Bachelor of Technology (Honors)

Computer Science and Engineering (Data Science)

Program Outcomes(POs)

- **PO 1:** Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems..

- **PO 2:** Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.   .

- **PO 3:** Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

- **PO4:** Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

- **PO 5:** Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

- **PO6:** The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice

- **PO 7:** Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development..

- **PO 8:** Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

- **PO9:** Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

- **PO 10:** Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

- **PO 11:** Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to

one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

➢ **PO 12:** Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

ProgramSpecificOutcomes(PSO)

- ✓ **PSO1:** Possess strong analytical, mathematical, statistical, Computer Science and Data Science knowledge to solve the problems of various diverse domain using standard tools, frameworks and technologies in practice to make best suitable for industry, academia and research.

- ✓ **PSO2:** The ability to analyze, design and develop algorithms and computer programs in the areas related to Data Science to predict and build models to solve real world problems.

Course Outcomes

2017 -2021 Batch

Semester	Course Code	Course Name		CO Statements
III	17CCC31	DATA STRUCTURES AND ALGORITHMS	CO1	Describe linear data structures using array and linked list
			CO2	Apply data structures like stacks, queues in linear data structure
			CO3	Discuss non-linear data structures tree and its application
			CO4	Apply various algorithms in graph
			CO5	Solve searching, sorting and hashing techniques in data structures
			CO6	Interpret sorting algorithms for a give problem
	17CCC31L	DATA STRUCTURES AND ALGORITHMS LAB	CO1	Compare various kinds of searching and sorting techniques
			CO2	Construct Linear and nonlinear data structures using arrays and linked list
			CO3	Develop Programs employing dynamic memory management
			CO4	Choose appropriate data structure to solve various computing problems
			CO5	Originate hash tables and collision resolution Techniques
			CO6	Identify suitable data structure and algorithm to solve a real world problem
	17CS3SP01	OBJECT ORIENTED PROGRAMMING USING JAVA	CO1	Define and understand Object Oriented programming concepts using basic syntaxes of control Structures, strings and function for developing skills of logic building activity
			CO2	Explain classes, objects, members of a class and the relationships among them needed for finding the solution to specific problem
			CO3	Demonstrate how to achieve reusability using inheritance, interfaces and packages and describe how faster application development can be achieved.
			CO4	Design and create applications using JDBC connectivity

			CO5	Create grpahic applications	
			CO6	Create front end and back end applications	
	17CS3SP01L	OBJECT ORIENTED PROGRAMMING USING JAVA -LAB	CO1	Discuss OOP concepts and basics of Java programming	
			CO2	Apply OOP and Java programming in problem solving	
			CO3	Extend his/her knowledge of Java programming further on his/her own	
			CO4	Create different programms using packages	
			CO5	Analyze various techniques with functions	
			CO6	Evaluate inhenritance using Java	
	17CS0SP02	RELATIONAL DATABASE MANAGEMENT SYSTEM	CO1	Construct Entity-Relationship (ER) model and also to learn different issues in the design and implementation of a Database system	
			CO2	Demonstrate by providing solutions through Relational Algebraic expressions and structured query language commands.	
			CO3	Construct SQL queries for retrieving multiple tuples using Iterators CURSORs and Triggers.	
			CO4	Analyze the different normalization techniques by understanding the essential DBMS concepts	
			CO5	Demonstrate the ACID properties of Transaction	
			CO6	Apply techniques for achieving Concurrency control and for database recovery.	
	17CS0SP02L	RELATIONAL DATABASE MANAGEMENT SYSTEM LAB	CO1	Apply Data Definition Language, Data Manipulation Language, Data Control Language and Transaction Control Language commands on sample database.	
			CO2	Create a Student database with necessary constraints and to get it populated with the data.	
			CO3	Execute simple and complex queries on Student Database.	
			CO4	Create Employee database with necessary constraints, populate it with the data and to execute queries on the database.	
			CO5	Create Library database with necessary constraints, populate it with the data and to execute queries on the database.	
			CO6	Demonstrate the learned	

				concepts through exhibiting a mini project
	17BS3CS03	STATISTICS AND PROBABILITY - I	CO1	Assess importance of statistics in different research areas.
			CO2	Discuss the basic concepts of Statistics and its evolution.
			CO3	Employ the suitable statistical measures to describe and summarize the data.
			CO4	Describe the application of statistical test to appropriate research environment.
			CO5	Explain the basic concepts of probability and its applications.
			CO6	Identify the application of probability in finding the expected values and its uses.
	17CS0SP03	COMPUTER NETWORKS	CO1	Describe basic computer network technology.
			CO2	Demonstrate the layers of the OSI model and TCP/IP and explain the functions of each layer.
			CO3	Identify the design issues, perform error detection and correction.
			CO4	Apply the various routing algorithms for the different network designs.
			CO5	Analyze the various protocols used in respective layers of OSI reference model.
			CO6	Design a network for the given scenario.
	17MCC03	ENERGY STUDIES	CO1	Discuss energy scenario and its importance to the society.
			CO2	Recommend few energy management and energy conservation techniques in daily life.
			CO3	interpret energy policies.
			CO4	Discuss emerging technologies importance in today's energy scenario
	17HSSC08	ECONOMICS FOR ENGINEERS	CO1	Describe the fundamental theories and principles used in Engineering Economics and Management and to some extent are able to compare and evaluate them
			CO2	Learn, compare and apply various cost concepts and analysis techniques
			CO3	Select a business plan for an entrepreneurship project using economics and Management fundamentals
			CO4	Apply the knowledge and techniques, skills and methods to become successful project leaders

			CO5	Apply professional ethical principles and corporate social responsibility concepts in personal, financial and economic decisions for sustainable growth and development	
			CO6	Analyze and think through basic economic problems of our country	
IV	17CS4SP04	Operating System Building Blocks	CO1	Discuss the features of the operating system functions, structures, and design issues associated with operating systems.	
			CO2	Use the various process management issues including scheduling, synchronization, deadlocks and multithreading.	
			CO3	Apply the concepts of memory management including virtual memory, resource sharing among the users, and Process scheduling techniques to solve the real world problems	
			CO4	Use UNIX tools using features such as filters, pipes, Unix file systems, redirection, and regular expressions Customize their UNIX working environment and security	
	17BS4CS02	Statistics and Probability – II	CO1	Discuss the application of random variables in different distribution Functions and apply the different estimation techniques to find out the mean and variance to draw the statistical inferences	
			CO2	Compute and interpret the results of Bivariate and Multivariate Regression and Correlation Analysis for forecasting and also perform ANOVA and F-test	
			CO3	Describe the philosophy and basic concepts of quality improvement and Demonstrate the ability to use the methods of statistical process control.	
			CO4	Identify the importance of probability in the stochastic process and simulations process.	
	17CS4DS01	Scientific Programming using R	CO1	Design and Implement the core programming concepts of R language	
			CO2	Discuss the uniqueness in R programming concepts and its speed to other statistical programming languages	
			CO3	Create the different options in I/O operations in R	

				programming.
			CO4	Recognize the importance of simulation concepts in R for cross validation of the data mining techniques
			CO5	Discuss the basic concepts of statistical functions in R for the analysis.
			CO6	Analysis of Variance for one way variation and two variation
	17CS4DS02	**Data Analytics using SQL**	CO1	Explain the concept of SQL
			CO2	Use SQL Databases
			CO3	Create database, create table, alter table and manipulate table
			CO4	Classify different conditional statement for Aggregating and grouping data
			CO5	Identify the application and importance of multi table join operation
			CO6	Identify the ways to extract data from different tables in a database
	17BS4MA02	**Linear Algebra and Vector Spaces**	CO1	Explain the concepts of vector spaces and matrix algebra and its application in data science
			CO2	Apply the matrix theory for solving system of linear equations and importance of Eigen values and Eigen Vectors for matrix ,diagonalisation process in data science.
			CO3	Recall the importance of symmetric matrices and quadratic forms and Orthogonality in dimension reduction techniques
			CO4	Explain the basics concepts of relations and functions and to know the representation of data /mapping of data in matrix and graph form
	17CS4DS03	**NoSQL Databases**	CO1	Apply the NoSQL Business Driver and understand NoSQL Case Studies. To analyze the difference between RDBMS and NoSQL.
			CO2	Apply the Document Structure and Common Features by Understanding the concept of Document Database,To analyze internal architecture of NoSQL databases and can be implemented on semi structured.
			CO3	Analyze the various techniques/types of Key-Value Stores and Understand

				the concept of Managing User Information
			CO4	Apply the Document Structure and Common Features by Understanding the concept of Document Database
			CO5	Analyze the various techniques/types of Key-Value Stores and Understand the concept of Managing User Information
			CO6	Analyze the various techniques/types of Triple queries and apply the Data Integrity and Triple Store Structure
	17HSS04	Business Communication and Presentation Skills	CO1	Overcome common obstacles in public speaking.
			CO2	Demonstrate critical and innovative thinking.
			CO3	Illustrate oral, written and visualization.
			CO4	Discuss the importance of research in developing your topic.
			CO5	Use resources to gather information effectively.
	17CS4DS02L	Data Analytics using SQL - Lab	CO1	Discuss the concept of SQL
			CO2	Use SQL Databases
			CO3	Create database, create table, alter table and manipulate table
			CO4	Classify different conditional statement for Aggregating and grouping data
			CO5	Describe the application and importance of multi table join operation
			CO6	Discuss the ways to extract data from different tables in a database
	17CS4DS01L	Scientific Programming using R Lab	CO1	Demonstrate R Environment and R Studio
			CO2	Create basic data structures with R inbuilt functions.
			CO3	Create basic data types with R inbuilt functions.
			CO4	Test data on basic summary measures using R and simple user defined functions.
			CO5	Examine data on simple user defined functions.
			CO6	Analyze data statistically and come out with new insights
	17CS4SP04L	Operating System Building Blocks–Lab	CO1	Experiment basic commands of shell script.
			CO2	Apply basic operations in shell scripts which are required for different applications
			CO3	Identify and understand concept of file systems in shell script

			CO4	Apply concept of creating new process from parent process	
V	17BS5CS01	**Inferential Statistics**	CO1	Classify the different estimation methods in statistical inference.	
			CO2	Discuss the importance of maximum likelihood estimator in the parameter estimation in continuous probability distributions and Neyman-Pearson lemma in deciding the critical region.	
			CO3	Analyzing the important difference between parametric and non-parametric tests for large and small samples.	
			CO4	Assess the importance of Bayesian statistical inference	
	17CS5DS04	**Advanced Data Analyitics Using SQL**	CO1	Explain the concept of SQL, its history, feature, process, roles, types, standards, architectures, OLAP and OLTP Applications.	
			CO2	Summarize and classify SQL statements for its execution.	
			CO3	Use of basic SQL commands for creating and dropping database, index and tables, inserting and altering table structure and data	
			CO4	Compare and contrast by executing the queries for the SQL tables using different operators and order by clause.	
			CO5	Evaluate SQL arithmetic functions and other functions for manipulating data with respect to non-functional use of SQL queries.	
			CO6	Formulate Grouping, summarizing and aggregating results and different join operations while providing real world SQL solutions though assignments and mini projects.	
	17CS5DS05	**Big Data Analysis - I**	CO1	Use Big Data and analyze the difference with traditional data	
			CO2	Interpret and summarize Hadoop and its components	
			CO3	Analyze the HDFS storage unit of Hadoop layer	
			CO4	Design and conduct experiments using MapReduce	
			CO5	Analyze YARN architecture and compare and contrast with Hadoop 1.X	
			CO6	Design Hadoop cluster, conducting MapReduce jobs and analyzing the efficiency	
	17CS5DS06	**Machine Learning Algorithms - I**	CO1	Discuss the basic concepts of statistical learning methods	

				and models.
			CO2	Analyse the importance of unsupervised learning to handle multivariate data sets.
			CO3	Apply the different supervised algorithms related to classification techniques.
			CO4	Compare the performance of different machine learning algorithms.
			CO5	Apply multiple linear regression model to solve a real-world problem based on predictive data analytics.
			CO6	Analyse the concepts of hypothesis testing in parametric and nonparametric classification techniques.
	17CS5DS07	**Optimisation Techniques**	CO1	Use linear programming and its preliminary concepts
			CO2	Apply the concept of simplex method in solving linear programming.
			CO3	Describe the sensitivity analysis in linear programming problem.
			CO4	Analyze the importance of transportation problem in optimizing the distances between the places.
			CO5	Apply game theory and its applications in linear programming problems.
			CO6	Apply classical optimization techniques in identifying the solutions for objective function.
	17CS5DS08	**Python Programming For Data Science**	CO1	Explore Python language fundamentals, including basic syntax, variables, types, control statements and functions.
			CO2	Applying various data structures, integrate data from disparate sources, transform data from one format to another, and program data management in relational databases.
			CO3	Create and customize plots on real data using various test and analysis of data.
			CO4	Implement regression models using machine learning.
	17CS5DS09	**Data Visualisation**	CO1	Identify the application of different visualization tool for the business report representation.
			CO2	Select the different visualization techniques to find out the distribution of data set.

			CO3	Apply the visualization techniques for business, social and research purpose using different graph, plot, map and charts.
			CO4	Analyze the importance of choosing an appropriate visualization technique for a particular data and visualization objective.
			CO5	Evaluate the effectiveness of different visualization techniques for static, bivariate and multivariate graphical validations.
			CO6	Create visualizations for reports, thesis, books and research articles using different customization methods.
	17CS5DS04L	Advanced Data Analytics Using SQL Lab	CO1	Use Given schema of a database, the tables can be created using SQL commands over MYSQL.
			CO2	Recall the set of data for a particular query from the tables.
			CO3	Demonstrate data analytics while working on self-downloaded datasets.
			CO4	Analysis the performance of various SQL constructs.
	17CS5DS06L	Machine Learning Algorithms - I LAB	CO1	Apply the basic concepts of statistical learning methods and machine learning models.
			CO2	Apply the different supervised algorithms related to classification techniques.
			CO3	Apply the different unsupervised algorithms related to clustering techniques.
			CO4	Compare the performance of different machine learning algorithms.
	17CS5DS05L	Big Data Analysis - I Lab	CO1	Apply Hadoop commands for managing HDFS file storage system.
			CO2	Use infrastructure of Ubuntu operating system, communication tools and virtual machine for Hadoop installation.
			CO3	Create Psuedo-distributed Hadoop cluster with different configuration and to meet Hadoop experiment requirements.
			CO4	Apply MapReduce programs to exploit Hadoop efficiency.
	17CS5DS08L	PYTHON PROGRAMMING FOR DATA SCIENCE LAB	CO1	Applying various data structures, integrate data from disparate sources, transform data from one format to

				another, and program data management in relational databases.
			CO2	Create and customize plots on real data using various test and analysis of data.
			CO3	Implement regression models using machine learning.
			CO4	Implement Machine learning models to solve real world problems
VI	17CS6DS10	EXPLORATORY DATA ANALYSIS	CO1	Classify data based on observation, measurement, availability, inherent nature and structural form.
			CO2	Describe exploratory data analysis and visualization concepts.
			CO3	Identify how to preprocess the data and generate new features from various sources such as text and images.
			CO4	Apply univariate data analysis and displays, and some basic techniques for meaningful data characterization like: Basic Descriptive Statistics, Graphs, Tables, Charts, etc.
			CO5	Analyze multivariate summaries and displays to analyze data, detect outliers, and/or formulate preliminary hypotheses.
	17CS6DS11	BIG DATA ANALYSIS	CO1	Explain the concept of Big Data and analyze the difference with traditional data
			CO2	Use basic knowledge and architecture of Hadoop tool and design Hadoop cluster
			CO3	Analyze the basics of storage layer, processing layer and YARN of Hadoop
			CO4	Create projects using teams by designing Hadoop cluster, conducting MapReduce jobs and analyzing the efficiency over traditional computing over YARN
	17CS6DS12	MACHINE LEARNING ALGORITHMS	CO1	Explain the concept of advanced machine learning algorithms such as decision tree, Logistic regression, SVM, ANN, etc.
			CO2	Applying these machine learning algorithms for solving classification and regression problems.
			CO3	Analyzing the performance of these algorithms with hypothesis measure.
			CO4	Analyzing the effectiveness of decision tree, SVM, etc. with different error measure such as confusion matrix, RMSE,

				etc.
			CO5	Evaluate the assessment method to find the better fit model for classification techniques.
			CO6	Estimating prediction performance of these algorithms with OOB error and validation score.
	17CS6DS13	TIME SERIES ANALYSIS	CO1	Apply the Concepts and methods underlying the analysis of univariate time series, and the context for interpretation of results.
			CO2	Simplify a time series into trend, Seasonal, Cyclical Variations and irregular components.
			CO3	Interpret time-series models and regression models for time series.
			CO4	Apply the concept of stationarity to the analysis of time series data in various contexts (such as actuarial studies, climatology, economics, finance, geography, meteorology, political science, and sociology) and the importance of ARMA and ARIMA models for forecasting.
	17CS6DS14	ARTIFICIAL INTELLIGENCE	CO1	Apply the knowledge of intelligent agents in real life applications.
			CO2	Solve the problems using search techniques.
			CO3	Create the knowledge base and apply the inference techniques.
			CO4	Use first order logic to solve the problems.
			CO5	Plan and execute the agent to solve the goal.
			CO6	Use the learning techniques in AI applications.
	17DE6DS11	CLOUD COMPUTING	CO1	Analyze the Cloud computing setup with its vulnerabilities and applications using different architectures
			CO2	Design different workflows according to requirements and apply map reduce programming model
			CO3	Apply and design suitable Virtualization concept, Cloud Resource Management and design scheduling algorithms
			CO4	Create combinatorial auctions for cloud resources and design scheduling algorithms for computing clouds.

			CO5	Assess cloud Storage systems and Cloud security, the risks involved, its impact and develop cloud application
			CO6	Assess the impact of engineering on legal and societal issues involved in addressing the security issues of cloud computing
	17DE6DS12	**MOBILE COMPUTING**	CO1	Use knowledge of Wireless Communication
			CO2	Discuss the Cellular networks and GPRS
			CO3	Describe the Mobile Handoff
			CO4	Explain the different types fo Multiple Access Techniques
			CO5	Compare GSM and WAP
			CO6	Contrast WML and VoIP
	17DE6DS13	**INTERNET OF THINGS**	CO1	Explain the basics of Embedded systems and Arduino
			CO2	Identify the different architecture and instructions used in Arduino
			CO3	Apply the knowledge of Arduino, Embedded applications
			CO4	Apply different protocols used in IoT.
			CO5	Develop an Embedded applications used in daily life.
			CO6	Design an real time application in IoT.
	17DE6DS21	**SAMPLING TECHNIQUES**	CO1	Apply Methods for designing and selecting a sample from a population and to estimate parameters
			CO2	Explain and compare various allocations using stratified random sampling.
			CO3	Implement a variety of sampling methods in systematic sampling.
			CO4	Develop clear understanding of Single Stage Cluster Sampling Determine
			CO5	Determine sources of errors, measure of estimation to an appropriate level of accuracy and its Management
	17DE6DS22	**MULTIVARIATE STATISTICAL ANALYSIS**	CO1	Explain the basic concepts of multivariate statistical analysis and related terminologies.
			CO2	Discuss the importance of mean vector and correlation matrix in multivariate statistical analysis.
			CO3	Identify the importance of profile analysis and its estimation.
			CO4	Apply the importance of interval estimation and its

				application in the statistical inference.
			CO5	Apply the concepts of discriminant analysis and its practical application in classification.
	17DE6DS23	**DESIGN OF EXPERIMENTS**	CO1	Describe the basic concepts and terminologies in design of experiments.
			CO2	Classify fixed effect model and parameter estimation of fixed effect model.
			CO3	Discuss the significance parametric and non-parametric design of experiments.
			CO4	Identify the importance block effects and design related with blocking effect.
			CO5	Employ the mechanism of factorial design and difference between blocking effect and factorial effect.
	17CS6DS11L	**MACHINE LEARNING ALGORITHMS LAB**	CO1	Discuss the concept of advanced machine learning algorithms such as decision tree, Logistic regression, SVM, ANN, etc.
			CO2	Applying these machine learning algorithms for solving classification and regression problems.
			CO3	Analyzing the performance of these algorithms with hypothesis measure.
			CO4	Analyzing the effectiveness of decision tree, SVM, etc. with different error measure such as confusion matrix, RMSE, etc.
			CO5	Evaluate the assessment method to find the better fit model for classification techniques.
			CO6	Estimating prediction performance of these algorithms with OOB error and validation score.
	17DE6DS11L	**CLOUD COMPUTING LAB**	CO1	Analyze the Cloud computing setup with its vulnerabilities and applications using different architectures
			CO2	Design different workflows according to requirements and apply map reduce programming model
			CO3	Apply and design suitable Virtualization concept, Cloud Resource Management and design scheduling algorithms
			CO4	Create combinatorial auctions for cloud resources and design scheduling algorithms for computing clouds.

			CO5	Assess cloud Storage systems and Cloud security, the risks involved, its impact and develop cloud application	
			CO6	Identify the impact of engineering on legal and societal issues involved in addressing the security issues of cloud computing	
	17DE6DS12L	MOBILE COMPUTING LAB	CO1	Use the WML to write simple code for mobile computing	
			CO2	Design application using WML for mobile computing	
			CO3	Write program on WML for mobile computing	
			CO4	Design mobile application using WML Script	
	17DE6DS13L	INTERNET OF THINGS LAB	CO1	Design and analyze simple IoT prototyping Projects	
			CO2	Apply the suitable knowledge of IoT Cloud and Social Networking to Automate the day to day task	
			CO3	Propose practical applications of IoT	
			CO4	Identify appropriate architecture of IoT	
			CO5	Propose applications area of IoT with the Integration of Hyper Cloud based Concepts.	
	17CS6DS12L	BIG DATA ANALYSIS LAB	CO1	Discuss the advance concept of BigData Analytics	
			CO2	Classify different types of Data Processing Tools	
			CO3	Explain the architecture of different tools in Hadoop Cluster	
			CO4	Describe ETL process in Hadoop Cluster	
			CO5	Explain internal concept Hive, Pig, Sqoop	
			CO6	Describe the different data processing techniques	
VII	17CS7DS15	Dimensionality Reduction and Model Validation	CO1	Illustrate the different dimension reduction techniques for parametric and non-parametric models.	
			CO2	Apply principle component analysis for data dimension reduction for data science project.	
			CO3	Illustrate nonlinear dimension reduction technique to reduce unimportant variables.	
			CO4	Simplify factor analysis for data dimension reduction for data science project.	
			CO5	Simplify model validation technique for classification models.	
			CO6	Evaluate model validation technique for regression analysis and find the better fit	

				model.
	17CS7DS15L	**Dimensionality Reduction and Model Validation Lab**	CO1	Choose to work with decision tree and random forest for dimensionality reduction procedures.
			CO2	Illustrate the factor analysis and principle component analysis for dimensionality reduction methods.
			CO3	Simplify the factor analysis for data dimension reduction for data science project.
			CO4	Evaluate validation techniques for general linear model and generalized linear model.
	17DE7DS31	**Elective III - Natural Language Processing**	CO1	Explain the basic concepts of natural language processing and its important terminologies
			CO2	Interpret the key role of syntactic parsing and semantic analysis in natural language processing.
			CO3	Infer the importance of corpus creation in natural language processing
			CO4	Analyze the statistical techniques used in natural language processing.
			CO5	Classify the words based on concept of Part-of-Speech tagging in English
			CO6	Summarize the application of natural language processing in sentimental analysis and in biological sciences.
	17DE7DS31L	**Elective III - Natural Language Processing Lab**	CO1	Choose to Design and develop various text pre-processing and text analysis algorithms.
			CO2	Simplify perfect language generators and corpus structure for text data analysis and interpretation.
			CO3	Simplify different data visualization techniques which can be easily understood by the Non-IT people
			CO4	Evaluate natural language processing in sentimental analysis and in biological sciences.
	17DE7DS32	**Elective III - Real Time Data Processing**	CO1	Discuss the advanced processing of Real time Data and different types of Real time Processing Tool
			CO2	Explain architecture of Apache Spark and Employing Apache Spark and its components
			CO3	Apply different available services for Apache Spark

			CO4	Analyze the processing and Storing Challenges for Real time Architecture
			CO5	Analyze different data storage and processing techniques
			CO6	Analyze GraphX and Mlib
17DE7DS32L	Elective III - Real Time Data Processing Lab		CO1	Apply different types of Real time Processing Tool
			CO2	Employ Apache Spark and its components
			CO3	Analyze the processing and Storing Challenges for Real time Architecture
			CO4	Evaluate different data storage and processing techniques
17DE7DS33	Elective III - Big Data Analytics on Cloud		CO1	Discuss the advanced analytics concept of Big Data use cases
			CO2	Explain architecture of Cloud and different types of Cloud Services
			CO3	Employ cloud over Big Data and different available services
			CO4	Apply data storage and processing techniques on Cloud
			CO5	Analyze the security and challenges assessment for Cloud Employment
			CO6	Evaluate cluster management while communicating to Cloud
17DE7DS33L	Elective III - Big Data Analytics on Cloud lab		CO1	Discuss architecture of Cloud and different types of Cloud Services
			CO2	Employ cloud over Big Data and different available services
			CO3	Analyze data storage and processing techniques on Cloud
			CO4	Analyze cluster management while communicating to Cloud
17DE7DS41	Elective IV - Deep Learning		CO1	Describe basic building blocks for much deep architecture, through applied mathematics and machine learning basics.
			CO2	Applying neural network techniques for optimization problems using gradient descent and stochastic gradient descent methods.
			CO3	Applying the single layer and multilayer feedforward neural network for training the data and finding patterns.
			CO4	Analyze the efficiency of CNN and RNN for image classification and speech recognition.
			CO5	Analyze the performance of RNN by applying them for

				different tasks with sequential input/output.
			CO6	Evaluation of ANN technique by merging it with genetic based deep learning.
	17DE7DS41L	**Elective IV - Deep Learning Lab**	CO1	Applying PCA for dimensionality reduction in the context of artificial neural network and deep learning using Python.
			CO2	Implementing deep neural network with back propagation to fit model for various applications using Python.
			CO3	Analyzing the performance of CNN and RNN by applying them for different tasks with sequential input/output.
			CO4	Evaluation of deep learning techniques by applying error based calculations for classification and regression problems.
	17DE7DS42	**Elective IV - Artificial Neural Networks**	CO1	Explain the basic concepts of neural networks and its components.
			CO2	Demonstrate neural network learning and adaption techniques.
			CO3	Simplify the detailed concepts of single layer perceptron neural networks.
			CO4	Simplify the detailed concepts of multilayer perceptron neural networks.
			CO5	Select the different associative memory concepts in retrieving information in data.
			CO6	Evaluate the different field of application on neural network models.
	17DE7DS42L	**Elective IV - Artificial Neural Networks Lab**	CO1	Classify the test and train and create their own neural network model
			CO2	Demonstrate more about python programming.
			CO3	Simplify solving deep learning problem using Neural network.
			CO4	Select the different associative memory concepts in retrieving information in data.
	17DE7DS43	**Elective IV - Probabilistic Graphical Models**	CO1	Discuss the different elementary models related to Probabilistic graphical techniques.
			CO2	Illustrate different representation techniques for probabilistic graphical models.
			CO3	Simplify the important

				application of undirected graphical models.
			CO4	Simplify the use of Gaussian Network models.
			CO5	Select inference techniques on probabilistic graphical models.
			CO6	Evaluate different techniques of probabilistic graphical models.
	17DE7DS43L	**Elective IV - Probabilistic Graphical Models Lab**	CO1	Choose to fit conditional probabilistic model for the given data base using R user defined function.
			CO2	Apply to fit medical expert system model with the help of Probabilistic Graphical Model using R.
			CO3	Evaluate different parameters for Probabilistic Graphical Model using R
			CO4	Recommend different techniques of probabilistic graphical models.
	17DE7DS51	**Elective V - Software Engineering**	CO1	Apply software engineering principles and techniques to solve the problems.
			CO2	Develop, maintain and evaluate large-scale software systems, and produce efficient, reliable, robust and cost-effective software solutions.
			CO3	Demonstrate independent research and analysis.
			CO4	Communicate and coordinate competently by listening, speaking, reading and writing English for technical and general purposes.
			CO5	Employ ethical standards and legal responsibilities.
			CO6	Analyze independent research and analysis.
	17DE7DS53	**Elective V - Object Oriented Modeling and Design**	CO1	Discuss the basic concepts of Object oriented modeling and Design.
			CO2	Demonstrate Object Oriented notations and process that extends from analysis through design to implementations.
			CO3	Apply all the standard UML notations.
			CO4	Simplify for modeling the requirements with use cases and describe the dynamic behavior and structure of the design.
			CO5	Distinguish a modular design with components and relate the logical design to the physical environment.
			CO6	Use the concept of design

					patterns and apply it where suitable.
	17DE7DS61	Elective VI - Advanced Optimization Techniques	CO1	Recognize inventory control models for inventory management.
			CO2	Choose the important application of replacement and maintenance problems.
			CO3	Apply Markov chain analysis to find out the transition probabilities.
			CO4	Simplify the application of sequencing problem in optimization techniques.
			CO5	Simplify the application of dynamic programming problems.
			CO6	Select the application of queuing theory in solving optimizing the waiting time in commercial complexes.
	17DE7DS62	Elective VI - Reinforcement Learning	CO1	Identify what constitute the main component of a Reinforcement Learning method.
			CO2	Choose to know contemporary Reinforcement learning methods.
			CO3	Analyze how to solving relational and first order logical Markov decision process.
			CO4	Simplify sequential decision making under uncertainty.
			CO5	Use the influence of Reinforcement Learning in other fields.
			CO6	Evaluating Elevator Dispatching and Dynamic Channel Allocation problems.
	17DE7DS63	Elective VI - Pattern Recognition	CO1	Discuss the Concept of Regression, classification, supervised and unsupervised learning.
			CO2	Applying more frequently used machine learning algorithm such as naive Bayes, Bayesian Decision Theory, decision tree as classifiers for pattern recognition problems.
			CO3	Analyzing the supervised problem by using CART and KNN Classification.
			CO4	Analyzing clustering problems by using unsupervised techniques such as K means clustering.
			CO5	Evaluating the performance of SVM with various kernels such as linear, RBF by using real time dataset.
			CO6	Estimating the prediction

				performance such as generalization error, F measure, and Confusion matrix.
	17DSOE711	**Open Elective – I - Introduction to Data Science**	CO1	Discuss the need of Data Science in day to day life.
			CO2	Describe the process and components of Data Science project.
			CO3	Discuss the importance of probability and statistics in Data Science
			CO4	Demonstrate the machine learning in today's business world.
			CO5	Simplify various components of computer science being used for Data Science
			CO6	Evaluate the execution flow of a Data Science project.
	17DSOE721	**Open Elective – II - Python Programming**	CO1	Select Areas Where Pattern Recognition Can Offer a Solution
			CO2	Use Strength and Limitations of Some Techniques for Classification, Regression and Density Estimation Problems
			CO3	Implement Learning Algorithms for Supervised Tasks
			CO4	Describe parameter and supervised learning algorithms used in pattern recognition research
			CO5	Discuss pattern recognition theories, such as Bayes classifier, linear discriminant analysis.
			CO6	Discuss the concept of kernel methods used in pattern recognition.
	17DSOE722	**Open Elective – II - R Programming**	CO1	Use the core programming concepts of R language.
			CO2	Demonstrate the uniqueness in R programming concepts and its speed to other statistical programming languages.
			CO3	Use the different options in I/O operations in R programming.
			CO4	Simplify the importance of simulation concepts in R for cross validation of the data mining techniques.
			CO5	Analyze the basic concepts of statistical functions in R for the analysis.
			CO6	Evaluate the applications of R programming for different statistical analysis and application.

VIII	17DSOE811	**Open Elective-III - Exploratory Data Analysis**	CO1	Classify the different types of data: based on observation, measurement, availability, inherent nature and structural form and understanding the concept of sample data and population.
			CO2	Describe data analysis and its different techniques and different visualization methods used in Exploratory Data Analysis.
			CO3	Illustrate the different phases of data preparation.
			CO4	Demonstrate the concept of univariate data analysis by considering real time data sets.
			CO5	Examine the different graphical representations used for EDA and to perform bivariate analysis to analyze the data.
			CO6	Recommend an appropriate predictive modelling for the given data set.
	17DSOE822	**Open Elective-III - Data Visualization Techniques**	CO1	Describe the application of different visualization tool for the business report representation.
			CO2	Classify the different visualization techniques to find out the distribution of data set.
			CO3	Illustrate the different data visualization techniques for business, social and research purpose using different graph, plot, map and charts.
			CO4	Examine the importance of choosing an appropriate visualization technique for a particular data and visualization objective.
			CO5	Evaluate the effectiveness of different visualization techniques for static, bivariate and multivariate graphical validations.
			CO6	Develop visualizations for reports, thesis, books and research articles using different customization methods.