

FACULTY OF ENGINEERING & TECHNOLOGY

BACHELOR OF ENGINEERING

**MINOR DEGREE IN DATA SCIENCE
(DRAFT SYLLABUS)**

Course Structure

Sr. No.	Semester	Temp. Course Code	Course Title	L	T	P	Credits
1.	3	DAS-1	Data Science using Python	3	0	2	4
2.	4	DAS-2	Computational Data analytics	3	0	2	4
3.	5	DAS-3	Machine Learning and Data Analytics	3	0	2	4
4.	6	DAS-4	Data Science Tools	3	0	2	4
5.	6	DAS-5	Mini-project	0	0	4	2
TOTAL				12	0	12	18

Detailed Syllabus

Course code:	DAS-1
Name of the course:	Data Science using Python
Semester:	3
Category of Course:	DAS

Course objectives:

The main objective of the course is to make students learn about the basic concepts of Python in data manipulation and analysis. Students will be able to write and execute Python code. At the end of the course, students should be able to write short scripts to perform data preprocessing, exploratory data analysis and data visualization.

Teaching & Examination Scheme:

Teaching Scheme			Credits	Examination Marks(Maximum/Passing)		Total
L	T	P	C	External		
				ESE(T)	ESE(P)	
3	0	2	4	50/25	50/25	100/50

ESE(T): End Semester Examination(Theory)

ESE(P): End Semester Examination(Practical)

Course Contents:

Unit	Contents	Hours.
1	Introduction of data science What is data, What is data science, Fundamentals of data science, Data science life cycle, Why data science is important, Applications of data science, Why Python is necessary for data science	2
2	Getting started with Python Jupyter/pycharm/spyder or any other python tool set up and installation. Basics of Python including data types, operators, variables, expressions, control structures using sample dataset, objects and functions. Python sequence data structures including String, Array, List, Tuple, Set, and Dictionary. Introduction to various python libraries for data science	8
3	Basic data Processing Introduction to DataFrames in Pandas, Learning to access elements with indexes, Re-indexing in pandas Series and Dataframes, Data preparation .Numerical Computing with NumPy, Going from Python list to Numpy arrays, working with multi-dimensional array, array operations. Several scientific numerical routines through SciPy.	8
4	Exploratory data analysis and Data preprocessing (data loading, dealing with missing values and outliers, data wrangling, filtering data, Data Normalization , Data Formatting ,data cleaning), Web scraping with beautiful soup.	8
5	Data Visualization Basic visualizations with Matplotlib, Advanced visualizations with Seaborn, Plotting images, graphs and grids of charts.	4

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
12%	20%	20%	20%	16%	12%

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate
C: Create**

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Python for data science for dummies 2nd Edition, John Paul Mueller, Luca Massaron, and Wiley
2. Programming through Python, M. T. Savaliya, R. K. Maurya, G. M. Magar, STAREDU Solutions

2. Pandas for everyone: Python Data Analysis, Daniel Y. Chen, Pearson
3. Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools, Davy Cielen, Arno D.B. Meysman, et al., Minning
4. Applied Data Science with Python and Jupyter: Use powerful industry-standard tools to unlock new, actionable insights from your data.

Course Outcomes (CO):

Sr. No.	Course Outcome Statements	% weightage
1	Apply various Python data structures to effectively manage various types of data.	20
2	Learn the fundamentals of some of the widely used python packages and apply them into data analytics.	25
3	Design applications applying various operations for data cleansing and transformation.	30
4.	Describe the various areas where data science is applied	25

List of Practicals/Tutorials:

1. Write a program to create a list, insert elements into the list and sort it in ascending order.
2. Write a program to create a dictionary of 10 elements, change/delete the values of few keys and display the dictionary before and after the updates.
3. Write a program to create a tuple and a list. Convert the list to tuple and display the elements of both. Write the program to remove the duplicate element of the list.
4. Write a program to perform all basic data pre processing steps on the given data set.
5. Write a program to perform exploratory data analysis on the given dataset.
6. Develop programs to learn the concept of Modules and packages.
7. Develop a program to learn concept of array and numpy module.
8. Write a NumPy program to convert a list of numeric value into a one-dimensional NumPy array. And perform all operations on that array.
9. Write a NumPy program to find the union of two arrays. Union will return the unique, sorted array of values that are in either of the two input arrays.
10. Write a Pandas program to convert a NumPy array to a Pandas series. Also write a Pandas program to calculate the frequency counts of each unique value of a given series.
11. Write a Pandas program to read a dataset from diamonds DataFrame and modify the default columns values and print the first 6 rows. Also find the number of rows and columns and data type of each column of diamonds DataFrame.
12. Consider dataset with student name, gender, Enrollmentno, 4 semester result with marks of each subject, his mobile number, and city. Implement following in Python. Plot various graphs and chart to visualize students' data.

Supplementary Learning Material:

- www.anaconda.com
- www.python.org
- www.w3schools.com
- <https://www.learnpython.org/>

Course Articulation Matrix:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	-	-	-	-	-	-	-	-	-	3	3	2
CO2	3	3	2	-	-	-	-	-	-	-	-	-	3	3	2
CO3	3	3	3	-	-	-	-	-	-	-	-	-	3	3	3
CO4	3	3	3	3	2	-	2	2	2	-	-	-	3	3	3

1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High) ‘ - ‘ No correlation

Detailed Syllabus

Course code:	DAS-2
Name of the course:	Computational Data analytics
Semester:	4
Category of Course:	DAS

Course objectives:

This computing course aims to produce high-quality, technically competent, innovative graduates that will become leading practitioners in the field of data analytics.

Teaching & Examination Scheme:

Teaching Scheme			Credits	Examination Marks(Maximum/Passing)		Total
L	T	P	C	External		
				ESE(T)	ESE(P)	
3	0	2	4	50/25	50/25	100/50

ESE(T): End Semester Examination(Theory)

ESE(P): End Semester Examination(Practical)

Course Contents:

Unit	Contents	Hours
1	Data analytics importance and overview, data analytics benefits Terminologies in data analytics, Data categorization (constant and variable; discrete and continuous; Qualitative and Quantitative; structure, semi-structured and unstructured, cross-sectional, time-series and panel), data measurement scale. Types of Analytics(Descriptive, predictive, prescriptive, diagnostic) Descriptive Analytics: Measures of Central Tendency, Measures of Variation, Measures of Shape and symmetry	6
2	Probability Distribution: Conditional Probability and Bayes' Theorem, Random variable and probability distribution. Probability Density Function (PDF) and Cumulative Distribution Function (CDF) of a Continuous Random variable. Various probability distribution (Binomial, Poisson, Geometric, Uniform, Exponential, Normal, Chi-Square, Student's t-distribution, F-distribution)	6
3	Inferential Statistics: Sampling and its various techniques, Estimation, Sampling distribution of mean and proportion, Normal distribution and z — statistic, Central limit theorem, Confidence Interval estimation for mean and proportion, sample size estimation, estimation of parameters	6
4	Basic Analysis Techniques: One Sample test (Hypothesis testing, Z-test, t-Test) Two Sample test (F-test, Analysis of variance, Correlation analysis) Chi-Square test, Maximum likelihood test	6
5	Data analytics in different sectors: How Google, LinkedIn, Amazon, Netflix uses analytics Data analytics in media and entertainment industry, education, government, weather forecasting.	6

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10%	10%	20%	30%	20%	10%

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate
C: Create**

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

Business Analytics: The Science of Data - Driven Decision Making - The Science of Data - Driven Decision Making, U Dinesh Kumar, Wiley India.

Data Science & Analytics, V.K. Jain, Khanna Book Publishing, New Delhi

Course Outcomes (CO):

Sr. No.	Course Outcome Statements	% weightage
CO-1	To explore data for understanding data characteristics.	20
CO-2	To explore the statistical analysis techniques for analyzing data.	30
CO-3	To learn the probability distributions and density estimation to perform analysis of various kinds of data.	30
CO-4	To analyze the data generated in real life problems with the help of important statistical tools and techniques.	20

List of Practicals/Tutorials:

1	<p>Perform descriptive analytics of the given data. The cumulative grade point average (CGPA) of students are given in the dataset.</p> <p>(a) Calculate the mean, median and mode. Calculate the standard deviation.</p> <p>(b) Calculate the 90th and 95th percentile of CGPA.</p> <p>(c) Calculate the inter quartile range (IQR).</p> <p>(d) The Dean of the school believes that the CGPA is a right tailed distribution. Is there an evidence to support dean's belief?</p> <p>(e) Create a histogram for the data, what should be the ideal number of bins in the histogram.</p>
2	Perform descriptive analytics of weather forecast dataset and provide the predictive data analysis.
3	<p>The Bank of India (BoI) situated in Delhi, India receives several applications for home loan and home improvement loan. The description of the data captured in 'know your customer' (KYC) document is as per dataset (Data file: BoI.xls):</p> <p>(a) Develop appropriate charts for the variables. What insights can be obtained based on the charts?</p> <p>(b) Calculate the mean, median, mode, variance, standard deviation, skewness and kurtosis of variables monthly salary and balance in saving account.</p> <p>(c) Use box plot to check whether there are outliers among variables loan amount requested, down payment, and EMI.</p> <p>(d) Which variable among continuous variables have high skewness?</p>
4	Generate Probability Density Function (PDF) and Cumulative Distribution Function (CDF) for the given Iris data set to find the distribution of various attributes of the dataset.

5	Perform various distributions on the Iris dataset to gain an insight into the relation between various attributes.
6	Generate different confidence interval for population mean and standard deviation, for Flight Schedule dataset
7	Consider a specific dataset and elaborate the concept of central limit theorem.
8	Estimate various population parameters from sample statistics for the Indians Diabetes Dataset.
9	Perform one-sample tests on the selected dataset to generate data analysis outcomes.
10	Perform two-sample tests on the selected dataset to generate data analysis outcomes.
11	Perform business insights through Google analytics to improve decision making.
12	Perform Analytics of data to get an insight in Educational sector with specific data analytics tool.

Supplementary Learning Material:

“Introduction to Data Analytics”, <https://nptel.ac.in/courses/110/106/110106072/>

“Data Analytics with Python”, <https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-cs46/>

Course Articulation Matrix:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO-1	1	2	-	3	1	-	3	2	-	-	-	1	1	2	-
CO-2	1	3	-	-	2	1	-	2	3	-	-	-	1	3	-
CO-3	-	-	1	2	-	-	3	-	-	3	2	1	-	-	1
CO-4	1	2	3	-	1	2	-	3	-	-	-	-	1	2	3

1. Slight (Low)

2. Moderate (Medium)

3. Substantial (High)

‘ - ‘ No correlation

Detailed Syllabus

Course code:	DAS-3
Name of the course:	Machine Learning and Data Analytics
Semester:	5
Category of Course:	DAS

Course objectives:

Machine learning is the technology of designing and implementing algorithms that allow computers to automatically learn from data or past experience and improve their performance without being explicitly programmed. It forms the basis of artificial intelligence. It involves algorithms to design coding by which computers can decipher information. This course covers the fundamental concepts of machine learning and popular machine learning algorithms, core concepts of supervised learning, unsupervised learning along with hands-on problem solving using simple python programming

Teaching & Examination Scheme:

Teaching Scheme			Credits	Examination Marks(Maximum/Passing)		Total
L	T	P	C	External		
				ESE(T)	ESE(P)	
3	0	2	4	50/25	50/25	100/50

ESE(T): End Semester Examination(Theory)

ESE(P): End Semester Examination(Practical)

Course Contents:

Unit	Contents	Hours
1	Basics of Machine Learning and Python Review of Linear Algebra, Definition of learning systems; Designing a learning system, Goals and applications of machine learning; Classification of learning system, Basic concepts in Machine Learning. Python Basics – string, number, list, tuple, Dictionary, functions, conditional statement, Loop statements, Numpy, Matplotlib, simple programming exercises using python.	6
2	Supervised Learning Linear regression with one variable, Linear regression with multiple variables, Logistic regression; Linear Methods for Classification; Linear Methods for Regression; Decision trees, overfitting.	6
3	Support Vector Machines Introduction, Maximum Margin Classification, Mathematics behind Maximum Margin Classification, Maximum Margin linear separators, non-linear SVM, Kernels for learning non-linear functions	6
4	Unsupervised Learning Learning from unclassified data, Clustering - Hierarchical Agglomerative	6

	Clustering, K-means partitional clustering, Expectation maximization (EM) for soft clustering; Dimensionality reduction – Principal Component Analysis, factor Analysis, Multidimensional scaling, Linear Discriminant Analysis.	
5	Applications of Machine Learning Strategies, guidelines for good design, performance measurement, Reading Data, PreProcessing Data, handwriting recognition, object detection, face detection	6

Suggested Specification table with Marks (Theory) (Revised Bloom’s Taxonomy):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
45%	30%	15%	10%	0	0

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom’s Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. The Elements of Statistical Learning, by Trevor Hastie, Robert Tibshirani, Jerome H. Friedman (freely available online)
2. Pattern Recognition and Machine Learning, by Christopher Bishop (optional)
3. EthemAlpaydin, Introduction to Machine Learning, 2nd edition, MIT Press 2010
4. Tom Mitchell, Machine Learning, McGraw-Hill, 1997
5. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective, MIT Press 2012.

Course Outcomes (CO):

Sr. No.	Course Outcome Statements	% weightage
1	Explain Machine Learning concepts, classifications of Machine Learning and write simple programs using python.	20
2	Describe Supervised Learning concepts	20
3	Explain Support Vector Machine concepts.	20
4	Describe unsupervised learning concepts and dimensionality reduction techniques.	20
5	Discuss simple Machine Learning applications in a range of real-world applications using Python programming	20

List of Practicals/Tutorials:

Sr. No **Make use of Data sets in implementing the machine learning algorithms**

- 1 For the given dataset learn to separate data set into training dataset, testing dataset and validation data set. Also learn to how to build and validate the model.
- 2 Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.
- 3 For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.
- 4 Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
- 5 Build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets.
- 6 Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.
- 7 Assuming a set of documents that need to be classified, use the naïve Bayesian Classifier model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the accuracy, precision, and recall for your data set.
- 8 Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set. You can use Java/Python ML library classes/API.
- 9 Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.
- 10 Write a program to implement k-Nearest Neighbor algorithm to classify the iris data set. Print both correct and wrong predictions. Java/Python ML library classes can be used for this problem.
- 11 Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs.
- 12 Apply machine learning to perform hand written character recognition.

Supplementary Learning Materials:

1. AndrewNg, “MachineLearning”, StanfordUniversity <https://www.coursera.org/learn/machine-learning/home/info>
2. Sudeshna Sarkar, “Introduction to Machine Learning”, IIT Kharagpur. <https://nptel.ac.in/courses/106105152/1>
3. Prof. BalaramanRavindran, “Introduction to Machine Learning”, IIT Madras <https://nptel.ac.in/courses/106106139/1>

Course Articulation Matrix:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	-	-	-	-	1	-	-	-	-	-	1	1	-	-
CO2	3	3	3	1	-	1	-	1	1	-	1	1	3	2	1
CO3	3	3	2	1	-	1	-	1	1	-	1	1	3	2	1
CO4	3	1	2	1	-	1	-	-	-	-	-	1	-	-	-
CO5	3	1	3	-	-	1	-	1	-	-	-	1	-	1	-

1. Slight (Low)

2. Moderate (Medium)

3. Substantial (High)

‘ - ‘ No correlation

Detailed Syllabus

Course code:	DAS-4
Name of the course:	Data Science Tools
Semester:	6
Category of Course:	DAS

Course objectives: Learning various data science tools to equip with the technologies that fulfils the requirement of the current industries.

Teaching & Examination Scheme:

Teaching Scheme			Credits	Examination Marks(Maximum/Passing)		Total
L	T	P	C	External		
				ESE(T)	ESE(P)	
3	0	2	4	50/25	50/25	100/50

ESE(T): End Semester Examination(Theory)

ESE(P): End Semester Examination(Practical)

Course Contents:

Unit	Contents	Hours
1	MS Excel Conditional Formatting, Sparklines and Number Formats, macros, drop down lists, Mastering charting techniques, Create an Interactive Dashboard	6
2	Power BI Introduction to Power BI, Power BI Desktop,	6

	Data Analysis Expressions, Data Visualization, QlikView Workbench	
3	Tableau Intro to Tableau, Common charts, Transformations and calculations, Interactions, Data storytelling	6
4	MySQL what is database,SQL and MySQL, basic DDL and DML statements, joins and views) and MongoDB database (Importing-exporting and querying data, creating and manipulating documents, CRUD operation, indexing and aggregation pipeline	6
5	R Studio: Importing data, data inputting, data visualization, manipulating and managing data, statistical modeling, R and database.	6

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10%	10%	20%	30%	20%	10%

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate
C: Create**

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Analyzing Data with Microsoft Power BI and Power Pivot for Excel, Marco Russo, Alberto Ferrari, PHI
2. Learn Power BI: A beginner's guide to developing interactive business intelligence solutions using Microsoft Power BI, Greg Deckler.
3. Communicating Data with Tableau: Designing, Developing, and Delivering Data Visualizations, Ben Jones, O'Reilly publisher
4. MongoDB Simply In Depth, Ajit Singh, Sultan Ahmad
5. MongoDB Tutorial, A basic guide with step-by-step instructions for the complete beginner, ThanhXTran
6. Data Analytics with R, Bharti Motwani, Wiley Publication
7. Essentials of R for Data Analytics, Saroj Dahiya Ratnoo, Himmat Singh Ratnoo, Wiley Publication

Course Outcomes (CO):

Sr. No.	Course Outcome Statements	% weightage
1	Get acquainted with various analysis and visualization tools.	60
2	To develop dashboard for understanding and handling data through different data science tools.	20
3	To learn the strategies adopted to analyze the data in various companies for better decision making.	20

List of Practicals/Tutorials:

1	Create table, perform operations with formula and functions, create charts through Excel. Use of advanced formulas, functions and macros.
2	Data base tutorials with Excel.(Importing data, building dataset and Creating data model and using excel as dataset)
3	Creating, managing and handling MongoDB database.
4	Apply different CRUD operation, aggregation using MaondoDB.
5	Creating, managing and handling MySQL database.
6	Create table, apply different CRUD operation, aggregation using MySQL.
7	To do credit risk modeling in financial sectors through R.
8	Perform stock market analysis using R.
9	Perform data blending, data collaboration through Tableau.
10	Social media data analysis through Tableau.
11	Study of Real time passenger traffic analysis and decision support accordingly for any transportation system through PowerBI.
12	Analyze your E-commerce data through PowerBI.

Supplementary Learning Materials:

<https://www.coursera.org/learn/excel-data-visualization#syllabus>

<https://courses.ceu.edu/sites/courses.ceu.hu/files/attachment/course/4442/datavisualization1aratofall2020-21.pdf>

university.mongodb.com

https://www.edureka.co/power-bi-certification-training?utm_source=Google-Search-Brand&utm_medium=cpc&utm_campaign=Brand-Course-Search-India-BMM&gclid=CjwKCAjwz_WGBhA1EiwAUAxIcV152yP7ht0Neas3S96QlwcxQSF07z0ES3fDnjJdw9-SyLZTPDhnbxoCnOMQAvD_BwE

BigML.com

Course Articulation Matrix:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	-	-	-	-	1	-	-	-	-	-	1	1	-	1
CO2	3	3	3	1	-	1	-	1	1	-	1	1	2	1	-
CO3	3	3	2	1	-	1	-	1	1	-	1	1	-	2	2

1. Slight (Low)

2. Moderate (Medium)

3. Substantial (High)

‘ - ‘ No correlation

Detailed Syllabus

Course code:	DAS-5
Name of the course:	Mini-project
Semester:	6
Category of Course:	DAS

Course objectives:

The main objective of Mini Project is to let the students apply the knowledge of theoretical concepts which they have learnt as a part of the curriculum of the minor degree using real time problems or situations.

Teaching & Examination Scheme:

Teaching Scheme			Credits	Examination Marks(Maximum/Passing)		Total
L	T	P	C	External		
				ESE(T)	ESE(P)	
0	0	4	2	00	100/50	100/50

ESE(T): End Semester Examination(Theory)

ESE(P): End Semester Examination(Practical)

Course Guidelines:

- The mini-project is desirable to be done in a group of 2 students. Each group has to prepare a title related to any engineering discipline, and the title must emulate any real-world problem.

- Submit an early proposal. This proposal is a 1-2page(s) report, describes what the project is about and the final product's output. The project proposal will be submitted to the respective guide.

Course Outcomes (CO):

- Understand, plan and execute a Mini Project with team.
- Students will be able to practice acquired knowledge within the chosen area of technology for project development.
- Identify, discuss and justify the technical aspects of the chosen project with a comprehensive and systematic approach.
- Communicate and report effectively project related activities and findings.

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

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

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.

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.

4.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.

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.

6.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.

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.

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

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

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.

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.

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.

PROGRAM SPECIFIC OUTCOMES (PSOs)

1. Ability to conceptualize interdisciplinary domain knowledge to specific branch of engineering.
2. Ability to acquire employability skills and deep knowledge in emerging and multidisciplinary areas.
3. Carry out engineering projects in broad areas of engineering.
