Course Structure & Syllabus of M.Tech – Computer Science & Engineering

Applicable for Batch: 2021-2023

DIT UNIVERSITY

Dehradun

Detailed Course Structure & Syllabus

of

M.Tech – CSE

Approved by the Academic Council at its 17th Meeting held on 24.03.2021

Course Structure & Syllabus of M.Tech – Computer Science & Engineering

Applicable for Batch: 2021-2023

About the Program:

The M.Tech in Computer Science and Engineering is a rigorous and advanced research and development (R&D) based program to prepare graduates for a high end career in the industry and research labs. The program allows students to register in relevant courses and specialize in the most promising emerging areas of computer industry, as follows:

(a) Artificial Intelligence, Machine Learning and Robotics

(b) Internet of Things

(c) Data Science and Engineering

(d) Computer Vision and Biometrics

Program Specific Objectives (POs):

Graduates of this program, by the time of graduation will be able to:

1. Review core concepts of computing and mathematical modelling.
2. Acquirecore knowledge of variousconcepts appropriate to the specialized discipline.
3. Acquire advanced knowledge of various concepts appropriate to the specialized discipline.
4. Apply appropriate techniques, skills, and knowledgeto identify gaps in existing research problems, develop research objectives, and solve them.

Program Educational Objectives (PEOs):

Our program educational objectives for students 3 to 5 years after graduating with a Master of Technologyin Computer Science and Engineering are that they will be:

1. Globally competent and provide sustainable solutions toresearch and development challenges of the society.
2. Able to lead professional activities with ethical practices in Computer Science research to contribute to society with their innovative skills.

Program Highlights:

- 48 credits program in two options - With thesis (32 credits of coursework + 16 credits of Thesis), Without Thesis (44 credits of coursework and a scholarly research paper of 4 credits).
- Advanced core and elective courses with latest curriculum and research trends.

Course Structure & Syllabus of M.Tech – Computer Science & Engineering

Applicable for Batch: 2021-2023

- Campus Placement in high-end companies and multinational research labs.
- Students intending to pursue a Ph.D. after M.Techshould apply for the Thesis option rather than the Non-Thesis option. Alternatively, students will have the option to be fast-tracked to the Ph.D. program in the later part of the program after having completed a minimum of two semesters of the M.Tech Thesis program. Each fast-tracking application will be evaluated by a committee. Evaluation criteria will include excellent academic record with a passion for research.

Eligibility

- B.Tech degree in CSE/IT/ECE/EE and allied areas with a minimum of 55% marks OR
- MCA/M.Sc(CS/IT/Electronics and allied areas) degree with a minimum of 55% marks OR
- MSc in Mathematics with at least 55% marks in both B.Sc and M.Sc.

Admission Procedure

- Candidates with a valid GATE (CS &IT)/UGC-NET Score: Personal interview.
- Candidates without a valid GATE (CS &IT)/UGC-NET Score: DIT University Entrance Test (DUET) followed by Personal interview.

Program Curriculum (Total Credits = 48)

Thesis Option:

- Core Courses: 08 credits
- Specialized Core Courses: 08 Credits
- Specialized Elective Courses: 16 Credits
- Thesis: 16 Credits

Non-Thesis Option:

- Core Courses: 08 credits
- Specialized Core Courses: 08 Credits
- Specialized Elective Courses: 28 Credits

Scholarly Paper: 04 Credits

Course Structure & Syllabus of M.Tech – Computer Science & Engineering

Applicable for Batch: 2021-2023

List of Core Courses:

- CSF601 Data Structures and Algorithm Design
- CSF602 Modelling and Simulation

List of Specialized Core Courses:

- **AI, Machine Learning and Robotics:** CSF611 Artificial Intelligence and Knowledge Representation, CSF612 Robotics Systems
- **Internet of Things:**CSF613 Data Communication Systems, CSF614 Wireless and Mobile Computing
- **Data Science and Engineering:** CSF615 Introduction to Data Science, CSF616 Data Mining
- **Computer Vision and Biometrics:**CSF617 Visual Computing, CSF618 Advanced Image Processing

Note:

- **First digit is 6 for first year of a Post Graduate Program**
- **Second digit is 0 for core courses, 1 for specialized core courses, 4-7 for elective courses**
- **Third digit is 1-9 for numbering of the course**

List of Specialized Elective Courses:

- CSF641 Internet of Things and Edge Computing
- CSF642 Cloud Computing and Virtualization
- CSF643 Programming for Data Science
- CSF644 Applied Machine Learning and Deep Learning
- CSF645 Data Analytics
- CSF646 Image and Video Processing
- CSF647 Natural Language Processing
- CSF648 Research Ethics and Methods
- CSF649 Fuzzy Neural Networks
- CSF651 Evolutionary Computing Techniques
- CSF652 Applied Cryptography

Course Structure & Syllabus of M.Tech – Computer Science & Engineering

Applicable for Batch: 2021-2023

List of Core Courses:

- CSF601 Data Structures and Algorithm Design
- CSF602 Modelling and Simulation

List of Specialized Core Courses:

- **AI, Machine Learning and Robotics:** CSF611 Artificial Intelligence and Knowledge Representation, CSF612 Robotics Systems
- **Internet of Things:**CSF613 Data Communication Systems, CSF614 Wireless and Mobile Computing
- **Data Science and Engineering:** CSF615 Introduction to Data Science, CSF616 Data Mining
- **Computer Vision and Biometrics:**CSF617 Visual Computing, CSF618 Advanced Image Processing

Note:

- **First digit is 6 for first year of a Post Graduate Program**
- **Second digit is 0 for core courses, 1 for specialized core courses, 4-7 for elective courses**
- **Third digit is 1-9 for numbering of the course**

List of Specialized Elective Courses:

- CSF641 Internet of Things and Edge Computing
- CSF642 Cloud Computing and Virtualization
- CSF643 Programming for Data Science
- CSF644 Applied Machine Learning and Deep Learning
- CSF645 Data Analytics
- CSF646 Image and Video Processing
- CSF647 Natural Language Processing
- CSF648 Research Ethics and Methods
- CSF649 Fuzzy Neural Networks
- CSF651 Evolutionary Computing Techniques
- CSF652 Applied Cryptography

CSF601 Data Structures and Algorithms Design [3 0 2 4]

Course Objectives: To understand and implement different types of data structures and their applications and learn different types of algorithmic techniques and strategies.

Course Contents:

Analysis of Algorithms: Asymptotic Analysis, Asymptotic Notations, Running time calculation.

Linear Data Structures: Arrays, Stacks, Queues, Lists, their operations, and implementations.

Searching and Sorting: Linear Search, Binary Search, Bubble Sort, Selection Sort, Insertion Sort, Shell Sort, Quick Sort, Heap Sort, Merge Sort, etc.

Algorithmic Strategies: Brute Force approach, Greedy approach, Divide and Conquer algorithms, Recursive Algorithms, Backtracking Algorithms, Dynamic Programming, etc with appropriate examples.

Non-Linear Data Structures: Hash tables, Trees, Graphs, their operations, implementation with relevant examples.

Miscellaneous Topics: P NP Problems, Randomized Algorithms, other miscellaneous algorithmic techniques.

Laboratory work: Implementation of problems related to Arrays, Recursion, Stacks, Queues, Lists, Trees, Graphs, Searching and Sorting Techniques. Implementation of problems based on prominent algorithmic techniques.

Course Outcomes (COs): After the completion of the course, students will be able to:

1. Analyze complexity of Algorithms,
2. Implement linear data structures and solve problems using fundamental algorithms.
3. Implement non-linear data structures and solve problems using fundamental algorithms.
4. Understand and Implement various algorithmic techniques to solve real world problems.

CSF602 Modelling and Simulation [3 0 2 4]

Course Objectives: Introduce computer simulation technologies and techniques, provides the foundations for the student to understand computer simulation needs, and to implement and test a variety of simulation and programs.

Course Contents:

System Models: Concepts of a System, System Environment, Stochastic Activities, Continuous and Discrete System, Types of Models.

Discrete System Simulation: Monte Carlo method, Random Numbers, Congruence Generators, Uniformity and Independence Testing.

Queuing Theory: Notation, Little theorem, Queuing Model, Time Oriented Simulation, Event Oriented Simulation, Simulation of two server queuing system.

Simulation of Inventory Systems: Classification of Inventory Systems, Inventory Costs, Single Item Constant Demand Inventory Model, EOQ with constant Lead Time and Shortage.

Miscellaneous Topics: Simulation of PERT, CPM Computations, Verification and Validation of Simulation Models, Design of Simulation Experiment.

Laboratory work: Implementation of problems related to Random Number Generator, Statistical functions, Single-Server Model, Two-Server Models, and Inventory Systems etc.

Course Outcomes (COs): After the completion of the course, students will be able to:

1. To create simulation models of various types,
2. Identify and Implement different types of models and simulations techniques.
3. Understand and Explain the use of models and simulations for hypothesis testing
4. Implement various algorithmic techniques use to link the physical world, the virtual world and the science of prediction.

CSF611 Artificial Intelligence and Knowledge Representation [3 0 2 4]

Course Objectives: To provide the foundation for AI problem solving techniques and knowledge representation formalisms.

Course Contents:
Introduction to AI: Definitions, The Foundations AI, The History of AI, Intelligent Agents, Structure of Intelligent Agents, Environments

Problem-solving: Problem solving Agents, Problem Formulation, Search Strategies, Constraint Satisfaction Search, Informed Search Methods

Knowledge representation and reasoning: Agents that Reason Logically, Propositional Logic and Inference, First-Order Logic, Inference in First-Order Logic

Planning and Learning: Introduction to Planning, Types, Learning from observations, Forms of Learning, Inductive Learning, Learning decision trees, Reinforcement Learning

Uncertain knowledge and reasoning: Acting under Uncertainty, Basic Probability Notation, The Axioms of Probability, Bayes' Rule and Its Use, Probabilistic Reasoning System

Laboratory work: Using Python, implementation of problems based on Informed Search algorithms, Uninformed search algorithms, constraint Satisfaction problem, propositional logic and inference, first-order logic, and inference, Unification, Resolution.

Course Outcomes (COs): After the completion of the course, students will be able to:

1. Ability to compare different AI algorithms in terms of design issues, computational complexity, and assumptions.
2. Apply basic search techniques and AI algorithms for problem solving.
3. Able to explain how to represent knowledge required for problem solving.
4. Use the concepts of AI for real world problem solving.

CSF612 Robotics System [3 0 2 4]

Course Objectives: To become familiar with different types of robotics components and their applications and learn different types of techniques and strategies.

Course Contents:

Introduction to Robotics, History of robots, Classification of robots, Present status and future trends. Basic components of robotic system. Basic terminology- Accuracy, Repeatability, Resolution, Degree of freedom. Mechanisms and transmission.

Drive system- hydraulic, pneumatic and electric systems Sensors in robot – Touch sensors, Tactile sensor, Proximity and range sensors, Robotic vision sensor, Force sensor, Light sensors, Pressure sensors.

Introduction to lego robotics kits, Introduction to robot manipulation. Forward and inverse kinematics of robots and some case studies. Manipulator dynamics. Basics of robot control. Task planning with emphasis on computational geometry methods for robot path finding, robot arm reachability, grasp planning. Overview of robot vision and Parallel robots.

Designing a Reactive Implementation, Overview, Behaviours as Objects in OOP Example: A primitive move-to-goal behavior Example: An abstract follow-corridor behaviour, steps in Designing a Reactive Behavioural System Case Study: Unmanned Ground Robotics Competition Assemblages of Behaviours Finite state automata Pick Up the Trash FSA Implementation Examples Abstract Behaviors Scripts.

Course Outcomes (COs): After the completion of the course, students will be able to:

1. To calculate the forward kinematics and inverse kinematics of serial and parallel robots.
2. To calculate the Jacobian for serial and parallel robot.
3. To do the path planning for a robotic system.

Laboratory work: Implementation of problems related to robotics components, Sensors, Actuators, Implementation of problems based upon lego robotics kits.

CSF613 Data Communication Systems [3 1 0 4]

Course Objectives: This course aims to provide advanced background on relevant computer networking topics to have a comprehensive and deep knowledge in computer networks. Algorithms and protocols at the application, transport, network and medium access layers .The course explores emerging research challenges in the field of information and content centric networks, last mile network access from wireless and mobile devices and new networking paradigms.

Course Contents:

Network Layer: Design Issues, IPv4, IPv6, Shortest Path Routing, Distance Vector Routing, Flooding, Hierarchical Routing, Broadcast Routing, and Multicast Routing.

Wireless Networks: GSM Architecture, CDMA, Mobility in networks, Handoffs. Mobile IP- IP Packet Delivery, Agent Discovery, Registration, Tunneling and Encapsulation.

Mobile TCP: Traditional TCP (Congestion Control, Slow Start, Fast Retransmit/Fast Recovery), Indirect TCP, Snooping TCP, Mobile TCP, Selective Retransmission, Transaction Oriented TCP

Wireless LAN: Infrared Vs Radio Transmission, Infrastructure and Ad-hoc Network, IEEE 802.11-System Architecture, Protocol Architecture, Physical Layer, Bluetooth.

IP Security: Architecture, Authentication header, Encapsulating security payloads, combining security associations, key management, SSL.

Course Outcomes (COs): After the completion of the course, students will be able to:

1. Explain design principles and core ideas behind several advanced computer network architectures to academic audiences.
2. Explain concepts of protocols, network interfaces, and Design/performance issues in local area networks and wide area networks.
3. Describe wireless networking concepts that lead discussions on current topics in network protocols, algorithms, applications and architecture research in both device-to-device communication and content networking paradigms.
4. Understand contemporary issues in networking technologies and security.

CSF614 Wireless and Mobile Systems [3 0 2 4]

Course Objectives: The objective of this course is to impart knowledge of various types of cellular, wireless and mobile systems architectures and technologies.

Course Contents:

Introduction: Introduction, history and generations of Wireless and Mobile Systems.

Propagation Mechanisms: Free Space and Land Propagation, Path loss and fading, Doppler Effect, Delay Spread and Inter Symbol Interference.

Cellular Concepts: Cell,Clustering, Splitting and Sectoring, Interference, Multiple Division Techniques, Channel Allocation Techniques.

Mobile Communication Systems: Cellular System Infrastructure, Registration, Handoff and Roaming Support, Multicasting, Security and Privacy.

Miscellaneous Topics: Wireless MANS, PANS, and LANS. Case studies of prominent systems.

Course Outcomes (COs): After the completion of the course, students will be able to:

1. Explain various radio propagation mechanisms.
2. Describe cellular concepts, multiple division techniques and channel allocation techniques.
3. Explain mobile communication system architecture.
4. Describe wireless MANS, LANS and PANS.

CSF615 Introduction to Data Science [3 0 2 4]

Course Objectives: Gain an in-depth understanding of Data Science processes, data wrangling, data exploration, data visualization, hypothesis building, and testing.

Course Contents:

Data Science Overview: Introduction to Data Science, Different Sectors Using Data Science, Purpose of Python.

Linear algebra: Algebraic view - vectors, matrices, product of matrix & vector, rank, null space. Geometric view - vectors, distance, projections, eigenvalue decomposition.

Statistical Analysis: Descriptive statistics, notion of probability, distributions, mean, variance, covariance, covariance matrix, understanding univariate and multivariate normal distributions, introduction to hypothesis testing, confidence interval for estimates

Optimization: Optimization, Typology of data science problems and a solution framework.

Regression: Simple linear regression and verifying assumptions used in linear regression, Multivariate linear regression, model assessment, assessing importance of different variables, subset selection

Classification: Classification using logistic regression, Classification using KNN and k-means clustering.

Laboratory work: Implementation of problems related to Strings, List, Arrays, Tuples, Dictionary, Sets and Range, Plots, Case study of Regression and Classification.

Course Outcomes (COs): After the completion of the course, students will be able to:

1. Implementation of Statistical tools in Data Science using Python.
2. Implement optimization in field of Data Science and provide solution framework.
3. Implement regression techniques for real life problems.
4. Implement classification techniques for real life problems.

CSF616 Data Mining [3 0 2 4]

Course Objectives: This course will introduce the concepts of data warehousing and data mining, which describes the requirements, applications, architectures and design of data warehousing and examine the types of data to be mined through pre-processing of data and apply data mining algorithms to discover interesting patterns.

Course Contents:

Introduction to Data Warehousing: Data Warehouse Definition, Perspectives of DW, Applications of DW.

Dimensional Modelling and ETL: Multi-Dimensional Data Model, Data Cubes, Stars and Snowflakes schema, Fact Constellations, Mapping ER to DW Schema, Extraction, Transformation, and Loading.

OLAP: OLAP functions, OLAP vs. OLTP, ROLAP, MOLAP, HOLAP, MDX query language.

Data Pre-processing: Data Cleaning, Missing Values, Noisy Data, Binning, Clustering, Regression, Inconsistent Data, Data Integration and Transformation, Dimensionality reduction, Data Compression, Dimensionality reduction.

Introduction to Data Mining: Data warehousing to Mining, Motivation (for Data Mining), Data Mining- Definition & Functionalities.

Association Rule Mining: Apriori Algorithm, Mining Multilevel Association rules from Transaction Databases.

Classification and Prediction: Regression, Decision tree Classification, Bayesian Classification, Support Vector Machine, Classification by Backpropagation.

Cluster Analysis: Partitioning methods. Hierarchical Clustering- AGNES, DIANA CURE and Chameleon, Density-Based Methods-DBSCAN, OPTICS, Grid-Based Methods- STING, CLIQUE, Outlier Analysis.

Laboratory Work: Data Analysis using MDX Query and OLAP tools, Implementation of Data Preprocessing, Cleaning and Transformation, Dimensionality Reduction Techniques, Implementation of Association Rule Mining, Implementation of Classification Regression and Clustering Algorithms.

Course Outcomes (COs): After the completion of the course, students will be able to:

1. Understand the architecture of data warehousing system and ETL operations.
2. Design data models for a data warehouse and perform business analysis with OLAP tools.
3. Apply suitable data-preprocessing techniques for data cleaning and transformation.
4. Implement data mining algorithms for frequent itemset mining, classification, prediction, and clustering.

CSF617 Visual Computing [3 0 2 4]

Course Objectives: Computer Vision focuses on development of algorithms and techniques to analyse and interpret the visible world around us. This requires understanding of the fundamental concepts related to multi-dimensional signal processing, feature extraction, pattern analysis visual geometric modelling, stochastic optimization etc. Knowledge of these concepts is necessary in this field, to explore and contribute to research and further developments in the field of computer vision. Applications range from Biometrics, Medical diagnosis, document processing, mining of visual content, to surveillance, advanced rendering etc.

Course Contents:

Digital Image Formation and Low-Level Processing: Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc. Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing**.**

Depth Estimation and Multi-Camera Views: Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration.

Feature Extraction: Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.

Image Segmentation: Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection.

Pattern Analysis: Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods.

Motion Analysis: Background Subtraction and Modelling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation.

Laboratory work: Implementation of Histogram Processing, Image Transformation, Affine Transformation, Image Enhancement, Fourier Transformation. Implementation of RANSAC, Edge Based Segmentation, PCA, Clustering and Wavelet Transforms. Implementation of problems related to Background Subtraction and Spatio-Temporal Analysis.

Course Outcomes (COs): After the completion of the course, students will be able to:

1. To apply mathematical modelling methods for low, intermediate and high- level image processing tasks.
2. To be able to design new algorithms to solve recent state of the art computer vision problems.
3. To perform software experiments on computer vision problems and compare their performance.
4. To develop a broad knowledge base so as to easily relate to the existing literature.
5. To gather a basic understanding about the geometric relationships between 2D images and the 3D world.

CSF618 Advanced Image Processing [3 0 2 4]

Course Objectives:

1. To learn about the basic concepts of Digital Image Processing and various Image Transforms.
2. To familiarize the student with the Image Enhancement Techniques.
3. To expose the student to a broad range of Image Processing Techniques and their Applications.
4. To appreciate the use of current technologies those are specific to Image Processing Systems. To expose the students to real-world applications of Image Processing.

Course Contents:

Fundamentals of Image Processing: Introduction–Applications of Image Processing – Steps in Image Processing Applications – Digital Imaging System – Sampling and Quantization – Pixel Connectivity – Distance Measures – Colour Fundamentals and Models – File Formats, Image Operations.

Image Enhancement: Image Transforms: Fast Fourier Transform and Discrete Fourier Transform – Image Enhancement in Spatial and Frequency Domain – Grey level Transformations–Histogram Processing – Spatial Filtering – Smoothing and Sharpening – Filtering in Frequency Domain.

Image Restoration And Multi-Resolution Analysis: Multiresolution Analysis: Image Pyramids – Multi Resolution Expansion – Wavelet Transforms–Image Restoration–Image Degradation Model–Noise Modelling – Blur – Order Statistic Filters–Image restoration Algorithms.

Image Segmentation and Feature Extraction: Image Segmentation – Detection of Discontinuities – Edge Operators – Edge Linking and Boundary Detection – Thresholding – Region based Segmentation –Image Features and Extraction–Image Features– Types of Features–Feature Extraction–SIFT, SURF and Texture–Feature Reduction Algorithms.

Image Processing Applications: Image Classifiers – Supervised Learning – Support Vector Machines, Image Clustering – Unsupervised Learning – Hierarchical and Partition Based Clustering Algorithms – EM Algorithm – Case Studies in Biometrics – Iris, Fingerprint and Face Recognition – Case Studies on Image Security – Steganography and Digital Watermarking – Case Studies on Medical Imaging and Remote Sensing.

Laboratory work: Implement spatial filters, noise modelling, histogram techniques, PCA, image classifier using SVM, image clustering algorithms, and feature extraction techniques, etc.

Course Outcomes (COs): After the completion of the course, students will be able to:

1. Implement basic Image Processing Operations.
2. Apply and develop new techniques in the areas of Image Enhancement and Restoration.
3. Understand the Image segmentation algorithms.
4. Extract features from Images.
5. Apply classifier and Clustering algorithms for Image classification and Clustering.
6. Design and develop an image processing application that uses different concepts of Image Processing.

CSF 641 Internet of Things and Edge Computing [3 0 2 4]

Course Objectives: The objective of this course is to impart fundamental and applied concepts of IoT systems, and understand various kinds of communication using system-on-chip devices so that students can develop end-to-end IoT prototypes.

Course Contents:

Introduction: IoT Architecture, Sensing, Communication and Actuation, Hardware and Software setup.

GPIO: Pin setup and interfacing using GPIO pins.

Communication and Protocols: Serial Communication in IoT, Serial Peripheral Interface (SPI) and Inter-Integrated Circuit (I2C) in IoT.

IoT Analytics: Data transmission in Cloud, IoT Analytics and Visualization.

Miscellaneous Topics: IoT Security, IoT Project execution and demonstration.

Laboratory work: Lab work will include use of Arduino and Raspberry Pi platform to solve problems related to GPIO programming, interfacing various sensors, SPI and I2C programming, and Cloud Integration.

Course Outcomes (COs): After the completion of the course, students will be able to:

1. Understand fundamental concepts and building blocks of an IoT system.
2. Implement IoT prototypes using GPIO programming, sensors, and various communication protocols.
3. Develop end-to-end systems by syncing with Cloud.
4. Understand security aspects of an IoT system.

CSF642 Cloud Computing and Virtualization [3 0 2 4]

Course Objectives: To become familiar with different cloud deployments and service models and learn various aspects of cloud security.

Course Contents:

Definition of Cloud Computing: Define cloud computing, service models, deployment models, Difference between Cloud Computing and other computing paradigm.

Public Cloud: Concept of Public Cloud, Public cloud players, IaaS/PaaS/SaaS Vendors and their services comparisons (AWS, Microsoft, Google, IBM, Salesforce).

Private Cloud: Basics of Virtualization Technologies, Virtualization Types, Hypervisors Concepts and Its Types, Private Cloud Concept, Concept of Multitenancy and its Types. API and Billing Services.

Multi Cloud: Multi Cloud Concepts, Need and benefits of Multi Cloud, Challenges in managing heterogeneous clouds, Introduction of OpenStack, ESXi Server,Xen, KVM.

Cloud Security: Cloud Security Reference Model, Public cloud security breaches, Malicious insider, Service Hijacking, Identity Management,Abuse and Nefarious Use of Cloud.

Miscellaneous Topics: Case study on: Private cloud, Multi-Cloud Management System (Right Scale Cloud Management System).

Laboratory work: Implementation and understanding of Hypervisors using VMWare/Virtual Box, Google App Engine, Hyper-V, Application development and Deployment in Cloud Environment (using IBM Cloud).

Course Outcomes (COs): After the completion of the course, students will be able to:

1. Define the cloud deployment and service model.
2. Describe and analyse the public and private cloud architecture.
3. Understand the Multi-Cloud concepts and their usages.
4. Understand the different security concerns of different cloud deployments.

CSF643 Programming for Data Science [3 0 2 4]

Course Objectives: To become familiar with the basic concepts of R programming and its utilities to implement and analyse various statistical and machine learning approaches in data science.

Course Contents:

Introduction to Data Science and R: Definition: Big Data and Data Science Hype, Why data science, Data Science Process: Overview, Defining goals, Retrieving data, Data preparation, Data exploration, Data modeling, Presentation, Introduction of R,Vectors and Data Frames, Data analysis with summary statistics and scatter plots, Summary tables, working with Script Files.

R Programming Basics: R data types and objects: Number and Text, Vector, Matrix, Factor, Array, List Data Frame, Manipulating Objects. Control structures, looping, scoping rules, Operations on Dates and Times, functions, debugging tools. R built-in packages and functions.

Data Visualization using R: Reading and loading data into R: Using CSV files, XML files, Web Data, JSON files, Databases, Excel files. Working with Charts and Graphs using R: Histograms,Boxplots,Bar Charts, Line Graphs, Scatterplots, and Pie Charts.

Introduction to Statistical using R: Normal and Binomial distributions,Dispersion: variance, standard deviation, shape– skewness, kurtosis, percentiles,Central Tendency, Time Series Analysis,Linear and Multiple Regression, Logistic Regression.

Machine Learning using R: Introduction to machine learning, Application of Machine Learning, types of machine learning, supervised learning: Regression, Classification, Specifying and Validation of models, supervised learning packages. Unsupervised Learning: Dimensionality reduction, clustering, association rule.

Laboratory work: Implementation of problems related to Distribution, Dispersion, Linear and Multiple Regression, Logistic Regression, Decision Tree, Random forest, k-means clustering.

Course Outcomes (COs): After the completion of the course, students will be able to:

1. Understand basic terminologies of data science.
2. Understand fundamentals of R programming with the focus of data science.
3. Implement statistical and machine learning problems using R programming.
4. Construct real life data science applications using R programming.

CSF644 Applied Machine Learning and Deep Learning [3 0 2 4]

Course Objectives: To become familiar with different types of learning such as supervised and unsupervised learning and their applications and learn different types of techniques and strategies.

Course Contents:

Definition of learning systems, Goals and applications of machine learning. Aspects of developing a learning system: training data, concept representation, function approximation. Types of Learning: Supervised learning and unsupervised learning. Overview of classification: setup, training, test, validation dataset, over fitting. Classification Families: linear discriminative, non-linear discriminative, decision trees, KNN.

Logistic regression, Perceptron, Exponential family, Generative learning algorithms, Gaussian discriminant analysis, Naive Bayes, Support vector machines: Optimal hyper plane, Kernels. Model selection and feature selection. Combining classifiers: Bagging, boosting (The Ada boost algorithm), Evaluating and debugging learning algorithms, Classification errors.

Unsupervised learning: Clustering. K-means. EM Algorithm. Mixture of Gaussians. Factor analysis. PCA (Principal components analysis).

Introduction to Convolutional Neural Networks: Introduction to CNNs, Introduction to RNNs Kernel filter, Principles behind CNNs, Multiple Filters, CNN applications Introduction to Recurrent Neural Networks: Introduction to RNNs, Unfolded RNNs, Seq2Seq RNNs, LSTM, RNN applications

Deep Learning applications: Image Processing, Natural Language Processing, Speech Recognition, Video Analytic

Course Outcomes (COs): After the completion of the course, students will be able to:

1. Discuss about the use of various machine learning algorithms and implementation.

2. Understanding the application of Deep Learning Methods.

3. Will understand the concepts of various learning.

Laboratory work: Study and Implement the Naive Bayes learner, Study and Implement the Decision Tree learners, Estimate the accuracy of decision classifier on breast cancer dataset using 5-fold cross-validation, Estimate the precision, recall, accuracy, and F-measure of the decision tree classifier on the text classification task for each of the 10 categories using 10-fold cross-validation. Implementation of RNN Network and CNN Network.

CSF645 Data Analytics [3 0 2 4]

Course Objectives:

To become familiar with various data analytics approaches to solve many real life problems.

Course Contents:

Data Definitions and Analysis Techniques: Elements, Variables, and Data categorization, Levels of Measurement, Data management and indexing, Introduction to statistical learning.

Descriptive Statistics: Introduction to graphical approaches**,** Measures of central tendency, Measures of location of dispersions.

Data Quality and Pre-processing: Data Quality, Missing values, redundant data, inconsistent data, noisy data, outliers, Data transformation, Dimensionality reduction, Attribute aggregation.

Probability distributions and Inferential statistics: Random Variables and Probability distributions, inferential statistics: Motivation, Single Sample test, Two sample tests, Type1 and Type 2 Errors, Confidence intervals, ANOVA and Test of Independence, Basics of Regression.

Basic analysis techniques: Statistical hypothesis generation and testing, Chi-Square test, t-Test, Analysis of variance, Correlation analysis, Maximum likelihood test.

Data analysis techniques: Regression analysis, Classification techniques, Clustering, Association rules analysis.

Introduction to Big Data Analytics: Big Data, V's definition of Big Data, Scalable and parallel computing for data intensive and computation intensive applications.

Laboratory work: Implementation of Descriptive Statistics approaches, Chi-Square test, t-Test, hypothesis test, regression, classification, association rule mining and clustering.

Course Outcomes (COs): After the completion of the course, students will be able to:

1. Understand fundamental concepts of statistical and data analysis approaches to solve real life industrial problems.
2. Estimate various probability distributions, hypothesis testing and their practical implications.
3. Examine the various data preprocessing terminologies.
4. Understand concepts of Big data and its processing.

CSF646 Image and Video Processing [3 0 2 4] L T P

Course Objectives:

- To provide the basic understanding of the digital image formation and visualization.
- To provide the visualization of relationships between spatial and frequency.
- To provide the understanding of mapping the signal processing techniques to the digital image.
- To provide an idea of multimedia data (image, video).
- To provide an exposure to various image and video compression standards.

Course Contents:

Fundamentals of Image processing and Image Transforms: Basic steps of Image processing system sampling and quantization of an Image – Basic relationship between pixels Image Transforms: 2 – D Discrete Fourier Transform, Discrete Cosine Transform (DCT), Discrete Wavelet transforms

Image Processing Techniques: Image Enhancement: Spatial Domain methods: Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial filters, Sharpening Spatial filters Frequency Domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, selective filtering Image Segmentation: Segmentation concepts, point, line and Edge detection, Thresholding, region based segmentation Image Compression

Image compression fundamentals – coding Redundancy, spatial and temporal redundancy. Compression models : Lossy and Lossless, Huffmann coding, Arithmetic coding, LZW coding, run length coding, Bit Plane coding, transform coding, predictive coding , wavelet coding, JPEG standards

Basic Steps of Video Processing: Analog video, Digital Video, Time varying Image Formation models : 3D motion models, Geometric Image formation , Photometric Image formation, sampling of video signals, filtering operations

2-D Motion Estimation: Optical flow, general methodologies, pixel based motion estimation, Block matching algorithm, Mesh based motion Estimation, global Motion Estimation, Region based motion estimation, multi resolution motion estimation. Waveform based coding, Block based transform coding, predictive coding, Application of motion estimation in video coding.

Laboratory work: Lab work will include implementation of problems using image processing techniques, image compression techniques, video processing techniques and 2-D video techniques.

Course Outcomes (COs): After the completion of the course, students will be able to:

1. Implement basic Image Processing Operations.
2. Apply and develop new techniques in the areas of Image Enhancement and segmentation.
3. Explain the various image and video compression standards.
4. Explain basic techniques in digital video processing, including imaging characteristics and sensors.
5. Apply motion estimation and object tracking algorithms on video sequence.

CSF647 Natural Language Processing [3 0 2 4]

Course Objectives: To gain a foundational understanding of natural language processing methods, strategies and how computational methods be used for language phenomena and develop skills for finding solutions of real-world problems and building applications using natural language processing techniques.

Course Contents:

Introduction: NLP tasks in syntax, semantics, and pragmatics, Applications such as information extraction, question answering, and machine translation, problem of ambiguity, role of machine learning in NLP.

Regular expressions: Chomsky hierarchy, regular languages and their limitations, Finite-state automata, Regular Expressions, Text Normalization, and Edit Distance, Morphology & Finite-state Transducers.

Introduction to probability theory: Probabilistic models, Events, and counting, Joint and conditional probability, marginals, independence, Bayes rule, combining evidence, examples of applications in natural language.

N-gram language models: The role of language models, Simple N-gram models, Estimating parameters and smoothing. Evaluating language models.

Part of Speech tagging and sequence labeling: Lexical syntax, Hidden Markov Models, Viterbi and A* decoding, Word classes and POS tagging.

Syntactic parsing: Efficient parsing for context-free grammars, Statistical parsing and probabilistic CFGs, CFG for English and Parsing.

Semantics: Introduction & Distributional semantics,Lexical semantics, and word-sense disambiguation. Compositional semantics, Semantic Role Labeling and Semantic Parsing.

Advance topics: Text classification, Text Summarization, Sentiment analysis, Stylometry analysis, Web mining.

Laboratory Work: Implementation of Word Analysis, Word Generation, Morphology, N-Grams, N-Grams Smoothing, POS Tagging: Hidden Markov Model and Viterbi Decoding, Implementation of Text classification, Text Summarization, Sentiment analysis, Stylometry analysis, Web mining.

Course Outcomes (COs): After the completion of the course, students will be able to:

1. Understand the fundamental concept natural language processing and its applications and limitations.
2. Apply and analyze different NLP models such as HMM, n-gram and Wordnet etc.
3. Implement existing NLP models and study their performance with respect to different datasets.
4. Apply real-world datasets in order to build models for advanced problems such as Text classification, Text Summarization, Sentiment analysis etc.

CSF648 Research Ethics and Methods [3 0 2 4]

Course Objectives: To become familiar with research, methodologies, and comprehend different techniques for the data collection and analysis.

Course Contents:

Introduction to Research: Meaning and importance of Research, Types of Research, Research Design and Stages, Selection and Formulation of Research Problem, Objective(s) and Hypothesis, Developing Research Plan – Exploration, Description, Diagnosis, Experimentation, Determining Experimental and Sample Design.

Data Collection: Sources of Data, Primary and Secondary, Types of Data – Categorical (nominal and ordinal), Numerical (discrete, continuous, ratio and interval), Methods of Data Collection: Survey, Interviews (in-depth or Key Informant interviews), Focus Group Discussion (FGD), Observation, Records or Experimental Observations.

Data Processing and Analysis: Statistical Graphics – Histograms, Frequency Polygon, Ogive, Dotplots, Stemplots, Bar Graphs, Pareto Charts, Pie Charts, Scatterplots, Boxplots, Descriptive Analysis – Frequency Distributions, Measures of Central Tendency, Measures of Variation/Dispersion, Skewness and Kurtosis, Measures of Relative Standing, ANOVA, Multivariate Analysis, SPSS

Scientific Writing: Structure and Components of Scientific Reports – Types of Report – Technical Reports and Thesis – Significance – Different steps in the preparation – Layout, Structure and Language of Typical Reports – Illustrations and Tables – Bibliography, Referencing and Foot Notes. Preparation of the Project Proposal – Title, Abstract, Introduction – Rationale, Objectives, Methodology – Time frame and Work Plan – Budget and Justification – References.

Ethical Issues: Ethical Committees, Commercialization, copy right, royalty, Intellectual Property rights and patent law, Track Related aspects of intellectual property Rights, Reproduction of published material, Plagiarism, Citation and Acknowledgement, Reproducibility and accountability.

Laboratory work: Data collection, analysis and plotting of graphs using ANOVA and SPSS.

Course Outcomes (COs): After the completion of the course, students will be able to:

1. Formulate the research problem statement and plan.
2. Collection of data using various techniques.
3. Statistically analyse the data.
4. Understand the importance of research ethics for scientific writing.

CS649 Fuzzy Neural Network [3 0 2 4]

Course Objectives: To provide knowledge of fuzzy logic and neural network with its different approaches and methods that can be applied to solve real life problems.

Course Contents:

Introduction to Fuzzy Sets: Basic Concepts of Crisp sets vs. Fuzzy Sets, Comparison with classical Logic, Elements of Fuzzy Logic, Fuzzification, Membership Function, Fuzzy Set operations, Relation Matrix, Min-Max Theorem, De-fuzzification, MOM and COG method.

Fuzzy Logic: Fuzzy Inference System Rules, Propositional logic and predicate logic, Approximate Reasoning, Mamdani Fuzzy inference system, Fuzzy Modeling, Fuzzy Decision Making, Fuzzy Control Systems.

Introduction to Neural Networks: Basic concepts of Neural Networks, Biological Neural System, Artificial Intelligent Systems, Modeling human performance. Uncertain & incomplete knowledge, Expert Systems Vs Neural Networks, Multilayer feed forward networks and recurrent networks.

Artificial Neural Networks: ANN Architecture, Activation functions, Characteristics of Neural Networks, Single layer perception, Multilayer Perception, Supervised and Unsupervised learning, Reinforcement learning, Backpropagation networks, Competitive Learning Neural Networks, Hopfield network - energy; stability; capacity.

Application of Fuzzy Logic and Neural Network: Hybrid Systems, Design of Fuzzy systems, Use of Fuzzy Approach in Neural Networks, Neuro-Fuzzy Systems: Types of Fuzzy Neural Nets, Neural components in a Fuzzy System, Fuzzy-ANN Controller, Application in pattern recognition, Image processing and computer vision, Application in control: Fuzzy controllers, neuro controllers and fuzzy neuro controllers, applications in expert systems and decision-making systems, application in real world computing.

Laboratory work: Implementation of problems related to Fuzzy Logic, Reasoning, System Modelling, Decision making problems, Automation of systems, real life decision problems, approximation problems and implementation of Neural network approaches in engineering analysis, design and diagnostics problems; real-life problems.

Course Outcomes (COs): After the completion of the course, students will be able to:

1. Understand the concept and theories of Fuzzy Logic and Neural Network.
2. Identify and analyse the different approaches and methods of Fuzzy logic and Neural Network.
3. Apply Fuzzy logic for control system design.
4. Design and Develop Fuzzy based Neural Network systems.
5. Implement Neural Network and evaluate different solutions of various real-life problems.

CSF651 Evolutionary Computing Techniques [3 0 2 4]

Course Objectives: The main goal of this course is to help students learn evolution method for computer solvable problems using Darwinian laws. Students shall be able to get familiar with advanced concepts of mutation and the implementation of the biological concepts through methods such as neural networks and statistical methods.

Course Contents:

Evolutionary Computing: The Origins, The Main Evolutionary Computing Metaphor, Brief History, The Inspiration from Biology: Darwinian Evolution, Genetics, Taboo Search.

Evolutionary Algorithm: What Is an Evolutionary Algorithm, Components of Evolutionary Algorithms: Representation, Evaluation Function, Parent Selection, Variation Operators (Mutation and Recombination), Survivor Selection Mechanism (Replacement), Termination Condition.

Representation, Mutation, and Recombination: Representation and the Roles of Variation Operators, Binary Representation, Integer Representation, Real-Valued or Floating-Point Representation, Permutation Representation, Tree Representation.

Fitness, Selection, and Population Management: Population Management Models**,** Parent SelectionSurvivor Selection**,** Selection Pressure**,** Multimodal Problems, Selection, and the Need for Diversity

Application: Genetic Algorithms, Genetic Programming, Global and local optimisation, Particle Swarm Optimisation Ant System (AS).

Laboratory work: Implementation of parent selection, Mutation and cross over algorithm

Course Outcomes (COs): On successful completion of the course, students will be able to achieve the following:

1. Understand the fundamental of evolution-based learning algorithms, advanced searching and optimization techniques.
2. Understand and implement the concepts of genetic algorithms and genetic programming
3. Ability to solve problems using swarm intelligence, Ant Colony Optimization
4. Understand multimodal problems and their solution and understand the concept of Spatial Distribution
5. Visualize the basic use of evolutionary computing algorithms and its implementations with neural network and parallel Evolutionary Computing.

CSF652 Applied Cryptography[3 0 2 4]

Course Objectives: Gain an in-depth knowledge of Encryption and Decryption, Cryptanalysis, Intrusion Detection System, Non-conventional Encryption and Decryption, Botnet.

Course Contents:

Basic Cryptography Concepts: Purpose of Cryptography, Need for security, Encryption Techniques and Classical methods.

Number Theory: Finite fields, Modular arithmetic, Efficient algorithms for modular arithmetic, Fermat's little theorem, Euler's criteria, Euler's function, Primality testing, prime factorization.

Modern ciphers and Public Key Cryptography: Block ciphers and their applications, Structure of a block cipher, Data Encryption Standard (DES), AES, Diffie-Hellman method, RSA and related methods.

Cryptanalysis: Linear cryptanalysis, Differential cryptanalysis.

Intrusion Detection System: Basic of Intrusion Detection and Prevention System, Host-based and Network based IDS.

Non-conventional Methods: Genetic Algorithm, Fuzzy Logic, Neural Network and Chaos based Encryption techniques.

Laboratory work: Implementation of AES, DES, DH, RSA, IDS, and Chaos based Encryption.

Course Outcomes (COs): After the completion of the course, students will be able to:

1. Implementation of encryption and decryption of modern ciphers like AES.
2. Implementation of public key cryptography.
3. Check the strength of cryptosystems by using various cryptanalysis techniques..
4. Implementation on Non-conventional encryption techniques.