total Credits	Contact Hours/Week
CSM301	Audit Course II	2:0:0	0	2
PRACTICAL:				
CSM391	Project Part-I	0:0:12	6	12
	TOTAL:	**0:0:12**	**6**	**12**

Semester IV:

Subject Code	Subject Name	L:T:P/Week	Total Credits	Contact Hours/Week
PRACTICAL:				
CSM491	Comprehensive Viva Voce	0:0:0	4	0
CSM492	Project Part-II	0:0:12	6	12
	TOTAL:	**0:0:12**	**10**	**12**

Audit Course II

1. Constitution of India
2. Pedagogy Studies
3. Stress Management by Yoga
4. Personality Development through Life Enlightenment Skills.

Semester-I

Subject Code	Subject Name	Credits/Subject Th:T:P	Total Credits	Contact Hours/Week
PROGRAM CORE				
CSM101	Mathematical Foundations of Computer	4:0:0	4	4
CSM102	Advanced Data Structures	4:0:0	4	4
ELECTIVE I				
CSM103A	Machine Learning	4:0:0	4	4
CSM103B	Wireless Sensor Networks	4:0:0	4	4
CSM103C	Mobile Device Programming	4:0:0	4	4
CSM103D	Digital Image Processing	4:0:0	4	4
CSM103E	Web & Internet Technologies	4:0:0	4	4
ELECTIVE II				
CSM104A	Information Theory & Coding	4:0:0	4	4
CSM104B	Cloud Computing	4:0:0	4	4
CSM104C	Distributed Systems	4:0:0	4	4
CSM104D	Advanced Computer Architecture	4:0:0	4	4
CSM104E	Pattern Recognition	4:0:0	4	4
COMPULSORY				
CSM105	Research Methodology and IPR	4:0:0	4	4
CSM106	Operations Research	4:0:0	4	4
PRACTICAL:				
CSEM192	Advanced Data Structures Lab	0:0:3	3	3
CSM193A	Machine Learning Lab	0:0:3	3	3
CSM193B	Wireless Sensor Networks Lab	0:0:3	3	3
CSM193C	Mobile Device Programming Lab	0:0:3	3	3
CSM193D	Digital Image Processing Lab	0:0:3	3	3
CSM193E	Web & Internet Technologies Lab	0:0:3	3	3
	TOTAL:	24:0:6	30	30

Course Name: Mathematical Foundation of Computer Science

Course Code: CSM101

Contact (L:T:P/Week): 4:0:0

Total Contact Hours: 48

Credits: 4

Prerequisites: UG Level Mathematics, Discrete Mathematics

Course Outcomes:

After completion of the course students will be able to

CO1	**Understand** the basic concepts of combinatorics and probability to **Explain or Illustrate** and **Identify** problems where students can **Apply** the concept appropriately to **Solve** them.
CO2	**Understand** and **explain** the fundamental concepts of statistical inference, and sampling distributions and **Identify** the scope of its application where students can **Apply** the appropriate strategy and **Analyze** the results.
CO3	**Understand** and **explain** the fundamental concepts of graph theory and number theory and **identify** the scope of its application where students can **Apply** the appropriate strategy and **analyze** the results.
CO4	**Understand** and **explain** the fundamental concepts of Calculus of Several Variables and algebraic structures and **identify** the scope of its application where students can **Apply** the appropriate strategy and **analyze** the results.
CO5	**Understand** and **Develop** ideas to **Propose** mathematical models to solve the problems and **Analyze** the effectiveness as well as limitations of solutions underscoring its utilitarian importance for further explorations leading towards lifelong learning.

Course Content:

MODULE-1

Combinatorics and counting [4L]: Sum and product rule, Permutation and Combination Principle of Inclusion Exclusion. Pigeon Hole Principle.

MODULE-2

Graph Theory [6L]: Graph Terminologies and their properties: Degree, Connectivity, Path, Cycle, Sub-Graph, Isomorphism, Eulerian and Hamiltonian Walks, Matrix representation of graphs, Graph Colouring and Matching: Colouring Vertices and Chromatic Number, Colouring Edges and Total Colouring, Independence and Chromatic Partitioning, Cliques, Perfect Graphs, Bounds on Chromatic Numbers, Chromatic Polynomials.

MODULE-3

Algebraic Structures [4L]: Group, Ring, Field; Linear Algebra: Systems of Linear Equations and Matrices, Vector Space, Linear Transformations, Eigen values & Eigen Vectors.

MODULE-4

Number Theory [4L]: Primes, Divisibility and the Fundamental Theorem of Arithmetic; Greatest Common Divisor (GCD), Euclidean Algorithm; Congruences, Chinese Remainder Hensel's Lemma, Primitive Roots; Quadratic Residues and Reciprocity; Arithmetic Functions, Diophantine Equations, Continued Fractions.

Calculus of Several Variables [4L]: Differential Calculus of Several Variables, Integral Calculus of Several Variables, Fundamental Theorems of Vector Calculus.

MODLUE- 5

Descriptive Statistics [4L]: Measures of Central Tendency, Measures of Dispersion, Skewness and Kurtosis, Correlation, Linear Regression Analysis, Index Numbers, Time Series Analysis; Basics of Probability: Axiomatic Probability, Conditional Probability, Bayes' Theorem, Random Variables and Mathematical Expectations.

MODULE-6

Distributions [6L]: Continuous Distributions - normal distribution, standard normal distribution, t-distribution, chi-square distribution, F-distribution

Discrete Distributions: Binomial distribution, Poisson distribution

Principles of Sampling, Types of Sampling, Unbiased and Consistent estimators, Point Estimation, Maximum Likelihood Estimation of parameters- Binomial, Poisson and Normal, Interval estimation

MODULE-7

Hypothesis Testing [8L]: Simple & Composite hypothesis, Tests of Significance, Null Hypothesis, Alternative Hypothesis, Types of Errors in Testing Hypothesis, Level of Significance, Critical Region, One-Tailed and Two-Tailed Tests, Different Hypothesis Testing: Population mean, population Variance, ratio of two population variances, difference between two population means, population proportion, difference between two proportions.

Application of Chi-Square Distribution in testing goodness of fit,

MODULE-8 [8L]

Analysis of Variance (ANOVA), One-Way Classification, Two-Way Classification Markov Model, Basic Concept of Markov Model and Hidden Markov Model and related applications; Statistical Decision Analysis: Decision making under Risk, Decision making under Conflict.

Text book:

- John Vince, Foundation Mathematics for Computer Science, Springer.
- Susanna S. Epp, Discrete Mathematics with Applications, 4th edition, Wadsworth Publishing Co. Inc.
- Applied Statistics and Probability for Engineers; Douglas C. Montogomery and George C. Runger; Wiley
- Serge Lang, Calculus of Several Variables, Springer-Verlag New York

Reference Books:

- M. Mitzenmacher and E. Upfal. Probability and Computing: Randomized Algorithms and Probabilistic Analysis
- Alan Tucker, Applied Combinatorics, Wiley
- K. Trivedi. Probability and Statistics with Reliability, Queuing, and Computer Science Applications. Wiley.
- Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons
- Data analysis using statistics and probability with R language; Partha Sarathi Bishnu and Vandana Bhattacherjee; PHI Learning

Course Name: Advanced Data Structures

Course Code: CSM102

Contact (L:T:P/Week): 4:0:0

Total Contact Hours: 48

Credits: 4

Prerequisites: UG level course in Data Structures

Course Outcomes:

After completion of the course students will be able to

CO1	**Understand** the basic concepts of data structures to **Explain or Illustrate** and **Identify** problems where students can **Apply** the concept appropriately to **Solve** them.
CO2	**Understand** and **explain** the fundamental concepts of search trees data structures and **Identify** the scope of its application where students can **Apply** the appropriate strategy and **Analyze** the results.
CO3	**Understand** and **explain** the fundamental concepts of randomized data structures and **identify** the scope of its application where students can **Apply** the appropriate strategy and **analyze** the results.
CO4	**Understand** and **explain** the fundamental concepts of heap, set and dictionary structures and **identify** the scope of its application where students can **Apply** the appropriate strategy and **analyze** the results.
CO5	**Understand** and **Develop** ideas to **Propose** new data structures to solve problems in different fields of applications and **Analyze** the effectiveness as well as limitations of solutions underscoring its utilitarian importance for further explorations leading towards lifelong learning.

Course Content:

MODULE-1 [10L]

Revision of Basic Data Structures: Linked List, Stack, Queue, Trees, Graph

MODULE-2 [15L]

Search Trees: Models of Search Trees, Properties and transformations, height of search tree, basic find, insert and delete, returning from leaf to root, dealing with non-unique keys, queries for keys in an interval, building optimal search trees, converting trees to lists, removing a tree.

Balanced Search Trees: Height balanced and weight balanced trees, B-trees, B+ Tree, Red Black Trees and Trees of almost optimal height, Finger trees and level linking, trees with partial rebuilding, Splay Trees, Joining and Splitting Balanced Search Trees, 2-3 Trees

Tree Search for Set of Intervals: Interval Trees, Trees for union of intervals, trees for sums of weighted intervals, trees for interval-restricted maximum sum queries, orthogonal range trees, higher dimensional segment trees, other systems of building blocks, range counting and semi group model, Quadtree, kd–trees, R-Tree and Quadtree

MODULE-3 [6L]

Skip Data Structures: Need for Randomizing Data Structures and Algorithms, Search and Update Operations on Skip Lists, Probabilistic Analysis of Skip Lists, Deterministic Skip Lists

Skip Trees and Skip Graphs

MODULE-4 [5L]

Heaps: Array based heaps, heap ordered trees and half ordered trees, Leftist Heaps, Skew heaps, Binomial heaps, changing keys in heaps, Fibonacci heaps, heaps of optimal complexity, Double ended heap structures and multidimensional heaps.

MODLUE- 5 [3L]

Union – Find and related structures: Union – Find, Union Find with copies and dynamic segment trees, list splitting, Problems on root directed trees, maintaining a linear order

MODULE-6 [9L]

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.

Miscellaneous: Use of Data Structures in Applications

Text book:

- Peter Brass; Advanced Data Structures, Cambridge University Press
- Suman Saha, S. Shukla; Advanced Data Structures: Theory and application, CRC press
- A.A. Puntambekar; Advanced Data Structures - A Conceptual Approach, Technical Publications

Reference Books:

- Ellis Horowitz and Sartaj Sahni, Fundamentals of Data Structures, Universities Press
- Dinesh P. Mehta, Sartaj Sahni; Handbook of Data Structures and Applications, CRC press
- Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein; Introduction to Algorithms, fourth edition, The MIT Press

Course Name: Machine Learning

Course Code: CSM103A

Contact (L:T:P/Week): 4:0:0

Total Contact Hours: 48

Credits: 4

Prerequisites: Data Structure, Design and Analysis of Algorithms, Statistics, Artificial Intelligence

Course Outcomes:

After completion of the course students will be able to

CO1	**Understand** the basic concepts of machine learning to **Explain or Illustrate** and **Identify** problems where students can **Apply** the concept appropriately to **Solve** them.
CO2	**Understand** the fundamental concepts of regression analysis so that they can **propose models** for predicting values based on exemplary data and **Analyze** their performances.
CO3	**Explain or Illustrate** the fundamental strategies of unsupervised machine learning paradigm to solve clustering problems and **Analyze** their performances.
CO4	**Explain or Illustrate** the concepts of Mining Frequent Patterns, Associations and Data Streams and Apply them to solve the relevant problems and **Analyze** their performances.
CO5	**Develop** ideas to **Propose** solutions to the problems of supervised learning and **Identify** problems where students can **Apply** the advanced concept appropriately and **Analyze** the effectiveness as well as limitations of solutions making the students aware of its utilitarian importance for further explorations leading towards lifelong learning.

Course Content:

MODULE-1: Introduction to Machine Learning [6L]

Basic Concepts, Various types of Machine Learning Techniques and related applications, Issues in Machine Learning Strategies, Data Exploration for Machine Learning: Data Types, Data Attributes, Statistical Description of Data, Data Visualization, Data Similarity Measures; Data Preprocessing: Data Cleaning, Data Integration, Data Reduction, Data Transformation & Discretization.

MODULE-2: Classification and Regression [14L]

Basic Concepts, assessing and visualizing performance of classification, k-Nearest-Neighbor Classifier, Decision Tree Classifier, Naïve Bayes Classifier; Ensemble Classification, Random Forest Strategy, Linear and Nonlinear Regression Methods and their performance analysis.

MODULE-3: Clustering, Association and Outlier Analysis [12L]

Basic Concepts, Partitioning Methods: k-Means and k-Medoids, Hierarchical Methods: Agglomerative and Divisive Hierarchical Clustering, Density-Based Methods: DBSCAN: Density-Based Clustering Based on Connected Regions with High Density; Outlier Analysis.

MODULE-4: Mining Frequent Patterns, Associations and Data Streams [8L]

Basic Concepts, Association analysis and Frequent Itemset Mining Methods: The Apriori Algorithm, Mining Time Series Data.

MODULE-5: Advanced Concepts [8L]

Introduction to advanced concepts of machine learning like Support Vector Machines and Artificial Neural Network and their applications in solving machine learning problems.

Text book:

- Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007
- Dr. Rajiv Chopra, Machine Learning, Khanna Publishing House, 2018
- Machine Learning by Saikat Dutt, Subramanian Chandramouli, Amit Kumar Das, Pearson.

Reference Books:

- Machine Learning using Python, Manaranjan Pradhan and U Dinesh Kumar, Wiley
- Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow, Aurélien Géron, O'Reilly
- Han J & Kamber M, "Data Mining: Concepts and Techniques", Morgan Kaufmann Publishers, Third Edition.

Course Name: Wireless Sensor Networks

Course Code: CSM103B

Contact (L:T:P/Week): 4:0:0

Total Contact Hours: 48

Credits: 4

Prerequisites: Basics of Computer Networking

Course Outcomes:

After completion of the course students will be able to

CO1	**Understand** the basic concepts of WSN to **Explain or Illustrate** and **Identify** problems where students can **Apply** the concept appropriately to **Solve** them.
CO2	**Understand** the fundamental concepts of WSN-MAC Layer so that they can **propose models** for predicting values based on exemplary data and **Analyze** their performances.
CO3	**Explain or Illustrate** the fundamental strategies of WSN-Security to solve clustering problems and **Analyze** their performances.
CO4	**Explain or Illustrate** the concepts of WSN-Routing Protocols and Apply them to solve the relevant problems and **Analyze** their performances.
CO5	**Develop** ideas to **Propose** solutions to the problems of WSN and **Identify** problems where students can **Apply** the advanced concept appropriately and **Analyze** the effectiveness as well as limitations of solutions making the students aware of its utilitarian importance for further explorations leading towards lifelong learning.

Course Content:

MODULE-1: [12L]

Fundamentals of wireless communication technology: the electromagnetic spectrum radio propagation, characteristics of wireless channels, modulation techniques, multiple access techniques, wireless LANs, PANs, WANs, and MANs, Wireless Internet.

Introduction to adhoc/sensor networks: Key definitions of adhoc/ sensor networks, unique constraints and challenges, advantages of ad-hoc/sensor network, driving applications, issues in adhoc wireless networks, issues in design of sensor network, sensor network architecture, data dissemination and gathering.

Network Architecture: Traditional layered stack, Cross-layer designs, Sensor Network Architecture

Hardware Platforms: Motes, Hardware parameters

MODULE-2: [12L]

Medium Access Control Protocol design: Fixed Access, Random Access, WSN protocols: synchronized, duty-cycled

Introduction to Markov Chain: Discrete time Markov Chain definition, properties, classification and analysis

MAC Protocol Analysis: Asynchronous duty-cycled. X-MAC Analysis (Markov Chain).

MODULE-3: [8L]

Security: Possible attacks, countermeasures, SPINS, Static and dynamic key distribution

MODULE-4: [8L]

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)

MODULE-5: [8L]

Advanced topics in wireless sensor networks.

Text book:

- W. Dargie and C. Poellabauer, “Fundamentals of Wireless Sensor Networks –Theory and Practice”, Wiley 2010
- Kazemv Sohraby, Daniel Minoli and TaiebZnati, “wireless sensor networks -Technology, Protocols, and Applications”, Wiley 2007

Reference Books:

- Takahiro Hara, Vladimir I. Zadorozhny, and Erik Buchmann, “Wireless Sensor Network Technologies for the Information Explosion Era”, Springer
- C. Siva Ram Murthy, and B. S. Manoj, "Ad Hoc Wireless networks ", Pearson Education - 2008.

Course Name: Mobile Device Programming

Course Code: CSM103C

Contact (L:T:P/Week): 4:0:0

Total Contact Hours: 48

Credits: 4

Prerequisites: Object-oriented programming

Course Outcomes:

After completion of the course students will be able to

CO1	Analyze architecture of android and current trends in mobile operating systems.
CO2	Apply suitable software tools and APIs for the development User Interface of a particular mobile application.
CO3	Apply intents and broadcast receivers in android application
CO4	Design apps for mobile devices
CO5	Develop apps for mobile devices using SQLite Database.

Course Content:

MODULE-I [10L]

Introduction to Android Operating System: Android OS and Features – Android development framework; Installing and running applications on Android Studio, Creating AVDs, Types of Android application; Creating Activities, Activity Life Cycle, Activity states, monitoring state changes.

MODULE- II [10L]

Android application components – Android Manifest file, Externalizing recourses like Simple Values, Drawables, Layouts, Menus, etc.

Building User Interfaces: Fundamental Android UI design, Layouts – Linear, Relative, Grid and Table Layouts. User Interface (UI) Components

MODULE-III [10L]

Fragments – Creating fragments, Lifecycle of fragments, Fragment states, Adding fragments to Activity, adding, removing and replacing fragments with fragment transactions, interfacing between fragments and Activities.

MODULE-IV [10L]

Intents and Broadcasts: Using intents to launch Activities, Types of Intents, Passing data to Intents, Getting results from Activities, Broadcast Receivers – Using Intent filters to service implicit Intents, Resolving Intent filters;

MODULE-V [8L]

Database: Introduction to SQLite database, creating and opening a database, creating tables, inserting retrieving and deleting data

TEXT BOOKS:

- Professional Android 4 Application Development, Reto Meier, Wiley India, (Wrox), 2012
- Android Application Development for Java Programmers, James C Sheusi, Cengage Learning, 2013

REFERENCEs:

- Beginning Android 4 Application Development, Wei-Meng Lee, Wiley India (Wrox), 2013
- Android Application Development (with Kitkat Support), Black Book, Pradeep Kothari, 2014, Dreamtech Press publisher, Kogent Learning Inc.,2014
- Android Programming: Pushing the Limits, Erik Hellman, 1st Edition,Wiley Publications, 2014

Course Name: Digital Image Processing

Course Code: CSM103D

Contact: 4:0:0

Total Contact Hours: 48

Credits: 4

Prerequisites: Design and Analysis of Algorithms, UG Level Mathematics

Course Outcomes:

After completion of the course students will be able to

CO1	**Understand** the basic concepts of digital image processing to **Explain or Illustrate** and **Identify** problems where students can **Apply** the concept appropriately to **Solve** them.
CO2	**Understand** and **explain** the fundamental concepts of image enhancement strategies and **Identify** the scope of enhancement where students can **Apply** the appropriate strategy and **Analyze** the performance.
CO3	**Illustrate** the fundamental image restoration strategies and **Apply** them appropriately to eliminate noise in the image.
CO4	**Illustrate** various Image Compression Techniques and **Apply** them to compress the images and **Analyze** their performances.
CO5	**Understand** and **Develop** ideas to **Propose** solutions to the problems of Morphological Image Processing and Image Segmentation and **Analyze** the effectiveness as well as limitations of solutions underscoring its utilitarian importance for further explorations leading towards lifelong learning.

Course Content:

MODULE-1: Introduction to Digital Image Processing [5L]

Applications of digital image processing, fundamental steps in digital image processing, components of image processing system. Digital Image Fundamentals: A simple image formation model, image sampling and quantization, Some Basic Relationships Between Pixels- Neighbors and Connectivity of pixels in image, Color Image Models.

MODULE-2: Image Enhancement [12L]

Image Enhancement in The Spatial Domain: Some Basic Gray Level Transformations, Histogram Processing, Basics of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters.

Image Enhancement in Frequency Domain:

Introduction, Fourier Transform, Discrete Fourier Transform (DFT) and its relation with image characterization, fundamental steps of image enhancement in Frequency Domain, Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters.

MODULE-3: Image Restoration [6L]

Basics of Image restoration and Noise characterization, Estimating the degradation function, Noise removal using spatial and frequency domain filtering, Image Restoration techniques.

MODULE-4: Morphological Image Processing [7L]

Basic Concepts, Erosion, Dilation, Opening, Closing, Skeletonization, Hole filling, Connected

components, Boundary Detection.

MODULE-5: Image Compression [7L]

Basic Concepts – Types of redundancy, Types of coding techniques, Lossless Compression: Run-Length Encoding, Huffman Coding, Lossy Compression: Vector Quantization, Sequential DCT-based Compression (JPEG Baseline Algorithm).

MODULE-6: Image Segmentation [11L]

Detection of Points, lines and Edges (Sobel and Canny); Edge Linking, Image Thresholding (Otsu's method), Region based segmentation, color-feature based segmentation in color images.

Text book:

- Digital Image Processing, Rafael C. Gonzales, Richard E. Woods, Third Edition, Pearson Education, 2010.
- Digital Image Processing, S. Sridhar, Oxford University Press, 2nd Ed, 2016.

Reference Books:

- Fundamentals of Digital Image Processing- Anil K. Jain, 2nd Edition, Prentice Hall of India.
- Image Processing, analysis and Machine Vision, Milan Sonka , Thomson Press India Ltd, Fourth Edition.

Course Name: Web & Internet Technologies

Course Code: CSM103E

Contact: 4:0:0

Total Contact Hours: 48

Credits: 4

Prerequisites: Basic Concepts of Computer Networking & Internet

Course Outcomes:

After completion of the course students will be able to:

CO1	**Understand** networks, IP, DNS, routing and other related technologies used in internet and **execute** and **solve** problems related to them leading to engineering problems solutions
CO2	**Understand** different web-based technologies like HTML, DHTML, CSS, XML and **demonstrate** their use in design of web-based solutions leading to engineering problems
CO3	**Comprehend** and **analyze** different client and server-side technologies like JavaScript, Servlet, CGI and **design** appropriate engineering solutions leading to lifelong learning
CO4	**Understand** and **implement** different types of technologies like JSP, JavaBean, JDBC and ODBC and **evaluate** their performances
CO5	**Understand** different web-based applications and network security techniques and **apply** them to protect the network against different attacks and **solve** related problems preferably as a team

Course Contents:

Module 1: [10L]
Introduction (1L): Overview, Network of Networks, Intranet, Extranet, and Internet. World Wide Web (1L): Domain and Sub domain, Address Resolution, DNS, Telnet, FTP, HTTP. Review of TCP/IP (1L): Features, Segment, Three-Way Handshaking, Flow Control, Error Control, Congestion control, IP Datagram, IPv4 and IPv6. IP Subnetting and addressing (1L): Classful and Classless Addressing, Subnetting. NAT, IP masquerading, IP tables. Internet Routing Protocol (1L): Routing -Intra and Inter Domain Routing, Unicast and Multicast Routing, Broadcast. Electronic Mail (1L): POP3, SMTP, Clients - Servers Communication.

Module -2: [12L]
HTML, DHTML & CSS: Introduction, Elements, Attributes, Heading, Paragraph. Formatting[1L]; Link, Table, List, Block, Layout, Html Forms, and input [1L]; Iframe, Colors[1L], Image Maps and attributes of image area [1L]; Introduction to CSS, basic syntax and structure of CSS, different types internal, external and inline CSS [1L]; Basic Introduction of DHTML, Difference between HTML and DHTML, Documentary Object Model (DOM) [1L]. Extended Markup Language (XML) : Introduction, Difference between HTML & XML,XML-Tree [1L]; Syntax, Elements, Attributes, Validation and parsing, DTD [2L].

Module 3: [16L]
Java Scripts: Basic Introduction, Statements, comments, variable, operators, data types [1L]; condition, switch, loop, break [1L]; Java script functions, objects, and events[1L]. CGI Scripts: Introduction, Environment Variable, GET and POST Methods [1L]. Java Servlet: Servlet environment and role, Servlet life cycle [1L]; Servlet methods- Request, Response, Get and post [1L]; Cookies and Session [1L].

Java Server Page (JSP):
JSP Architecture [1L]; JSP Servers, JSP Life Cycle [1L]; Understanding the layout of JSP, JSP Scriptlet Tag [1L]; JSP implicit object (request and response) [1L]; Variable declaration, methods in JSP [1L]; JSP directive (Taglib and Include), JavaBean- inserting JavaBean in JSP [1L]; JSP Action tags (Forward &

Include) [1L]; Creating ODBC data source name, Introduction to JDBC, prepared statement and callable statement [1L].

Module-4: [10L]
Threats[1L]: Malicious code-viruses, Trojan horses, worms; eavesdropping, spoofing, modification, denial of service attacks. Network security techniques: Password and Authentication; VPN, IP Security [1L], security in electronic transaction, Secure Socket Layer (SSL), Secure Shell (SSH)[1L]. Firewall (1L): Introduction, Packet filtering, Stateful, Application layer, Proxy. Search Engine and Web Crawler: Definition, Meta data, Web Crawler [1L], Indexing, Page rank, overview of SEO[1L].

Recent Trends in Web Application Development and Advanced Web Technologies.

Textbooks:

- "Web Technology: A Developer's Perspective", N.P. Gopalan and J. Akilandeswari, PHI Learning, Delhi, 2013. (Topics covered: html, CSS, imagemap, xml)
- "Learning PHP, MySQL & JavaScript", Robin Nixon, O'Reilly Publication. (Topics covered: Java Script)
- "Head First Servlet's & JSP", Bryan Basham, Kathy Sterra, Bert Bates, O'Reilly Publication. (Topics covered: Servlet, JSP)
- Cryptography and Network Security by William Stallings Publisher: Pearson Education India (Topics covered: Threats, Security techniques, Firewall)

Reference Books:
- "Programming the World Wide Web", Robert. W. Sebesta, Fourth Edition, Pearson Education, 2007.
- "Core Web Programming"- Second Edition-Volume I and II, Marty Hall and Larry Brown, Pearson Education, 2001

Course Name: Information Theory & Coding
Course Code: CSM104A
Contact: 4:0:0
Total Contact Hours: 48
Credits: 4

Prerequisites: Probability & Statistics

Course Outcome(s):
After completion of the course students will be able to

CO1	Understand the basic concept of information and apply this knowledge in designing solution for real life engineering problem.
CO2	Understand the basic concept of coding theory and use this knowledge for solving mathematica and engineering problem leading to lifelong learning.
CO3	Understand the concept of channel models to determine the mutual information in the channels.
CO4	Outline the concept of error detection techniques and design a model for building a new solution as a professional engineering practice as a team.
CO5	Understand how convolutional theory works and develop an approach to solve it by means of existing and new methods as a team work.

Course Content:

Module 1: Information Theory [6L]
Introduction, Measure of Information, Average Information Content (Entropy) of a Zero Memory Source, Extension of Zero Memory Source, Entropy of a Source with Memory.

Module 2: Source Coding [10L]
Introduction, Types of Codes, Prefix Codes, Source Coding Theorem, Shannon's Encoding Theorem, Huffman Coding, Arithmetic Coding, Lempel-Ziv Algorithm, Run Length Encoding, An Overview on Speech and Image Compression.

Module 3: Information Channels [5L]

Introduction, Channel Models, System Entropies, Mutual Information (Trans information), Channel Capacity, Capacity of Channels, Continuous Channels.

Module 4: Error Control Coding [12L]
Introduction, need for Error Control Coding, Types of Codes, Coding Gain, Linear Block Codes, The Hamming Codes, Probability of an Undetected Error Pattern for an LBC over a BSC, Equivalent Codes, Cyclic Codes, Golay Codes, Shortened Cyclic Codes.

Module 5: Burst Error Correcting Codes [8L]
Introduction, Burst Errors, Interleaved Codes, Product Codes, Fire Codes, BCH Codes, Non-Binary BCH Codes and Reed-Solomon Codes.

Module 6: Convolution Codes [7L]

Introduction, Convolution Encoder, Representation of Convolution Code, Transfer Function of a Convolution Code, Distance Properties of Convolution Codes, Decoding of Convolution Codes, Stack Algorithm, Known Good Convolution Codes.

Textbook:

- Information theory, coding and cryptography - Ranjan Bose; TMH.
- Information and Coding - N Abramson; McGraw Hill.

Reference Books:

- Introduction to Information Theory - M Mansurpur; McGraw Hill.
- Information Theory - R B Ash; Prentice Hall.
- Error Control Coding - Shu Lin and D J Costello Jr; Prentice Hall.

Course Name: Cloud Computing
Course Code: CSM104B
Total contact hours: 48
Contact: 4:0:0
Credits: 4

Prerequisite: Basic knowledge in Computer Network and Distributed System

Course Outcome(s):
After competition of the course the student able to do

CO1	Identify the appropriate cloud services for a given application
CO2	Assess the comparative advantages and disadvantages of Virtualization technology
CO3	Analyze authentication, confidentiality and privacy issues in cloud computing
CO4	Identify security implications in cloud computing.
CO5	Understand and explain the importance of protocols and standards in management for cloud services.

Course Content:
Module 1: Definition of Cloud Computing and its Basics [10L]

Definition of Cloud Computing: Defining a Cloud, Cloud Types – NIST model, Cloud Cube model, Deployment models (Public, Private, Hybrid and Community Clouds), Service models – Infrastructure as a Service, Platform as a Service, Software as a Service with examples of services/ service providers, Cloud Reference model, Characteristics of Cloud Computing – a shift in paradigm Benefits and advantages of Cloud Computing

Cloud Architecture: Cloud Infrastructure, Architecture of each component, Virtualization versus Traditional Approach, Virtualization Model for Cloud Computing.

Services and Applications by Type
IaaS – Basic concept, Workload, partitioning of virtual private server instances, Pods, aggregations, silos.
PaaS – Basic concept, tools and development environment with examples
SaaS - Basic concept and characteristics, Open SaaS and SOA, examples of SaaS platform
Identity as a Service (IDaaS) Compliance as a Service (CaaS)

Module 2: Use of Platforms in Cloud Computing [10L]

Concepts of Abstraction and Virtualization

Virtualization technologies: Types of virtualizations, Load Balancing and Virtualization: Basic Concepts, Network resources for load balancing; Classification of Virtualization Environment: Scheduling-based Environment, Load-Distribution-Based Environment, Energy Aware-Based Environment, Operational-Based Environment, Distributed Pattern-Based Environment, Transactional-Based Environment

Mention of The Google Cloud as an example of use of load balancing Hypervisors: Virtual machine technology and types, VMware vSphere Machine imaging (including mention of Open Virtualization Format – OVF)
Porting of applications in the Cloud: The simple Cloud API and AppZero Virtual Application appliance
Concepts of Platform as a Service
Definition of services, Distinction between SaaS and PaaS (knowledge of Salesforce.com and Force.com), Application development. Use of PaaS Application frameworks.

Module 3: Cloud Service Models [10L]

Use of Google Web Services
Discussion of Google Applications Portfolio – Indexed search, Dark Web, Aggregation and disintermediation, Productivity applications and service, Adwords, Google Analytics, Google Translate, a brief discussion on Google Toolkit (including introduction of Google APIs in brief), major features of Google App Engine service.

Use of Amazon Web Services

Amazon Web Service components and services: Amazon Elastic Cloud, Amazon Simple Storage system, Amazon Elastic Block Store, Amazon SimpleDB and Relational Database Service

Use of Microsoft Cloud Services
Windows Azure platform: Microsoft's approach, architecture, and main elements, overview of Windows Azure AppFabric, Content Delivery Network, SQL Azure, and Windows Live services

Module 4: Cloud Infrastructure [10L]

Types of services required in implementation – Consulting, Configuration, Customization and Support

Cloud Management
An overview of the features of network management systems and a brief introduction of related products from large cloud vendors, Monitoring of an entire cloud computing deployment stack – an overview with mention of some products, Lifecycle management of cloud services (six stages of lifecycle)

Live Migration of Virtual Machines:
Need of Live Migration of Virtual Machine, A Designing Process of Live Migration, and Security Issues during live migration.

Concepts of Cloud Security
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.
Auditing and Compliance in Cloud Environment:
Data Security in Cloud Computing Environment, Need for Auditing in Cloud Computing Environment, Third Party Service Provider, Cloud Auditing Outsourcing Lifecycle Phases, Auditing Classification.

Module 5: Concepts of Services and Applications [8L]

Service Oriented Architecture: Basic concepts of message-based transactions, Protocol stack for an SOA architecture, Event-driven SOA, Enterprise Service Bus, Service catalogs

Applications in the Cloud: Concepts of cloud transactions, functionality mapping, Application attributes, Cloud service attributes, System abstraction and Cloud Bursting, Applications and Cloud APIs

Cloud-based Storage: Cloud storage definition – Manned and Unmanned.

Webmail Services: Cloud mail services including Google Gmail, Mail2Web, Windows Live Hotmail, Yahoo mail, concepts of Syndication services

Text Book

- Kai Hwang, Geoffrey C Fox, Jack J Dongarra: Distributed and Cloud Computing – From Parallel Processing to the Internet of Things, Morgan Kaufmann Publishers – 2012.
- Barrie Sosinsky, "Cloud Computing Bible", Wiley India Edition.

Reference books

- Anthony Velte, tobyVelte, Robert Elsenpeter, "Cloud Computing – A Practical Approach", Tata McGraw-Hill Edition.
- Alex Amies, Harm Sluiman, Qiang Guo Tong and Guo Ning Liu: Developing and Hosting Applications on the cloud, IBM Press, 2012.
- George Reese: Cloud Application Architectures: Building Applications and Infrastructure in the Cloud (Theory in Practice), O'Reilly Publications, 2009
- Haley Beard: Cloud Computing Best Practices for Managing and Measuring Processes for On-demand Computing – applications and Data Centers in the Cloud with SLAs, Emereo Pty Limited, July 2008
- Michael Miller: Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online, Pearson Education, 2009.
- Richard N. Katz: The Tower and The Cloud, Higher Education in the Age of Cloud Computing, 2008.

Course Name: Distributed Systems
Course Code: CSM104C
Contact: 4:0:0
Total Contact Hours: 48
Credits: 4

Prerequisites: Probability & Statistics

Course Outcome(s):
After completion of the course students will be able to

CO1	Understand and explain the basic concept of Distributed Computing and apply this knowledge in designing solution to real life engineering problem.
CO2	Understand and explain the basic concept of Message Passing Systems
CO3	Understand, explain and use the concept of parallel processing systems
CO4	Understand explain and use the concept of Distributed Databases
CO5	Understand, explain the concept of parallel algorithms and use this concept for solving engineering problem leading to lifelong learning.

Course Content:

Module 1: [8L]

Fundamentals of Distributed Computing: Architectural models for distributed and mobile computing systems, Basic concepts in distributed computing.
Distributed Operating Systems: Overview, network operating systems,
Distributed file systems, Middleware, client/server model for computing.

Module 2: [7L]
Communication: Layered protocols, RPC, RMI, Remote objects. Basic Algorithms in Message Passing Systems, Leader Election in Rings, and Mutual Exclusion in Shared Memory, Message Passing, PVM and MPI.

Module 3: [12L]

Process Concepts: Threads, Clients and Servers, Code migration, Agent based Synchronization: Clock synchronization, Logical clocks, Election algorithms, Mutual exclusion, Distributed transactions, Naming concepts, Security in distributed systems, Distributed objects, CORBA, Distributed COM.

Module 4: [8L]

Distributed Databases: Distributed Data Storage, Fragmentation & Replication, Transparency, Distributed Query Processing and Optimization, Distributed Transaction Modelling and concurrency Control, Distributed Deadlock, Commit Protocols.

Module 5: Burst Error Correcting Codes [9L]

Parallel Processing: Basic Concepts: Introduction to parallel processing, Parallel processing terminology, Design of parallel algorithms, Design of Parallel Databases, Parallel Query Evaluation.

Module 6: [4L]

Recent trends in multiprocessor and distributed operating systems designs. Case study of parallel algorithms and optimization techniques.

Textbook:

- Distributed Systems, Principles and Paradigm by Tannenbaum, A, Maarten Van Steen, Prentice Hall India, 2002.
- Distributed Systems by Coulouris, Dollimore and Kindberg, Pearson, 2009.

Reference Books:

- Principles of Distributed Database Systems, Second Edition, M. Tamer Ozsu Patrick Valduriez.
- Parallel Programming for Multicore and Cluster Systems by Thomas Rauber and Gudula Runger.
- Scientific Parallel Computing by Scott, Clark, and Bagheri.
- Designing Efficient Algorithms for Parallel Computer by M.J. Quinn, McGraw Hill.

Course Name: Advanced Computer Architecture
Course Code: CSM104D
Contact: 4:0:0
Total Contact Hours: 48
Credits: 4

Prerequisites: Fundamentals of Computer Architecture.

Course Outcome(s):
After completion of the course students will be able to

CO1	Understand and explain the basic concept of Advanced Computer Architectures and apply this knowledge in designing solution to real life engineering problem.
CO2	Understand and explain the basic concept of parallel processing
CO3	Understand, explain and use the concept and design techniques of interconnection network in parallel computing architecture
CO4	Understand explain and use the concept of shared memory architecture
CO5	Understand, explain the concept of embedded system architecture and use this concept for solving engineering problem leading to lifelong learning.

Course Content:

Module 1: Introduction to Advanced Computer Architectures [10L]
Different types of architectural classifications – instruction vs. data (SISD, SIMD, MISD, MIMD), serial vs. parallel, pipelining vs. parallelism; Pipelining: Definition, different types of pipelining, hazards in pipelining.
Concept of reservation tables, issue of multiple instructions with minimum average latency (MAL).

Module 2: Parallel Processing & ILP [12L]
RISC architecture, characteristics of RISC instruction set & RISC pipeline, its comparisons with CISC, necessity of using optimizing compilers with RISC architecture, Review of instruction-level parallelism- Super pipelining, Superscalar architecture, Diversified pipelines and out of order execution, VLIW architecture, Dataflow and Control Flow Architectures, Loop Parallelization

Module 3: Interconnection Networks [12L]
Desirable properties of interconnection networks, static interconnection networks – path, cycle, double-loop, star, wheel, 2D mesh and its variants, multi-mesh, tree, shuffle-exchange, cube, cube connected cycles.
Dynamic interconnection networks: concepts of blocking, rearrangeable and blocking but rearrangeable networks, various types of multistage interconnection networks (MIN)- crossbar, clos, baseline, omega, Benes.

Module 4: Shared Memory Architecture [8L]
Fundamentals of UMA, NUMA, NORMA, COMA architectures, Performance measurement for parallel architectures –Amdahl’s law, Gustafson's law.

Module 5: Embedded System Architecture [6L]
Definition, Example, Classification of Embedded system, Embedded System Design Issues: Hardware issues (Processor, Memory, Peripherals), Software issues (Programming Languages, Time Criticality, RTOS).

Text Books:

- J. L. Hennessey and D. A. Patterson: Computer Architecture: A Quantitative Approach, 5th edition, Morgan Kaufmann, 2012.
- K. Hwang and F. A. Briggs: Computer Architecture and Parallel Processing, Tata McGraw Hill, New Delhi.

Reference Books:

- Tse-yun Feng, A Survey of Interconnection Networks, IEEE, 1981.
- Selim G. Akl, The Design and Analysis of Parallel Algorithms, Prentice-Hall, 1989.
- Raj Kamal, Embedded Systems Architectures Programming and Design, Second Edition , MacGraw-Hill(for Embedded System).

Course Name: Pattern Recognition

Course Code: CSM104E

Contact: 4:0:0

Total Contact Hours: 48

Credits: 4

Prerequisites: Data Structure, Design and Analysis of Algorithms, Statistics, Artificial Intelligence

Course Outcomes:

After completion of the course students will be able to

CO1	**Understand and explain** the fundamental concepts of Pattern Recognition recognizing their utilitarian importance in current technological context for further exploration leading towards lifelong learning.
CO2	**Understand and explain** the fundamental concepts of Pattern Classification & Parameter Estimation and apply the concepts to propose solutions to the challenging problems of pattern recognition.
CO3	**Understand and explain** the fundamental concepts of Pattern Clustering & Pattern Mining and apply the concepts to propose solutions to the challenging problems of pattern recognition.
CO4	**Understand and explain** the fundamental concepts of Feature Engineering and apply the concepts to propose solutions to the challenging problems of pattern recognition.
CO5	**Understand and explain** the fundamental concepts of Graph Mining, Social Network Analysis, Multi-relational Data Mining, Image Mining, Text Mining and World Wide Web (WWW) Mining and apply the concepts to propose solutions to the challenging problems of pattern recognition.

Course Content:

MODULE-1: Introduction to Pattern Recognition [4L]

Basic Concepts, Data Exploration: Data Types, Data Attributes, Statistical Description of Data, Data Visualization, Data Similarity Measures; Data Preprocessing: Data Cleaning, Data Integration, Data Reduction, Data Transformation & Discretization.

Introduction to various Pattern Recognition Techniques and Applications.

MODULE-2: Pattern Classification & Parameter Estimation [12L]

Basic Concepts, Bayesian decision making and Bayes Classifier.

Parameter Estimation Methods: Maximum-Likelihood estimation, Maximum a posteriori estimation, Bayesian estimation, Expectation-Maximization method for parameter estimation; Maximum entropy estimation.

ANN-Backpropagation Based Classifier: Overview of Artificial Neural Networks, Multilayer Feedforward Neural networks with Sigmoidal activation functions; Linear discriminant functions: Gradient descent procedures, Backpropagation Algorithm; Representational abilities of feedforward networks, Feedforward networks for Classification and Regression; Radial Basis Function Networks; Gaussian RBF networks.

Support Vector Machine Based Classifier: - Introduction, obtaining the optimal hyperplane, - SVM formulation with slack variables; nonlinear SVM classifiers, - Kernel Functions for nonlinear SVMs; Mercer and positive definite Kernels, - Support Vector Regression and ε-insensitive Loss function, examples of SVM learning.

MODULE-3: Pattern Clustering & Pattern Mining [6L]

Basic Concepts, k-Means Algorithm, Cluster validation; Frequent Itemset Mining Methods: The Apriori Algorithm; Pattern Mining in Multilevel and Multidimensional Space.

MODULE-4: Feature Engineering [6L]

Feature Extraction and Selection Strategies.

Dimensionality reduction: Linear discriminant Analysis, Fisher discriminant analysis; Principal component analysis; Factor Analysis

MODULE-5: Sequential Pattern Analysis [8L]

Basic Concepts of Sequential Pattern or Data Stream Analysis; Hidden Markov Model (HMM) and its application in Sequential Pattern Analysis

Analyzing Time Series Data; Analyzing Sequence Patterns in Biological Data.

MODULE-6: Advanced Topics: Graph Mining, Social Network Analysis, Multi-relational Data Mining, Image Mining, Text Mining and World Wide Web (WWW) Mining [12L]

Graph Mining: Methods for Mining Frequent Subgraphs (Apriori-based Approach & Pattern Growth Approach); Basic Concepts of Social Network Analysis and Multi-relational Data Mining;

Basic Concepts of Text Mining; Basic Concepts of Image Mining; Basic Concepts of World Wide Web (WWW) Mining.

Text book:

- S.Theodoridis and K.Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009
- C.M.Bishop, Pattern Recognition and Machine Learning, Springer, 2006

Reference Books:

- Han J & Kamber M, "Data Mining: Concepts and Techniques", Morgan Kaufmann Publishers, Third Edition.
- R.O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley, 2001

Course Name: Research Methodology and IPR

Course Code: CSM105

Contact: 4:0:0

Total Contact Hours: 48

Credits: 4

Prerequisites: Statistics

Course Outcomes:

After completion of the course students will be able to

CO1	**Understand and explain** the fundamental concepts of Research Methodology recognizing their utilitarian importance in current technological context for further exploration leading towards lifelong learning.
CO2	**Understand and explain** the research process and perform experimentation with data collection, result observation and interpretation, various result analysis techniques in statistics, Necessary instrumentations.
CO3	**Understand and explain** the fundamental techniques of technical writing and apply the techniques to write scientific articles and prepare for presentation.
CO4	**Understand and explain** the fundamental concepts of Intellectual Property.
CO5	**Understand and explain** the New Developments in IPR for further exploration leading towards lifelong learning.

Course Content:

MODULE-1: [8L]

The research process: characteristics and requirements; Types of research.

The research process: Deciding what to research (formulating a research problem), Planning a research study (conceptualizing a research design, constructing an instrument for data collection, selecting a sample, writing a research proposal), Conducting a research study (collecting data, processing and analyzing data, writing a research report)
Meaning of research problem, Sources of research problem, Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.

MODULE-2: [4L]

Research Methodology and Approaches of investigation of solutions for research problem, Experimentation with data collection, result observation and interpretation, various result analysis techniques in statistics, Necessary instrumentations.

Effective approaches to literature studies and analysis of existing methods.

Plagiarism, Research ethics.

MODULE-3: [12L]

Effective technical writing: how to write technical report and research article, Structure of a scientific research article.
Latex as scientific editing tool for technical writing.
Developing a Research Proposal, Format of research proposal, technical presentation and assessment by a review committee.

MODULE-4: [8L]

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.

MODULE-5: [8L]

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

MODULE-6: [8L]

New Developments in IPR: Administration of Patent System. IPR of Biological Systems, Computer Software etc. Traditional knowledge, Case Studies, IPR and IITs.

Text book:

- Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'", Juta & Co Ltd (Publisher)
- Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016, Aspen Law & Business (Publisher)

Reference Books:

- Ranjit Kumar, 3rd Edition, "Research Methodology: A Step-by-Step Guide for beginners", SAGE Publications Ltd.
- Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.

Course Name: Operations Research

Course Code: CSM106

Contact: 4:0:0

Total Contact Hours: 48

Credits: 4

Prerequisite:
Basic Knowledge of Function, plotting of Equation and inequations, Formulation of Mathematical Problem. Finding maximum and minimum from row or column or from Matrix.

Course Outcomes(s):
On successful completion of the learning sessions of the course, the learner will be able to:

CO1	**Understand** the basic concepts of Operations Research to **Explain or Illustrate** and **Identify** problems where students can **Apply** the concept appropriately to **Solve** them.
CO2	**Understand** the fundamental concepts of Linear Programming Problem and formulate a real-world problem as Linear Programming Problem for solving.
CO3	**Explain or Illustrate** the theoretical workings of Game Theory approaches and **Apply** the concept appropriately.
CO4	**Explain or Illustrate** the concepts of Network Optimization Models, Queuing Theory and Apply them to solve the relevant problems and **Analyse** their performances.
CO5	**Develop** ideas to **Propose** solutions to the problems of Nonlinear programming and **Identify** problems where students can **Apply** the concept appropriately and **Analyze** the effectiveness as well as limitations of solutions making the students aware of its utilitarian importance for further explorations leading towards lifelong learning.

Course Content:

Module 1: [11L]
Linear Programming Problem(LPP): Basics of Linear Programming Problem(LPP). General Mathematical Formulation of LPP; Definitions: Convex set, Solution, Feasible Solution, Basic and Non-Basic Variables, Basic Feasible Solution, Degenerate and Non-Degenerate solution, Optimum/Optimal Solution; Solution of LPP by Graphical Analysis/Method, Simplex Method, Charnes' Big M-Method; Duality Theory.

Module 2: [4L]
Transportation Problem, Assignment Problem.

Module 3: [4L]
Sequencing: Johnson's Algorithm (1957) For **n** Jobs and **two** machines, **n** Jobs and **three** machines.

Module 4: [4L]
Queuing Theory: Introduction and Basic Structure of Queuing Theory; Basic Definations and Notations; Birth-and-Death Model (Poisson / Exponential distribution); Poisson Queue Models: (M/M/1):(∞/FIFO)and(M/M/1):(N/FIFO) and Problems.

Module 5: [4L]
Network Optimisation Models: CPM PERT (Arrow network), Time estimates, earliest expected time, latest allowable occurrence time, latest allowable occurrence time and stack. Critical path, Probability of meeting scheduled date of completion of project.
Calculation of CPM network.Various floats for activities.

Module 6: [4L]
Inventory Control: Deterministic Continuous & Deterministic
peirodic Review Models, Stochastic Continuous & Stochastic Periodic Review Models.

Model 7: [4L]
Geometric Programming and its application

Module 8: [13L]

Nonlinear optimization: Unconstrained optimization-direct method, Powell's Method, conjugate direction, Indirect search methods: steepest descent, Newton's methods.
Nonlinear Programmkng (Constrained optimization): Sequential linear programming, Methods of feasible directions, gradient projection method, penalty function method, Augmented Lagrangian multipliers method. Kuhn-Tucker conditions (statements only)..

Text Books:

1. Operations Research by Kanti Swaroop and P.K. Man Mohan, Sultan Chand and Sons
2. Linear Programming and Theory of Games by Ghosh and Chakraborty, Central Book Agency
3. Linear Programming and Theory of Games by P.M.Karak, ABS Publishing House
4. Operations Research, D.K.Jana & T.K.Roy, Chhaya Prakashani Pvt. Ltd.
5. Operations Research, Kalavati,VIKAS
6. Operations Research,Humdy A Taha,PHI / Pearson

Reference Books:

1. Operations Research Theory and Applications by J.K.Sharma, Macmillan India Limited.
2. Operations Research, Vijayakumar, Scitech
3. Operations Research by S.D. Sharma, Kedar Nath Ram Nath Publishers.
4. Operations Research by A.P. Verma, S. K. Kataria & Sons.
5. Operations Research by P.K. Gupta & Hira, S.Chand
6. Operations Research by V.K. Kapoor

Course Name: Advanced Data Structure Lab

Course Code: CSM192

Contact: 0:0:3

Total Contact Hours: 36

Credits: 3

Prerequisites: Concepts of Data Structure, Programming Knowledge

Course Outcomes:

After completion of the course students will be able to

CO1	**Understand** and **Apply** the basics concepts of data structure through implementation to **Explain or Illustrate** and **Identify** problems where students can **Apply** the concept appropriately to **Solve** them.
CO2	**Understand** and **Apply** the fundamental concepts of dictionary data structure through implementation and **Analyze** the operations on it.
CO3	**Understand** and **Apply** the fundamental concepts of advanced tree data structures through implementation and **Analyze** the operations on them.
CO4	**Understand** and **Apply** the concepts of set and heap data structures through implementation and Apply them to solve the relevant problems and **Analyze** their performances.
CO5	**Develop** ideas to **Propose** data structures to the problems of various fields of applications and **Identify** problems where students can **Apply** and **Implement** the concept appropriately through programming with adequate documentation in collaborative environment for successfully carrying out projects on machine learning problems and **investigate** their effectiveness by **analyzing** the performances using proper techniques and tools and **Assess** the limitations of solutions underscoring utilitarian importance for further explorations leading towards lifelong learning.

Course Content:

1. 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 etc.)
2. 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)
3. Implementation of stack and queue (using array or linked list data structures)
4. Assignments on the application of Dictionaries using the operation viz. creation, deletion, and finding.
5. Implementation of hashing where collision resolution is done using open addressing method
6. Assignments on the implementation of Skip List (e.g. search and update operation)
7. Assignments on the implementation of various trees using array or linked list (e.g. Binary Search Tree, AVL Tree, Red Black Trees, 2-3 Trees, and B-Trees etc.)
8. Implementation of KMP algorithm for pattern matching
9. Implementation of Standard Tries
10. Assignments on the application of array data structure to search an element in a set of elements in Priority Range Trees, Quadtrees, k-D Trees etc.

11. Assignments on Heap Data Structures

12. Mini-Project on Advanced Data Structures: Application of one/ two data structures in real life applications

Text book:

- Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, 2ND Edition, Pearson, 2004.
- Ellis Horowitz and Sartaj Sahni, Fundamentals of Data Structures, Universities Press
- Peter Brass; Advanced Data Structures, Cambridge University Press
- Suman Saha, S. Shukla; Advanced Data Structures: Theory and application, CRC press
- A.A. Puntambekar; Advanced Data Structures - A Conceptual Approach, Technical Publications

Reference Books:

- Dinesh P. Mehta, Sartaj Sahni; Handbook of Data Structures and Applications, CRC press
- Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein; Introduction to Algorithms, fourth edition, The MIT Press

Course Name: Machine Learning Lab

Course Code: CSM193A

Contact: 0:0:3

Total Contact Hours: 36

Credits: 3

Prerequisites: Data Structure, Design and Analysis of Algorithms, Statistics, Artificial Intelligence, Python Programming

Course Outcomes:

After completion of the course students will be able to

CO1	**Understand** and **Apply** the basics concepts of machine learning through implementation to **Explain or Illustrate** and **Identify** problems where students can **Apply** the concept appropriately to **Solve** them.
CO2	**Understand** and **Apply** the fundamental concepts of regression analysis through implementation so that they can **propose models** for predicting values based on exemplary data and **Analyze** their performances.
CO3	**Understand** and **Apply** the fundamental strategies of unsupervised machine learning paradigm through implementation to solve clustering problems and **Analyze** their performances.
CO4	**Understand** and **Apply** the concepts of Mining Frequent Patterns, Associations and Data Streams through implementation and Apply them to solve the relevant problems and **Analyze** their performances.
CO5	**Develop** ideas to **Propose** solutions to the problems of supervised learning and **Identify** problems where students can **Apply** and **Implement** the concept appropriately through programming with adequate documentation in collaborative environment for successfully carrying out projects on machine learning problems and **investigate** their effectiveness by **analyzing** the performances using proper techniques and tools and **Assess** the limitations of solutions underscoring utilitarian importance for further explorations leading towards lifelong learning.

Course Content:

WEEK-1: Introduction to Machine Learning Programming Platform & Python Programming Basics

Introduction to Machine Learning Programming Platform and Python Programming Basics

WEEK-2: Data Exploration

Data Exploration: Data Types, Data Attributes, Statistical Description of Data, Data Visualization, Data Feature Vectors, Data Preprocessing: Data Cleaning, Data Transformation

WEEK -3: Regression

Implementation and Analysis of Linear and Nonlinear Regression Methods

WEEK -4: Classification

Implementation and Analysis of k-Nearest-Neighbor Classifier, Decision Tree Classifier, Naïve Bayes Classifier

WEEK -5: Classification

Implementation and Analysis of ANN-Backpropagation and SVM Based Classifier

WEEK-6: Clustering

Implementation and Analysis of k-Means and k-Medoids

WEEK -7: Association Analysis

Implementation and Analysis of Apriori Algorithm

WEEK -8: Mining Time-Series Data

Implementation and Analysis of Time-Series Data Mining Models

WEEK -9: Discussion on Project Problems and Allocation (Problem Description Report Submission)

WEEK -10: Designing Solution Model and Proposal Report Submission

WEEK -11: Project Implementation, Verification and Documentation

WEEK -12: Project Demonstration and Project Report Review

Text book:

- Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow, Aurélien Géron, O'Reilly
- Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007
- Dr. Rajiv Chopra, Machine Learning, Khanna Publishing House, 2018

Reference Books:

- Machine Learning by Saikat Dutt, Subramanian Chandramouli, Amit Kumar Das, Pearson.
- Machine Learning using Python, Manaranjan Pradhan and U Dinesh Kumar, Wiley

Course Name: Wireless Sensor Networks Lab

Course Code: CSM193B

Contact: 0:0:3

Total Contact Hours: 36

Credits: 3

Prerequisites: Basic concepts of Networking

Course Outcomes:

After completion of the course students will be able to

CO1	**Understand** and **Apply** the basics concepts of WSN through implementation to **Explain or Illustrate** and **Identify** problems where students can **Apply** the concept appropriately to **Solve** them.
CO2	**Understand** and **Apply** the fundamental concepts of WSN-MAC through implementation and **Analyze**.
CO3	**Understand** and **Apply** the fundamental concepts of WSN routing protocols through implementation and **Analyze**.
CO4	**Understand** and **Use** various network simulators for implementation of protocols and **Analyze** their performances.
CO5	**Develop** ideas to **Propose** solutions to the problems of various fields of WSN applications and **Identify** problems where students can **Apply** and **Implement** the concept appropriately through simulation with adequate documentation in collaborative environment for successfully carrying out projects on machine learning problems and **investigate** their effectiveness by **analyzing** the performances using proper techniques and tools and **Assess** the limitations of solutions underscoring utilitarian importance for further explorations leading towards lifelong learning.

Course Content:

1. Network Simulators (NS)
2. Installation of Network Simulator ns 2
3. Familiarization with ns 2
4. Learn programming in OTCL
5. Setup wired and wireless networks using existing protocols in OTCL
6. Observe the variation in the network performance of wireless ad hoc networks for various routing protocols
7. Observe the variation in the network performance of vehicular ad hoc networks for various routing protocols
8. Familiarization with Real time network simulator
9. 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.

10. Mini-Projects (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.

Text book:

- W. Dargie and C. Poellabauer, “Fundamentals of Wireless Sensor Networks –Theory and Practice”, Wiley 2010
- Kazem Sohraby, Daniel Minoli and TaiebZnati, “wireless sensor networks -Technology, Protocols, and Applications”, Wiley Interscience 2007

Reference Books:

- Takahiro Hara,Vladimir I. Zadorozhny, and Erik Buchmann, “Wireless Sensor Network Technologies for the Information Explosion Era”, Springer
- C. Siva Ram Murthy, and B. S. Manoj, "AdHoc Wireless networks ", Pearson Education - 2008.

Course Name: Mobile Device Programming Lab

Course Code: CSM193C

Contact: 0:0:3

Total Contact Hours: 36

Credits: 3

Prerequisites: Object-oriented programming

Course Outcomes:

After completion of the course students will be able to

CO1	Identify and Explain various concepts of mobile programming that make it unique from programming for other platforms
CO2	Critique mobile applications on their design pros and cons,
CO3	Utilize rapid prototyping techniques to design and develop sophisticated mobile interfaces,
CO4	Develop mobile applications for the Android operating system that use basic and advanced phone features
CO5	Deploy applications to the Android marketplace for distribution

Course Content:

WEEK-01

Installation of Android studio. Development Of Hello World Application

WEEK-02

Create an application that takes the name from a text box and shows hello message along with the name entered in text box, when the user clicks the OK button.

WEEK-03

Create a screen that has input boxes for User Name, Password, Address, Gender (radio buttons for male and female), Age (numeric), Date of Birth (Date Picket), State (Spinner) and a Submit button. On clicking the submit button, print all the data below the Submit Button (use any layout)

WEEK-04

Design an android application to create page using Intent and one Button and pass the Values from one Activity to second Activity.

WEEK-05

Design an android application Send SMS using Intent. Create an android application using Fragments. Design an android application Using Radio button.

WEEK-06

Design an android application for menu.

WEEK-07

Create a user registration application that stores the user details in a database table.

WEEK-08 To WEEK -12: Mini Project

TEXT BOOKS:

1. Professional Android 4 Application Development, Reto Meier, Wiley India, (Wrox), 2012

2. Android Application Development for Java Programmers, James C Sheusi, Cengage Learning, 2013

REFERENCES:

1. Beginning Android 4 Application Development, Wei-Meng Lee, Wiley India (Wrox), 2013

2. Android Application Development (with Kitkat Support), Black Book, Pradeep Kothari, 2014, Dreamtech Press publisher, Kogent Learning Inc.,2014

3. Android Programming: Pushing the Limits, Erik Hellman, 1st Edition,Wiley Publications, 2014

Course Name: Digital Image Processing Lab

Course Code: CSM193D

Contact: 0:0:3

Total Contact Hours: 36

Credits: 3

Prerequisites: Design and Analysis of Algorithms, UG Level Mathematics, Python/MATLAB Programming

Course Outcomes:

After completion of the course students will be able to

CO1	**Understand** the practical aspects of digital image processing and **identify** problems where students can implement the concept appropriately.
CO2	**Understand** the practical aspects of image enhancement strategies and **identify** the scope of enhancement where students can **apply** the appropriate strategy and analyze the performance.
CO3	**Implement** the fundamental image restoration strategies and **apply** them appropriately to eliminate noise in the image.
CO4	**Implement** various Image Compression Techniques and **Analyze** their performances.
CO5	**Understand** the ideas of Morphological Image Processing and Image Segmentation and **implement** them to **solve** related problems with adequate documentation in collaborative environment demonstrating the ability to carry out projects and **investigate** their effectiveness by **analyzing** the performances using proper techniques and tools and **assess** the limitations of the solutions underscoring utilitarian importance for further explorations leading towards lifelong learning.

Course Content:

WEEK-1: Introduction to Digital Image Processing Basics & Python/MATLAB Programming Basics

Introduction to Digital Image Processing Basics and Python/MATLAB Programming Basics

WEEK-2: Image Enhancement in Spatial Domain

Implementation of various image enhancement strategies in Spatial Domain.

WEEK -3: Image Enhancement in Frequency Domain

Implementation of various image enhancement strategies in Frequency Domain.

WEEK -4: Image Restoration

Implementation of various Image Restoration strategies

WEEK -5: Morphological Image Processing

Implementation of various Morphological Image Processing strategies

WEEK-6: Image Compression

Implementation of various Image Compression strategies**.**

WEEK -7: Image Segmentation: Detection of Points, lines and Edges (Sobel and Canny); Edge Linking

Implementation of various techniques for Detection of Points, lines and Edges (Sobel and Canny); Edge Linking

WEEK-8: Image Segmentation: Image Thresholding (Otsu's method), Region based segmentation, color-feature based segmentation in color images

Implementation of various techniques for Image Thresholding (Otsu's method), Region based segmentation, color-feature based segmentation in color images

WEEK -9: Discussion on Project Problems and Allocation (Problem Description Report Submission)

WEEK -10: Designing Solution Model and Proposal Report Submission

WEEK -11: Project Implementation, Verification and Documentation

WEEK -12: Project Demonstration and Project Report Review

Text book:

1. Digital Image Processing using MATLAB, Rafael C. Gonzales, Richard E. Woods, Steven L. Eddins, Pearson Education.
2. OpenCV with Python By Example, Prateek Joshi, oreilly.

Reference Books:

1. Practical Python and OpenCV: An Introductory, Example Driven Guide to Image Processing and Computer Vision, Adrian Rosebrock, PyImageSearch
2. Image Processing, analysis and Machine Vision, Milan Sonka , Thomson Press India Ltd, Fourth Edition.

Name of the Paper: Web & Internet Technologies Lab

Paper Code: CSM193E

Contact: 0:0:3

Total Contact Hours: 36

Credits: 3

Prerequisite: Fundamentals of Programming, Internet Technologies

Course Outcomes:

After completion of the course students will be able to:

CO1	**Understand** the working principles of the Internet, and web-based applications and e**xecute** and **solve** problems related to them leading to engineering problems solutions
CO2	**Understand** different web-based technologies like HTML, DHTML, CSS, XML and **demonstrate** their use in design of web-based solutions leading to engineering problems
CO3	**Comprehend** and **analyze** different client and server-side technologies and **design** the dynamic web pages by applying appropriate engineering solutions leading to lifelong learning
CO4	**Analyze** web-based applications, **apply** this advanced knowledge to **develop** complex web applications and **evaluate** their performances
CO5	**Understand** different technologies and **construct** web-based projects preferably as a team

List of Experiments:

1. Write a single html program through which you can explain a) anchor tag, b)'img' tag with 'src' attribute, c) paragraph d) heading.
2. Write programs in html which will create complex design.
3. Write a single html program where use of internal style sheet will be shown
4. Write a single html program which implements image map concept
5. Write a html program which will show use of JavaScript.
6. Write a xml parsing technique which will parse a text string into an XML DOM object and extracts the info from it with JavaScript.
7. Write a html program to find out m to the power n (m, n valid integer no) using a function using JavaScript.
8. Write a simple java script program to print the weekday and time.
9. Write a simple java script program to implement the function using the argument and no argument both.
10. Write a simple program in JSP through which you can create a login page of your own website
11. Write a simple JSP program which will show database connectivity property
12. Create an Online Registration form for individual user for a user.
13. Mini-Project

Textbooks:

1. “Web Technology: A Developer's Perspective”, N.P. Gopalan and J. Akilandeswari, PHI Learning, Delhi, 2013. (Topics covered: html, CSS, imagemap, xml)
2. “Learning PHP, MySQL & JavaScript”, Robin Nixon, O’Reilly Publication. (Topics covered: Java Script)
3. “Head First Servlet’s & JSP”, Bryan Basham, Kathy Sterra, Bert Bates, O’Reilly Publication. (Topics covered: Servlet, JSP)

Reference Books:

1. "Programming the World Wide Web", Robert. W. Sebesta, Fourth Edition, Pearson Education, 2007.
2. “Core Web Programming”- Second Edition-Volume I and II, Marty Hall and Larry Brown, Pearson Education, 2001.
3. “Web Technologies”, Black Book, Dream tech Press

Semester II:

Subject Code	Subject Name	L:T:P/Week	Total Credits	Contact Hours/Week
PROGRAM CORE				
CSM201	Advanced Algorithms	4:0:0	4	4
CSM202	Soft Computing	4:0:0	4	4
ELECTIVE III				
CSM203A	Neural Networks & Deep Learning	4:0:0	4	4
CSM203B	Cryptography & Network Security	4:0:0	4	4
CSM203C	Smart Sensors and Internet of Things	4:0:0	4	4
CSM203D	Quantum Computing	4:0:0	4	4
ELECTIVE IV				
CSM204A	Data Warehouse and Data Mining	4:0:0	4	4
CSM204B	Big Data Analytics	4:0:0	4	4
CSM204C	Natural Language Processing	4:0:0	4	4
CSM204D	Computer Vision	4:0:0	4	4
OPEN ELECTIVE				
CSM205A	Entrepreneurship	4:0:0	4	4
CSM205B	Cyber Law and Ethics	4:0:0	4	4
CSM205C	Optimization Techniques	4:0:0	4	4
CSM205D	Cost Management of Engineering Projects	4:0:0	4	4
AUDIT COURSE				
CSM206	Audit Course I	2:0:0	0	2
PRACTICAL:				
CSM291	Advanced Algorithms Lab	0:0:3	3	3
CSM292	Soft Computing Lab	0:0:3	3	3
CSM281	Mini Project with Seminar	0:0:3	3	3
	TOTAL:	26:0:9	29	31

Audit Course I

1. English for Research Paper Writing
2. Disaster Management
3. Sanskrit for Technical Knowledge
4. Value Education

Course Name: Advanced Algorithms

Course Code: CSM201

Contact: 4:0:0

Total Contact Hours: 48

Credits: 4

Prerequisites: UG Level Design & Analysis of Algorithm

Course Outcomes:

After completion of the course students will be able to

CO1	**Understand** the basic concepts of Algorithm Design Techniques and their computational complexities to **Explain or Illustrate** and **Identify** problems where students can **Apply** the concept appropriately to **Solve** them.
CO2	**Understand** the fundamental concepts of Graph Algorithms and **Identify** problems where students can **Apply** the concept appropriately to **Solve** them.
CO3	**Explain or Illustrate** the fundamental strategies of Flow-Networks to solve problems and **Analyze** their performances.
CO4	**Explain or Illustrate** the concepts of Number-Theoretic, String Matching and Computational Geometry Algorithms and Apply them to solve the relevant problems and **Analyze** their performances.
CO5	**Develop** Advanced Algorithms and **Identify** problems where students can **Apply** the advanced concept appropriately and **verify** the effectiveness as well as limitations of solutions making the students aware of its utilitarian importance for further explorations leading towards lifelong learning.

Course Content:

Module-I: [8L]

Basics of Design & Analysis of Algorithm: Review of various Algorithm Design Strategies (Divide & Conquer, Dynamic Programming, Greedy Programming, Backtracking, Branch & Bound Strategy.

Review of various sorting algorithms

Review of Time Complexity Analysis Techniques

Amortized Analysis:

Aggregate, Accounting, and Potential Method

Module-II: [12L]

Graph Algorithms:

Elementary Graph Algorithms: Breadth-first search, Depth-first search, Topological sort, Strongly connected components, Minimum Spanning Trees: The algorithms of Kruskal and Prim, Shortest Paths: The Bellman-Ford

algorithm, Dijkstra's algorithm, Proofs of shortest-paths properties**,** The Floyd-Warshall algorithm, Johnson's algorithm for sparse graphs.

Matroids:

Algorithm to compute a maximum weight maximal independent set. Application to Minimum Spanning Trees.

Graph Matching:

Algorithm to compute maximum matching. Characterization of maximum matching by augmenting paths, Edmond's Blossom algorithm to compute augmenting path.

Module-III: [12L]

Flow-Networks:

Maxflow-Mincut Theorem, Ford Fulkerson Method to compute Maximum Flow, Edmond-Karp maximum-flow algorithm, Maximum bipartite matching.

Matrix Computations:

Strassen's algorithm, inverse of a triangular matrix, relation between the time complexities of basic matrix operations, LUP-decomposition

Number-Theoretic Algorithms:

Elementary number-theoretic notions, Greatest common divisor, Modular arithmetic, Solving modular linear equations, The Chinese remainder theorem, Powers of an element, The RSA public-key cryptosystem, Primality testing, Integer factorization

Multithreaded Algorithms:

The basics of dynamic multithreading, Multithreaded matrix multiplication, Multithreaded merge sort

Module-IV: [8L]

String Matching:

The naive string-matching algorithm, The Rabin-Karp algorithm, String matching with finite automata, The Knuth-Morris-Pratt algorithm, Edit distance Computation

Computational Geometry:

Line-segment properties, determining whether any pair of segments intersects, Finding the convex hull, Finding the closest pair of points.

Module-V: [8L]

NP-completeness:

Examples, proof of NP-hardness and NP-completeness.

Randomized & Approximation Algorithms:

Randomized Algorithms: Las Vegas and Monte Carlo algorithms, Random Quicksort & its time complexity analysis

Approximation Algorithms: The vertex-cover problem, The traveling-salesman problem,

Problem Solving Application

Recent Trends in problem solving paradigms using recent searching and sorting techniques by applying recently proposed data structures.

Text book:

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

Reference Books:

1. "Algorithm Design" by Kleinberg and Tardos.
2. Design & Analysis of Algorithms, Gajendra Sharma, Khanna Publishing House, New Delhi

Course Name: Soft Computing
Course Code: CSM202
Contact: 4:0:0
Total Contact Hours: 48
Credits: 4

Prerequisites:
Discrete Mathematics, Probability and Statistics

Course Outcome(s):
After completion of the course students will be able to

CO1	Understand and explain the basic concept of soft computing and hard computing and apply them in designing solution to engineering problem.
CO2	Understand and explain appropriate ANN learning rules for each of the architectures and learn soft computing paradigms and apply the rules to solve engineering and other problems.
CO3	Understand and explain the concept of rough set and apply the concept to solve engineering and other problems.
CO4	Apply fuzzy logic and reasoning to handle uncertainty and solving interdisciplinary engineering problems
CO5	Design and implement GA, PSO and ACO algorithms for optimization problems in Engineering problem

Course Content:

Module-1: Introduction to Soft Computing: [12L]
An Overview of Artificial Intelligence, Evolution of Computing - Soft Computing Constituents – From Conventional Artificial Intelligence to Computational Intelligence - Machine Learning Basics. Soft Computing: Introduction of soft computing, soft computing vs. hard computing, various types of soft computing techniques, applications of soft computing

Artificial Neural Network: Back propagation, Different issues regarding convergence of Multilayer Perceptron, Competitive learning, Self-Organizing Feature Maps, Adaptive Resonance Theory, Associative Memories, Applications

Module-2: Fuzzy sets and Fuzzy logic [12L]
Introduction, Fuzzy sets versus crisp sets, operations on fuzzy sets, Extension principle, Fuzzy relations and relation equations, Fuzzy numbers, Linguistic variables.
Fuzzy logic, Linguistic hedges, Applications, fuzzy controllers, fuzzy pattern recognition, fuzzy image processing, fuzzy database.

Module-3: Evolutionary algorithms [6L]
A History of Evolutionary Computation, Introduction to Evolutionary Algorithms
Evolutional Strategies, Evolutionary Programming, – Different Components of Evolutionary Algorithms. – Experimental (statistical) Methods for the analysis of Evolutionary Algorithms – Theoretical Analysis of Evolutionary Algorithms – Interactive Evolutionary Algorithms – Experiment design and analysis involving Evolutionary Algorithms

Module -4: Genetic Algorithms & Rough Set [12L]
Evolutionary and Stochastic techniques: Genetic Algorithm (GA), different operators of Genetic Algorithm, Analysis of selection operations, Hypothesis of building Blocks, Schema theorem and convergence of Genetic Algorithm, Simulated annealing and Stochastic models, Boltzmann Machine, Applications.

Rough Set: Introduction, Imprecise Categories Approximations and Rough Sets, Reduction of Knowledge, Decision Tables, and Applications.

Module -5: Swarm Intelligence Algorithms [6L]
Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO), Differential Evolution (DE), Artificial Bee Colony (ABC) and Cuckoo Search Algorithms (CSA), Applications.
Latest Developments in Nature Inspired Algorithms.

Text book:
1."Neural Networks, Fuzzy logic, and Genetic Algorithms", S. Rajasekaran & G. A. V. Pai, PHI.
2."Principles of Soft Computing", S.N. Sivanandam, S.N Deepa, wiley publications.
3 A. E. Eiben and J. E. Smith, "An Introduction to Evolutionary Computing", Natural Computing Series, Springer, 2nd Edition, 2015.
4."An Introduction to Genetic Algorithm", Mitchell Melanie, Prentice Hall, 1998.

Reference Books:
1. "Genetic Algorithms in Search, Optimization and Machine Learning", David E. Goldberg, Addison Wesley, 1997.
2."Intelligent Hybrid Systems", D. Ruan, Kluwer Academic Publisher, 1997.
3. Soft Computing with MATLAB Programming, N. P. Padhy and S. P. Simon, Oxford University Press; UK ed. edition

Paper Name: Neural Networks and Deep Learning
Paper Code: CSM203A
Contact (L: T: P/Week): 4:0:0
Credit Point: 4
No. of Lectures: 48

Prerequisite:

1. A solid background in Statistics, Calculus, Linear Algebra and Probability.
2. Artificial Intelligence, Machine Learning

Course Outcome(s):

On completion of the course students will be able to

CO1	**Understand** the basic concepts of Neural Networks and Deep Learning to **Explain or Illustrate** and **Identify** problems where students can **Apply** the concept appropriately to **Solve** them.
CO2	**Understand** the fundamental concepts of Shallow & Deep Neural Networks so that they can **propose models** based on exemplary data and **Analyze** their performances.
CO3	**Explain or Illustrate** the fundamental strategies of Convolutional Neural Network models to solve computer vision problems and **Analyze** their performances.
CO4	**Explain or Illustrate** the concepts of Recurrent Neural Network models for Sequence data and Apply them to solve the relevant problems and **Analyse** their performances.
CO5	**Develop** ideas to **Propose** solutions to the problems of machine learning and **Identify** problems where students can **Apply** the concept appropriately and **Analyze** the effectiveness as well as limitations of solutions making the students aware of its utilitarian importance for further explorations leading towards lifelong learning.

Module 1: Introduction to Neural Networks and Deep Learning [10L]

What is a Neural Network? Supervised Learning with Neural Networks, why is Deep Learning taking off? Binary Classification, Logistic Regression, Logistic Regression Cost Function, Gradient Descent, Derivatives, Computation Graph, Derivatives with a Computation Graph, Logistic Regression Gradient Descent, Vectorization, Vectorizing Logistic Regression, Vectorizing Logistic Regression's Gradient Output.

Module 2: Shallow Neural Network & Deep Neural Network [12L]

Neural Networks Overview, Neural Network Representation, computing a Neural Network's Output, Vectorizing Across Multiple Examples, Activation Functions, why do you need Non-Linear Activation Functions? Derivatives of Activation Functions, Gradient Descent for Neural Networks, Backpropagation Intuition, Random Initialization, Deep L-layer Neural Network, Forward Propagation in a Deep Network, getting your Matrix Dimensions Right, Building Blocks of Deep Neural Networks, Forward and Backward Propagation, Parameters vs Hyperparameters.

Module 3: Foundations of Convolutional Neural Networks [10L]
Computer Vision, Edge Detection Example, Padding, Strided Convolutions, Convolutions Over Volume, One Layer of a Convolutional Network, Simple Convolutional Network Example, Pooling Layers, Why Convolutions? Classic Networks, ResNets, Why ResNets Work? Networks in Networks and 1X1 Convolutions, Inception Network, MobileNet Architecture, EfficientNet, Using Open-Source Implementation, Transfer Learning, Data Augmentation; Object Localization, Landmark Detection, Object Detection, Convolutional Implementation of Sliding Windows, Bounding Box Predictions, Non-max Suppression, Anchor Boxes, YOLO Algorithm, Semantic Segmentation with U-Net, Transpose Convolutions, U-Net Architecture, RCNN, Fast RCNN, Mask-RCNN.

Module 4: Sequence Models & Representation Learning [12L]
Why Sequence Models? Notation, Recurrent Neural Network Model, Backpropagation Through Time, Different Types of RNNs, Language Model and Sequence Generation, Sampling Novel Sequences, Vanishing Gradients with RNNs, Gated Recurrent Unit (GRU), Long Short Term Memory (LSTM), Bidirectional RNN, Deep RNNs, Representation Learning: Autoencoder Fundamentals, Regularization & Autoencoder, Word Representation, Using Word Embeddings, Properties of Word Embeddings, Embedding Matrix, Learning Word Embeddings, Word2Vec, GloVe Word Vectors, Sentiment Classification, Debiasing Word Embeddings, Basic Sequence Models, Picking the Most Likely Sentence, Beam Search, Refinements to Beam Search, Error Analysis in Beam Search, Attention Model, Trigger Word Detection, Transformer Network Intuition, Self-Attention, Multi-Head Attention.

Module 5: Generative Adversarial Network **[4L]**
Basic Concepts, Popular Variants of GAN, Applications of GAN,

Text Books:
1. Charu C. Aggarwal,"Neural Networks and Deep Learning: A Textbook", Springer; 1st ed. 2018 edition
2. Ian Goodfellow, Yoshua Bengio and Aaron Courville, " Deep Learning", published by MIT Press

Reference Books:
1. Francois Chollet, "Deep Learning with Python", Manning Publications; 1st edition
2. Simon Haykin, "Neural Networks and Learning Machines", Pearson Prentice Hall, 3rd Edition
3. Martin T. Hagan, Howard B. Demuth, Mark H. Beale, Orlando De Jess, "Neural Network Design (2nd Edition)".

Paper Name: Cryptography & Network Security
Paper Code: CSM203B
Contact (Periods/Week): 4:0:0
Credit Point: 4
No. of Lectures: 48

Prerequisite:

1. The student must have basic knowledge about Computer Network and mathematics.

Course Outcome(s)

CO1	Understand cryptography and network security concepts and application.
CO2	Apply security principles to system design.
CO3	Identify and investigate network security threat
CO4	Analyze and design network security protocols.
CO5	**Develop** ideas to **Propose** solutions to the problems of network security and **Identify** problems where students can **Apply** the concept appropriately and **Analyze** the effectiveness as well as limitations of solutions making the students aware of its utilitarian importance for further explorations leading towards lifelong learning.

Course Contents

Module-1 [10L]
Introduction - Services, Mechanisms, and Attacks, OSI security architecture, Network security model; Classical Encryption techniques (Symmetric cipher model, substitution techniques, transposition techniques, steganography)
Finite Fields and Number Theory: Groups, Rings, Fields, Modular arithmetic, Euclid's algorithm
Polynomial Arithmetic, Prime numbers, Fermat's and Euler's theorem
Testing for primality -The Chinese remainder theorem - Discrete logarithms

Module-2 [8L]

Data Encryption Standard- Block cipher principles, block cipher modes of operation
Advanced Encryption Standard (AES), Triple DES, Blowfish, RC5 algorithm
Public key cryptography: Principles of public key cryptosystems, The RSA algorithm
Key management - Diffie Hellman Key exchange, Elliptic curve arithmetic, Elliptic curve cryptography

Module-3 [8L]

Authentication requirement, Authentication function, MAC, Hash function
Security of hash function and MAC, MD5, SHA, HMAC, CMAC
Digital signature and authentication protocols, DSS, ElGamal, Schnorr

Module-4 [10L]

Authentication applications, Kerberos, X.509
Internet Firewalls for Trusted System: Roles of Firewalls, Firewall related terminology- Types of Firewalls, Firewall designs principles
SET for E-Commerce Transactions
Intruder, Intrusion detection system
Virus and related threats, Countermeasures
Trusted systems, Practical implementation of cryptography and security

Module-5 [12L]
E-mail Security: Security Services for E-mail-attacks possible through E-mail, Establishing keys privacy, authentication of the source
Message Integrity, Non-repudiation, Pretty Good Privacy, S/MIME
IP Security: Overview of IPSec, IPv4 and IPv6-Authentication Header, Encapsulation Security Payload (ESP)
Internet Key Exchange (Phases of IKE, ISAKMP/IKE Encoding)
Web Security: SSL/TLS Basic Protocol, computing the keys, client authentication
PKI as deployed by SSL Attacks fixed in v3, Exportability, Encoding, Secure Electronic Transaction

Textbooks
[1] Kahate, A. (2013). Cryptography and network security. Tata McGraw-Hill Education.
[2] Forouzan, B. A., & Mukhopadhyay, D. (2015). Cryptography and network security. New York, NY: Mc Graw Hill Education (India) Private Limited.

Reference Books
[1] Stallings, W. (2006). Cryptography and network security, 4/E. Pearson Education India.
[2] Daras, N. J., & Rassias, M. T. (Eds.). (2015). Computation, cryptography, and network security (pp. 253-287). Springer.
[3] Kumar, A., & Bose, S. (2017). Cryptography and network security. Pearson Education India.

Course Name: Smart Sensors and Internet of Things

Course Code: CSM203C

Contact: 4:0:0

Total Contact Hours: 48

Credits: 4

Prerequisites: Wireless Networks

CO1	Understand and explain the basic concept of sensor technologies.
CO2	Apply the concept of Architecture of Smart Sensors to meet the Market requirements of IoT.
CO3	Understand and explain the use of Devices, Gateways and Data Management in IoT.
CO4	Understand and explain IoT and M2M from a global context.
CO5	**Develop** ideas to **Propose** solutions to the problems of sensor technologies & IoT and **Identify** problems where students can **Apply** the concept appropriately and **Analyze** the effectiveness as well as limitations of solutions making the students aware of its utilitarian importance for further explorations leading towards lifelong learning.

Module-1 [7L]

Environmental Parameters Measurement and Monitoring: Why measurement and monitoring are important, effects of adverse parameters for the living being for IOT

Module-2 [8L]

Sensors: Working Principles: Different types; Selection of Sensors for Practical Applications, Introduction of Different Types of Sensors such as Capacitive, Resistive, Surface Acoustic Wave for Temperature, Pressure, Humidity, Toxic Gas etc.

Module-3 [11L]

Important Characteristics of Sensors: Determination of the Characteristics Fractional order element: Constant Phase Impedance for sensing applications such as humidity, water quality, milk quality Impedance Spectroscopy: Equivalent circuit of Sensors and Modelling of Sensors Importance and Adoption of Smart Sensors.

Module-4 [10L]

Architecture of Smart Sensors: Important components, their features Fabrication of Sensor and Smart Sensor: Electrode fabrication: Screen printing, Photolithography, Electroplating Sensing film deposition: Physical and chemical Vapor, Anodization, Sol-gel.
Interface Electronic Circuit for Smart Sensors and Challenges for Interfacing the Smart Sensor, Usefulness of Silicon Technology in Smart Sensor and Future scope of research in smart sensor.
Recent trends in smart sensor for day-to-day life, evolving sensors and their architecture.

Module-5 [12L]

Introduction to Internet of Things- Definition and Characteristics of IoT, Sensors, Actuators, Physical Design of IoT – IoT Protocols, IoT communication models, IoT Communication APIs, IoT enabled Technologies – Wireless Sensor Networks, Cloud Computing, Embedded Systems, IoT Levels and Templates, Domain Specific IoTs – Home, City, Environment, Energy, Agriculture and Industry.

IoT and M2M- Software defined networks, network function virtualization, difference between SDN and NFV for IoT, Basics of IoT System Management with NETCOZF, YANG- NETCONF, YANG, SNMP NETOPEER

Textbooks:

1. Yasuura, H., Kyung, C.-M., Liu, Y., Lin, Y.-L., Smart Sensors at the IoT Frontier, Springer International Publishing
2. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015 3. Editors Ovidiu Vermesan

Reference Books:

1. Kyung, C.-M., Yasuura, H., Liu, Y., Lin, Y.-L., Smart Sensors and Systems, Springer International Publishing
2. Internet of Things - A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015, ISBN: 9788173719547

Course Name: Quantum Computing

Course Code: CSM203D

Contact: 4:0:0

Total Contact Hours: 48

Credits: 4

Prerequisites: Discrete Structures

Course Outcomes:

After completion of the course students will be able to

CO1	**Understand** the basic idea of quantum computing including background of mathematics and physics required for **developing** and **solving** complex engineering problem in the domain of quantum computing possibly using modern engineering tools.
CO2	**Understand** and **explain** the concept of quantum circuits **using** single and multiple qubit gates and also **designing** of quantum circuits for solving engineering problem including societal and environmental issues.
CO3	**Compare** between classical and quantum information theory and **explain** and **apply** Bell states, Quantum teleportation, Quantum Cryptography and no cloning theorem in **solving** engineering problem possibly in a team maintain proper ethics of professional collaboration.
CO4	**Understand, explain and apply** different quantum algorithms including classical computation on quantum computers like Deutsch's algorithm, Deutsch's-Jozsa algorithm, Shor factorization, Grover search and also **relate** between quantum and classical complexity classes for solving engineering problem.
CO5	**Understand** noise and error correction including graph states and codes, quantum error correction, fault-tolerant computation and **apply** it in **designing** and **solving** complex engineering problems leading to their lifelong learning.

Course Content:

Module1: Introduction to Quantum Computation: [10L]

Quantum bits, Bloch sphere representation of a qubit, multiple qubits. Background Mathematics and Physics: Hilber space, Probabilities and measurements, entanglement, density operators and correlation, basics of quantum mechanics, Measurements in bases other than computational basis.

Module2: Quantum Circuits: [10L]

Single qubit gates, multiple qubit gates, design of quantum circuits.

Module3: Quantum Information and Cryptography: [10L]

Comparison between classical and quantum information theory. Bell states. Quantum teleportation. Quantum Cryptography, no cloning theorem.

Module4: Quantum Algorithms: [10L]

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

Module5: Noise and error correction: [8L]

Graph states and codes, Quantum error correction, fault-tolerant computation.

Text book:

1. Nielsen M. A., Quantum Computation and Quantum Information, Cambridge University Press.
2. 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.
3. Pittenger A. O., An Introduction to Quantum Computing Algorithms

Reference Books:

1. P Kaye, R Laflamme and M Mosca, An Introduction to Quantum Computing.
2. Eleanor G. Rieffel , Wolfgang H. Polak , “Quantum Computing - A Gentle Introduction” (Scientific and Engineering Computation)
3. Yanofsky's and Mannucci, Quantum Computing for Computer Scientists.
4. Riley Tipton Perry, “Quantum Computing from the Ground Up”, World Scientific Publishing Ltd.
5. Scott Aaronson, “Quantum Computing since Democritus”, Cambridge.
6. P. Kok, B. Lovett, “Introduction to Optical Quantum Information Processing”, Cambridge.

Course Name: Data Mining and Data Warehousing

Course Code: CSM204A

Contact: 4:0:0

Total Contact Hours: 48

Credits: 4

Prerequisites: Data Structure, Design and Analysis of Algorithms, Database Management Systems, Statistics, Artificial Intelligence

Course Outcomes:

After completion of the course students will be able to

CO1	**Understand and explain** the fundamental concepts of the evolving technologies in Data Mining (such as Mining Frequent Patterns and Data Streams, Associations, Supervised and Unsupervised Learning, Graph Mining, Web Mining etc.) and Data Warehousing (such as Data Cube and OLAP) recognizing their utilitarian importance in current technological context for further exploration leading towards lifelong learning.
CO2	**Identify** and **formulate** an engineering problem within the scope of Data Mining and Data Warehousing paradigm.
CO3	**Explore** relevant literature and **apply** the concepts of Data Mining and Data Warehousing to **solve** problems of making automated decisions dealing with large scale data.
CO4	**Develop** ideas for **proposing** solutions to the challenging problems of Data Mining and Data Warehousing.
CO5	**Implement** ideas of Data Mining and Data Warehousing through **developing** feasible algorithms or frameworks and **investigate** their effectiveness in solving the relevant problems by **analyzing** the performances using proper techniques.

Course Content:

MODULE-1: Introduction to Data Mining [6L]

Basic Concepts, Data Exploration: Data Types, Data Attributes, Statistical Description of Data, Data Visualization, Data Similarity Measures; Data Preprocessing: Data Cleaning, Data Integration, Data Reduction, Data Transformation & Discretization.

MODULE-2: Introduction to Data Warehousing [8L]

Basic Concepts, Data Warehouse Modeling: Data Cube and OLAP (OnLine Analytical Processing); Data Warehouse Design, Usage, and Implementation; Data Generalization by Attribute-Oriented Induction.

MODULE-3: Mining Frequent Patterns, Associations and Correlation Analysis [8L]

Basic Concepts, Frequent Itemset Mining Methods: The Apriori Algorithm, Mining Frequent Item Sets without Candidate Generation, Mining Frequent Item Sets Using Vertical Data Format, Correlation Analysis; Pattern Mining in Multilevel and Multidimensional Space.

MODULE-4: Classification and Regression [8L]

Basic Concepts, k-Nearest-Neighbor Classifier, Decision Tree Classifier, Naïve Bayes Classifier; ANN-Backpropagation Based Classifier, Support Vector Machine Based Classifier, Linear and Nonlinear Regression Methods.

MODULE-5: Clustering and Outlier Analysis [6L]

Basic Concepts, Partitioning Methods: k-Means and k-Medoids, Hierarchical Methods: Agglomerative and Divisive Hierarchical Clustering, Density-Based Methods: DBSCAN: Density-Based Clustering Based on Connected Regions with High Density, Frequent Pattern–Based Clustering Method; Outlier Analysis.

MODULE-6: Mining Data Stream, Time-Series, and Sequence Data [5L]

Basic Concepts of Data Stream Mining; Mining Time Series Data; Mining Sequence Patterns in Biological Data.

MODULE-7: Introduction to Graph Mining, Social Network Analysis, Multi-relational Data Mining, Text Mining and World Wide Web (WWW) Mining [7L]

Graph Mining: Methods for Mining Frequent Subgraphs (Apriori-based Approach & Pattern Growth Approach); Basic Concepts of Social Network Analysis and Multi-relational Data Mining; Basic Concepts of Text Mining; Basic Concepts of World Wide Web (WWW) Mining.

Text book:

- Han J & Kamber M, "Data Mining: Concepts and Techniques", Morgan Kaufmann Publishers, Third Edition.
- Parteek Bhatia, "Data Mining and Data Warehousing: Principles and Practical Techniques", Cambridge University Press.

Reference Books:

- Pang-Ning Tan, Vipin Kumar, Michael Steinbanch, "Introduction to Data Mining", Pearson Education.
- Robert Layton, "Learning Data Mining with Python", Packt Publishing

Course Name: Big Data Analytics

Course Code: CSM204B

Contact: 4:0:0

Total Contact Hours: 48

Credits: 4

Prerequisites: Data Structure, Design and Analysis of Algorithms, Database Management Systems, Statistics, Artificial Intelligence

Course Outcomes:

After completion of the course students will be able to

CO1	**Understand and explain** the fundamental concepts of the Big Data Analytics which are primarily explored for making automated decisions using machine learning strategies on analyzing large scale structured as well as unstructured data distributed across multiple locations (Map Reduce, Hadoop and NoSQL Framework) underscoring the utilitarian importance in current technological context for further exploration leading towards lifelong learning.
CO2	**Identify** and **formulate** an engineering problem of analyzing large scale data distributed across multiple locations to make automated meaningful decisions within the scope of Big Data Analytics Frameworks.
CO3	**Explore** relevant literature and **apply** the concepts of Big Data Analytics to **solve** problems of making automated decisions dealing with large scale structured as well as unstructured data using Map Reduce, Hadoop and advanced SQL Frameworks.
CO4	**Excogitate** ideas for **proposing** solutions to the challenging problems of Big Data Analytics.
CO5	**Apply** the concepts of Big Data Analytics through **developing** feasible algorithms or frameworks and **investigate** their effectiveness in solving the relevant problems by **analyzing** the performances using proper techniques.

Course Content:

Module – 1: Introduction to Basic Analytics [12L]

Introduction: Big data overview, Analyst's perspective on data repositories, Current analytical architecture, Drivers of big data, Examples of big data analytics.

Life Cycle of Data Analytics: Phase 1: Discovery, Phase 2: Data preparation, Phase 3: Model planning, Phase 4: Model building, Phase 5: Communication of results, Phase 6: Making operational.

Basic Analytic Methods: Visualization, Dirty data, Data exploration versus presentation, Statistical methods for evaluation – hypothesis testing, difference of means, rank sum test, type I and type II errors, ANOVA.

Module - 2: Advanced Analytic Methods I [12L]

Clustering: Overview, K-means, Determining the number of clusters, Diagnostics.

Association Rules: Overview, Apriori algorithm, Evaluation of candidate rules, Application of association rules, Validation and testing, Diagnostics.

Regression: Linear regression - model description, Logistic regression – model description, Other regression models.

Classification: Decision trees – overview, General algorithm, Decision tree algorithms, Evaluating a decision tree, Naïve Bayes – Bayes theorem, Naïve Bayes classifier, Diagnostics of classifiers.

Module – 3: Advanced Analytic Methods II [12L]

Time Series Analysis: Overview, Box-Jenkins methodology, Autocorrelation function (ACF), Autoregressive model, Moving average model, ARMA and ARIMA model, Building and evaluating an ARIMA model.

Text Analysis: Steps in text analysis, Collecting raw text, Representing text, Term Frequency-Inverse Document Frequency (TFIDF), Categorizing documents by types, Determining sentiments.

Map Reduce and Hadoop: Analytics for unstructured data – map reduce, Apache Hadoop, Hadoop Ecosystem – Pig, Hive, Hbase, Mahout.

Module – 4: Advanced Analytic Methods III [12L]

Technology and Tools: SQL essentials - Join, Set, Grouping extensions, Advanced SQL – Window functions, User-defined functions, Ordered aggregates, MADlib, NoSQL.

Integration of Techniques: Communicating and operationalizing an analytic project.

Creating final deliverables – Developing core materials, project goals, Main findings, Approach, Model description and model details, Recommendations, Providing technical specifications and code.

Data visualization basics - Key points, evolution of a graph, common representation methods, how to clean up a graphic.

Text book:

1. EMC Education Services (Editor), Data Science and Big Data Analytics. John Wiley & Sons, 2015.
2. Mike Barlow, Real-Time Big Data Analytics: Emerging Architecture. O'Reilly, 2013.

Reference Books:

1. Nathan Marz and James Warren, Big Data: Principles and Best Practices for Scalable Real-time Data Systems. Manning Publications, 2015.
2. Venkat Ankam, Big Data Analytics. Packt Publishing Ltd., UK, 2016.

Course Name: Natural Language Processing

Course Code: CSM204C

Contact: 4:0:0

Total Contact Hours: 48

Credits: 4

Prerequisites:

Statistics, Automata, Compiler Design

Course Outcomes:

After completion of the course students will be able to

CO1	**Understand** the basic concepts of NLP to **Explain or Illustrate** and **Identify** problems where students can **Apply** the concept appropriately to **Solve** them.
CO2	**Understand** the fundamental concepts of Text Preprocessing and Morphology so that they can **Apply** the concept to **Analyze** their CORPUS.
CO3	**Explain or Illustrate** the fundamental strategies of Language Modelling and Word Sense Disambiguation acquiring enough knowledge to **Propose** models for Word Prediction & Disambiguation and **Evaluate** their performances.
CO4	**Explain or Illustrate** the concepts of Markov Model for POS Tagging and Probabilistic Context Free Grammars and Probabilistic parsing so that they can **Apply** them to solve the relevant problems and **Analyze** their performances.
CO5	**Develop** ideas to **Propose** solutions to the problems of Syntax & Semantics Analysis for Machine Translation and **Identify** problems where students can **Apply** the concept appropriately and **Analyze** the effectiveness as well as limitations of solutions underscoring the utilitarian importance for further exploration of NLP issues leading towards lifelong learning.

Course Content:

Module-I: Introduction to NLP [6L]

Introduction to NLP - Various stages of NLP –The Ambiguity of Language: Why NLP Is Difficult Parts of Speech: Nouns and Pronouns, Words: Determiners and adjectives, verbs, Phrase Structure. Statistics Essential Information Theory: Entropy, perplexity, The relation to language, Cross entropy.

Module-II: Text Preprocessing and Morphology [6L]

Character Encoding, Word Segmentation, Sentence Segmentation, Introduction to Corpora, Corpora Analysis. Inflectional and Derivation Morphology, Morphological analysis and generation using Finite State Automata and Finite State transducer.

Module-III: Language Modeling [6L]

Introduction to N-grams, Chain Rule, Smoothing – Add-One Smoothing, Witten-Bell Discounting; Backoff, Deleted Interpolation, N-grams for Spelling and Word Prediction, Evaluation of language models.

Module-IV: Word Sense Disambiguation [9L]

Methodological Preliminaries, Supervised Disambiguation: Bayesian classification, An information theoretic approach, Dictionary-Based Disambiguation: Disambiguation based on sense, Thesaurus based disambiguation, Disambiguation based on translations in a second-language corpus.

Module-V: Markov Model and POS Tagging [6L]

Markov Model: Hidden Markov model, Fundamentals, Probability of properties, Parameter estimation, Variants, Multiple input observation. The Information Sources in Tagging: Markov model taggers, Viterbi algorithm, Applying HMMs to POS tagging, Applications of Tagging.

Module-VI: Probabilistic Context Free Grammars and Probabilistic parsing [6L]

The Probability of a String, Problems with the Inside-Outside Algorithm, Parsing for disambiguation, Treebanks, Parsing models vs. language models, Phrase structure grammars and dependency, Lexicalized models using derivational histories, Dependency-based models.

Module-VII: Syntax & Semantics Analysis and Machine Translation [9L]

Shallow Parsing and Chunking, Shallow Parsing with Conditional Random Fields (CRF), Lexical Semantics, WordNet, Thematic Roles, Semantic Role Labelling with CRFs. Statistical Alignment and Machine Translation, Text alignment, Word alignment, Information extraction, Text mining, Information Retrieval, NL interfaces, Sentimental Analysis, Question Answering Systems, Social network analysis.

Text book:

3. Speech and Language Processing, Jurafsky and Martin, Pearson Education
4. Foundation of Statistical Natural Language Processing, Manning and Schutze, MIT Press
5. Multilingual Natural Language Processing Applications from Theory to Practice: Bikel, Pearson.
6. Ela Kumar, "Natural Language Processing', Wiley

Reference Books:

1. Allen, James. 1995. – "Natural Language Understanding". Benjamin/Cummings, 2ed. 2.
2. Bharathi, A., Vineet Chaitanya and Rajeev Sangal. 1995. Natural Language Processing- "A Paninian Perspective". Prentice Hll India, Eastern Economy Edition.
3. Hobson lane, Cole Howard, Hannes Hapke, "Natural language processing in action" MANNING Publications, 2019

Course Name: Computer Vision
Course Code: CSM204D
Contact: 4:0:0
Total Contact Hours: 48
Credits: 4

Prerequisites: Digital Image Processing, Machine Learning

Course Outcome(s):
After completion of the course students will be able to

CO1	**Understand** the basic concepts of Computer Vision to **Explain or Illustrate** and **Identify** problems where students can **Apply** the concept appropriately to **Solve** them.
CO2	**Understand** the fundamental concepts of Image Analysis and Image Feature Descriptors, and Etraction Techniques and **Analyze** their performances.
CO3	**Explain or Illustrate** the fundamental strategies of Image Registration to solve related problems and **Analyze** their performances.
CO4	**Explain or Illustrate** the concepts of Shape Matching, Video Processing and Apply them to solve the relevant problems and **Analyse** their performances.
CO5	**Develop** ideas to **Propose** solutions to the problems of Computer Vision and **Identify** problems where students can **Apply** the concept appropriately and **Analyze** the effectiveness as well as limitations of solutions making the students aware of its utilitarian importance for further explorations leading towards lifelong learning.

Course Content:

Module 1: Introduction to Computer Vision [2L]

Basics of Computer Vision Systems, Computer Vision Problems, Computer Vision Solution Models.

Module 2: Image Analysis and Image Feature Descriptors [12L]

Image Analysis Basics, Edge Detection and Hough Transform – Definition Edges, Edges in real image, Gradient, Steps in Edge Detection, Different Edge Detectors, Second Derivative Operators, Laplacian Operator, Laplacian of Gaussian, Canny Edge Detector, Hough Transform, Hough space, Finding Circles by Hough Transform, Generalized Hough Transform.

Image Feature Descriptors and Extraction Techniques – Image Object Shape Descriptors, HOG, Harris Corner Detector, Scale Invariant Feature Transform (SIFT), SIFT-PCA, Speeded Up Robust Features (SURF).

Module 3: Texture Analysis [6L]
Definition and Applications, Texture Definition - Statistical Approach, Edge Density and Direction, Local Binary Pattern, Gray Level Co-occurance Matrix, Co-occurrence Features, Laws' Texture Energy Features, Law's texture masks, LBP: Applications to Medical Images.

Module 4: Image Registration [4L]

Transformation, Registration algorithms - Point-based Method, Landmark based Method, Intensity based Method, Surface-based Method, Similarity Measures

Module 5: Shape Descriptor & Shape Matching [6L]

Geometric Transformation, Shape Contexts, Shape Matching, Thin-Plate Spline Model, Hierarchical Matching of Deformable Shapes, The Shape Tree, Deformation Model, Elastic Matching

Module 6: Video Processing Basics [6L]

Digital Video Formation basics, Background subtraction in video, Object Tracking in video, Video Surveillance Applications.

Module 7: Advanced Computer Vision Applications [12L]

Image Object Detection and Recognition: Face Detection and Recognition, Image Object Segmentation, Image Retrieval, Document Image Processing.

Text Book:

- David A. Forsyth and Jean Ponce, Computer Vision: A Modern Approach, Pearson Education, 2003
- Anil K. Jain, Fundamentals of Digital Image Processing, Prentice Hall, 1989 - Technology & Engineering
- Simon J.D. Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 2012.

Reference(s):

- Insight into Images: Principles and Practice for Segmentation, Registration, and Image Analysis, By: T. S. Yoo, 2004
- Biomedical Images Analysis, by: R. M. Rangayya, 2004, eBook.

Course Name: Entrepreneurship
Course Code: CSM205A
Contact: 4:0:0
Total Contact Hours: 48
Credits: 4

Prerequisites: None

Course Outcome(s):
After completion of the course students will be able to

CO1	**Understand** the basic concepts of Entrepreneurial Perspectives to **Explain or Illustrate** and **Apply** the concept appropriately.
CO2	**Understand** the basic concepts of New Venture Creation to **Explain or Illustrate** and **Apply** the concept appropriately.
CO3	**Understand** the basic concepts of Management of MSMEs and Sick Enterprises to **Explain or Illustrate** and **Apply** the concept appropriately.
CO4	**Understand** the basic concepts of Managing Marketing and Growth of Enterprises to **Explain or Illustrate** and **Apply** the concept appropriately.
CO5	**Understand** the basic concepts of Strategic perspectives in Entrepreneurship to **Explain or Illustrate** and **Apply** the concept appropriately.

Course Content:

Module 1: Entrepreneurial Perspectives [12L]

Introduction to Entrepreneurship – Evolution - Concept of Entrepreneurship - Types of Entrepreneurs - Entrepreneurial Competencies, Capacity Building for Entrepreneurs. Entrepreneurial Training Methods - Entrepreneurial Motivations - Models for Entrepreneurial Development - The process of Entrepreneurial Development.

Module 2: New Venture Creation [12L]

Introduction, Mobility of Entrepreneurs, Models for Opportunity Evaluation; Business plans – Purpose, Contents, Presenting Business Plan, Procedure for setting up Enterprises, Central level - Startup and State level - T Hub, Other Institutions initiatives.

Module 3: Management of MSMEs and Sick Enterprises [6L]
Challenges of MSMEs, Preventing Sickness in Enterprises – Specific Management Problems; Industrial Sickness; Industrial Sickness in India – Symptoms, process and Rehabilitation of Sick Units.

Module 4: Managing Marketing and Growth of Enterprises [6L]

Essential Marketing Mix of Services, Key Success Factors in Service Marketing, Cost and Pricing, Branding, New Techniques in Marketing, International Trade

Module 5: Strategic perspectives in Entrepreneurship [12L]

Strategic Growth in Entrepreneurship, The Valuation Challenge in Entrepreneurship, The Final Harvest of New Ventures, Technology, Business Incubation, India way – Entrepreneurship; Women Entrepreneurs – Strategies to develop Women Entrepreneurs, Institutions supporting Women Entrepreneurship in India.

Text Book:

- Entrepreneurship Development and Small Business Enterprises, Poornima M. Charantimath, 2e, Pearson, 2014.
- Entrepreneurship, a South – Asian Perspective, D.F. Kuratko and T. V. Rao, 3e, Cengage, 2012.

Reference(s):

- Entrepreneurship, Arya Kumar, 4 e, Pearson 2015.
- The Dynamics of Entrepreneurial Development and Management, Vasant Desai, Himalaya Publishing House, 2015.

Course Name: Cyber Law and Ethics
Course Code: CSM205B
Contact: 4:0:0
Total Contact Hours: 48
Credits: 4

Prerequisite:
1. Familiarity in computer Networking, Internet.
2. Basic concepts about network security.

Course Outcome(s):
After completion of the course students will be able to

CO1	understand the importance of professional practice, Law and Ethics in their personal lives and professional careers.
CO2	acquire in depth knowledge of information technology act, security policies, and legal framework of right to privacy, data security and data protection.
CO3	Understand and explain the relationship between commerce and cyberspace
CO4	Understand the basic concepts of network security threats and countermeasures to Explain or Illustrate and Apply the concept appropriately.
CO5	Understand the basic concepts of ethics in cyber space to Explain or Illustrate and Apply the concept appropriately.

Course Contents:
Module – 1: Introduction of Cybercrime [10L]
Cybercrime, Forgery, Hacking, Software Piracy, Computer Network intrusion, Criminals plan attacks, passive attack, Active attacks, cyber stalking.

Module – 2: Cybercrime Mobile & Wireless devices [10L]
Security challenges in mobile devices, cryptographic security for mobile devices, Attacks on mobile/cell phones, Theft, Virus, Hacking. Bluetooth; Different viruses on laptop.

Module -3: Tools and Methods used in Cyber-crime [10L]
Proxy servers, Password checking, Random checking, Trojan Horses and Backdoors; DOS & DDOS attacks; SQL injection: Buffer over flow Attacks, Scripts Kiddies and Packaged Defense.

Module – 4: Cybercrime & Cyber security [10L]
Phishing methods, ID Theft; Online identity method Legal aspects, Indian laws, IT act, Public key certificate, Design of Cyber Security Policy of an Organization, Unicitral Model Law
Jurisdiction to prescribe/Legislative Jurisdiction; Jurisdiction to adjudicate to enforce; Cyber Jurisdiction in Civil, Criminal & International Cases.

Module -5: Cyber Ethics [8L]
The Importance of Cyber Law, Significance of Cyber-Ethics, Need for Cyber regulations and Ethics. Ethics in Information society, Introduction to Artificial Intelligence Ethics: Ethical Issues in AI and core Principles, Introduction to Block chain Ethics.

Text Books:

1. Cyber security by Nina Gobole & Sunit Belapune; Pub: Wiley India.
2. Chris Reed & John Angel, Computer Law, OUP, New York, (2007).
3. Justice Yatindra Singh, Cyber Laws, Universal Law Publishing Co, New Delhi, (2012).
4. Verma S, K, Mittal Raman, Legal Dimensions of Cyber Space, Indian Law Institute, New Delhi, (2004)

Reference Books:

1**.** Kenneth J. Knapp, "Cyber Security and Global Information Assurance:
Threat Analysis and Response Solutions", IGI Global, 2009.
2. Jonathan Rosenoer, "Cyber law: the Law of the Internet", Springer verlag, 1997
3. Vasu Deva, Cyber Crimes and Law Enforcement, Commonwealth Publishers, New Delhi, (2003) .

Course Name: Optimization Techniques
Course Code: CSM205C
Contact: 4:0:0
Total Contact Hours: 48
Credits: 4

Prerequisite: Linear Algebra and Numerical Methods

Course Outcome(s):
After completion of the course students will be able to

CO1	understand and explain the importance of Optimization Algorithms
CO2	acquire in depth knowledge of Optimization with equality constraint and apply it to solve problems.
CO3	Understand and explain Optimization with inequality constraint and apply it to solve problems.
CO4	Understand the basic concepts of nature inspired optimization algorithms to Explain or Illustrate and Apply the concept appropriately.
CO5	Understand the advanced concepts of Optimization Algorithms to apply the concept appropriately it to solve problems.

Course Contents:
Module – 1: [7L]
Optimization Algorithms, Constraints, The Feasible Region.

Module – 2: [7L]

Optimization with equality constraint: Optimization using calculus, Graphical Optimization, Lagrange's method of undetermined multiplier and applications

Module -3: [11L]

Optimization with inequality constraint –Non-linear Programming problem- Quadratic Programming, Semi Definite Programming with applications, Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

Module – 4: [8L]

Optimization Algorithms like Genetic Optimization, Particle Swarm Optimization, Ant Colony Optimization etc.

Module -5: [10L]
Applications of G.A, P.S.O and ACO in global optimization problems.

Module -6: [5L]

Applications in Biological sequence comparison

Text Books:

1. Cyber security by Nina Gobole & Sunit Belapune; Pub: Wiley India.
2. Chris Reed & John Angel, Computer Law, OUP, New York, (2007).
3. Justice Yatindra Singh, Cyber Laws, Universal Law Publishing Co, New Delhi, (2012).
4. Verma S, K, Mittal Raman, Legal Dimensions of Cyber Space, Indian Law Institute, New Delhi, (2004)

Reference Books:

1**.** Kenneth J. Knapp, "Cyber Security and Global Information Assurance:
Threat Analysis and Response Solutions", IGI Global, 2009.
2. Jonathan Rosenoer, "Cyber law: the Law of the Internet", Springer verlag, 1997
3. Vasu Deva, Cyber Crimes and Law Enforcement, Commonwealth Publishers, New Delhi, (2003) .

Course Name: Cost Management of Engineering Projects
Course Code: CSM205D
Contact: 4:0:0
Total Contact Hours: 48
Credits: 4

Prerequisite: Basics of Mathematics
Course Outcome(s):
After completion of the course students will be able to

CO1	Understand the importance of the Strategic Cost Management Process in decision-making
CO2	Understand the basic concepts of cost management in engineering projects to Explain or Illustrate and Apply the concept appropriately.
CO3	Understand the basic concepts of Cost Behavior and Profit Planning Marginal Costing to Explain or Illustrate and Apply the concept appropriately.
CO4	Understand the basic concepts of Material Requirement Planning, Enterprise Resource Planning to Explain or Illustrate and Apply the concept appropriately.
CO5	Understand the basic concepts of Quantitative techniques for cost management to Explain or Illustrate and Apply the concept appropriately.

Course Contents:

Module – 1: [10L]
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.

Module – 2: [10L]
Project: meaning, Different types, why to manage, cost overruns centers, 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.

Module -3: [10L]
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,

Module – 4: [10L]

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.

Module -5: [8L]

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

Text Books:

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

Reference Books:

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
2. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

Course Name: Advanced Algorithms Lab

Course Code: CSM291

Contact: 0:0:3

Total Contact Hours: 36

Credits: 3

Prerequisites: Data Structure, Design and Analysis of Algorithms, Programming Concept

Course Outcomes:

After completion of the course students will be able to

CO1	**Understand** and **Apply** the basics concepts of various Algorithm Design techniques through implementation to **Explain or Illustrate** and **Identify** problems where students can **Apply** the concept appropriately to **Solve** them.
CO2	**Understand** and **Apply** the fundamental concepts of graph algorithms through implementation and **Analyze** their performances.
CO3	**Understand** and **Apply** the fundamental strategies of network flow algorithms through implementation to solve clustering problems and **Analyze** their performances.
CO4	**Understand** and **Apply** the concepts of computational geometric and string matching algorithms through implementation and Apply them to solve the relevant problems and **Analyze** their performances.
CO5	**Develop** advanced algorithms to solve challenging problems and **Implement** the concept appropriately through programming with adequate documentation in collaborative environment for successfully carrying out projects on machine learning problems and **investigate** their effectiveness by **analyzing** the performances using proper techniques and tools and **Assess** the limitations of solutions underscoring utilitarian importance for further explorations leading towards lifelong learning.

Course Content:

WEEK-1:

1. Find second largest number in an array using Divide & Conquer Principle. [Do not use any sorting algorithm]
2. Given a sorted array and a number X, search two elements of array such that their sum is X. Expected time complexity is O(n).
3. Apply Binary Search on 2D NxN array (A) having numbers stored in non-decreasing order under row-major scanning. [Do not use any auxiliary array]
4. Given a sorted array and a number x, write a function that counts the occurrences of x in the array. Expected time complexity is O(log n).

WEEK-2:

1. A sorted array is rotated clockwise arbitrarily. Find the minimum element in it by developing a minimum time complexity algorithm.
2. You are given an array that represents elements of arithmetic progression in order. One element is missing in the progression. Find the missing number by developing a minimum time complexity algorithm.
3. A Bitonic Sequence is a sequence of numbers in which elements are initially in strictly increasing order but after a certain point they are in strictly decreasing order. A Bitonic Point is a point in bitonic sequence before which elements are in strictly increasing order and after which elements are in strictly decreasing order. Find bitonic point in a bitonic sequence by developing a minimum time complexity algorithm.
4. Develop an algorithm by applying the working principle of Merge Sort to count inversion pairs in an array. [Note: Two elements a[i] and a[j] form an inversion pair if a[i] > a[j] and i < j. Example: The sequence 2, 4, 1, 3, 5 has three inversions (2, 1), (4, 1), (4, 3)].

WEEK -3:

1. Given an array of digits, sort them with time complexity O(n) where n is the number of elements in the array.
2. Given two sorted arrays of size m and n respectively, find k'th element of the combined array with time complexity O(log n + log m).
3. Find the median element in an array using partitioning strategy of Quick-Sorting method.
4. There are 2 sorted arrays -- A and B with each having n elements. Write an algorithm to find the median of an array which is produced after merging the above 2 arrays – A and B (i.e. the size of the combined array is 2n). The expected time complexity is O(log(n)).

WEEK -4:

1. Apply min-heap building strategy to find k-th smallest element in an array.
2. Arrange a list of words (each of equal length) using dictionary sorting strategy.
3. Given a value ***V*** and infinite supply of coins of ***m***-denominations ***{C1=1 < C2<C3<…..<Cm}***, you are to make change for Rs. ***V***. Apply DP strategy to find out minimum number of coins to make the change?
4. Given a set of non-negative integers, and a value *sum*, determine if there is a subset of the given set with sum equal to given *sum*.

WEEK -5:

1. Given a cost 2D-matrix and a position (m, n), write a function that returns the cost of minimum cost-path to reach (m, n) from (0, 0).
2. We are given an array p[] which represents the chain of matrices such that the i-th matrix Ai is of dimension p[i-1] x p[i]. We need to write a function that should return the optimal parenthesizing expression resulting minimum multiplication cost to multiply the chain of matrices.
3. Given an array of n numbers, design an algorithm for finding a contiguous subsequence A[i], A[i+1],…, A[i+k] having largest sum.
4. Given weights and values of n items, you are to put these items in a knapsack of capacity W with an objective to get the maximum total value in the knapsack. You cannot break an item, either pick the item, or don't pick it. Write an algorithm for solving the problem and implement it.

WEEK-6:

Implementation of Network Flow and Graph Algorithms

WEEK -7:

Implementation of Computational Geometric and String-Matching Algorithms

WEEK -8:

Implementation of Approximation Algorithms

WEEK -9: Discussion on Project Problems and Allocation (Problem Description Report Submission)

WEEK -10: Designing Solution Model and Proposal Report Submission

WEEK -11: Project Implementation, Verification and Documentation

WEEK -12: Project Demonstration and Project Report Review

Text book:

- "Introduction to Algorithms" by Cormen, Leiserson, Rivest, Stein.
- "The Design and Analysis of Computer Algorithms" by Aho, Hopcroft, Ullman.

Reference Books:

- "Algorithm Design" by Kleinberg and Tardos.
- Design & Analysis of Algorithms, Gajendra Sharma, Khanna Publishing House, New Delhi

Course Name: Soft Computing Lab

Course Code: CSM292

Contact: 0:0:3

Total Contact Hours: 36

Credits: 3

Prerequisites: Python/MATLAB Programming Concept

Course Outcomes:

After completion of the course students will be able to

CO1	**Understand** and **Apply** the basics concepts of soft computing through implementation to **Explain or Illustrate** and **Identify** problems where students can **Apply** the concept appropriately to **Solve** them.
CO2	**Understand** and **Apply** the fundamental concepts of ANN through implementation so that they can **propose models** for predicting values based on exemplary data and **Analyze** their performances.
CO3	**Understand** and **Apply** the fundamental strategies of Fuzzy Logic Systems through implementation to solve problems and **Analyze** their performances.
CO4	**Understand** and **Apply** the concepts of genetic algorithm and Swarm Intelligence System through implementation and Apply them to solve the optimization problems and **Analyze** their performances.
CO5	**Understand** the concepts of advanced soft computing techniques to **Propose** solutions to the problems of optimization and **Implement** the concept appropriately through programming with adequate documentation in collaborative environment for successfully carrying out projects on machine learning problems and **investigate** their effectiveness by **analyzing** the performances using proper techniques and tools and **Assess** the limitations of solutions underscoring utilitarian importance for further explorations leading towards lifelong learning.

Course Content:

WEEK-1: Introduction to Soft Computing Programming Platform & Python/Matlab Programming Basics

Introduction to Soft Computing Programming Platform and Python/MATLAB Programming Basics

WEEK-2: ANN

Implementation of the concept of ANN

WEEK -3: Fuzzy Application

Implementation of the concept of Fuzzy Logic

WEEK -4: Genetic Algorithm

Implementation of the concept of Genetic Algorithm

WEEK -5: Rough Set

Implementation of the concept of Rough Set

WEEK-6: Swarm Intelligence System

Implementation of the concept of ACO

WEEK -7: Swarm Intelligence System

Implementation of the concept of PSO

WEEK -8: Swarm Intelligence System

Implementation of the concept of ABC and CSA

WEEK -9: Discussion on Project Problems and Allocation (Problem Description Report Submission)

WEEK -10: Designing Solution Model and Proposal Report Submission

WEEK -11: Project Implementation, Verification and Documentation

WEEK -12: Project Demonstration and Project Report Review

Text book:

1."Neural Networks, Fuzzy logic, and Genetic Algorithms", S. Rajasekaran & G. A. V. Pai, PHI.
2."Principles of Soft Computing", S.N. Sivanandam, S.N Deepa, wiley publications.
3 A. E. Eiben and J. E. Smith, "An Introduction to Evolutionary Computing", Natural Computing Series, Springer, 2nd Edition, 2015.
4."An Introduction to Genetic Algorithm", Mitchell Melanie, Prentice Hall, 1998.

Reference Books:

1. "Genetic Algorithms in Search, Optimization and Machine Learning", David E. Goldberg, Addison Wesley, 1997.
2."Intelligent Hybrid Systems", D. Ruan, Kluwer Academic Publisher, 1997.
3. Soft Computing with MATLAB Programming, N. P. Padhy and S. P. Simon, Oxford University Press; UK ed. Edition.

Semester III:

Subject Code	Subject Name	L:T:P/Week	Total Credits	Contact Hours/Week
CSM301	Audit Course II	2:0:0	0	2
PRACTICAL:				
CSM391	Project Part-I	0:0:12	6	12
	TOTAL:	**0:0:12**	**6**	**12**

Semester IV:

Subject Code	Subject Name	L:T:P/Week	Total Credits	Contact Hours/Week
PRACTICAL:				
CSM491	Comprehensive Viva Voce	0:0:0	4	0
CSM492	Project Part-II	0:0:12	6	12
	TOTAL:	**0:0:12**	**10**	**12**

Audit Course II

5. Constitution of India
6. Pedagogy Studies
7. Stress Management by Yoga
8. Personality Development through Life Enlightenment Skills.