गोंय विद्यापीठ
ताळगांव पठार,
गोंय – ४०३ २०६
फोन : +९१-८६६९६०९०४८

(Accredited by NAAC)

ATMANIRBHAR BHARAT
SWAYAMPURNA GOA

Goa University
Taleigao Plateau, Goa-403 206
Tel : +91-8669609048
Email : registrar@unigoa.ac.in
Website : www.unigoa.ac.in

GU/Acad –PG/BoS -NEP Engg. /2024-25/783 Date: 27.01.2025

CIRCULAR

Ref. No.: GU/Acad –PG/BoS -NEP Engg. /2024/633 dated 07.11.2024

In supersession to the above referred Circular, the Syllabus of Semester II of the **Master of Engineering (Data Sciences)** Programme approved by the Academic Council in its meeting held on 06th December 2024 is attached herewith. The syllabus of Semester I approved earlier by the Academic Council in its meeting held on 22nd August 2024 is also attached.

The Dean, Faculty of Engineering and Principals of affiliated Colleges offering the **Master of Engineering (Data Sciences)** are requested to take note of the above and bring the contents of the Circular to the notice of all concerned.

ASHWIN VYAS LAWANDE
Digitally signed by ASHWIN VYAS LAWANDE
Date: 2025.01.27 16:01:33 +05'30'

(Ashwin V. Lawande)

Deputy Registrar – Academic

To,

1. The Dean, Faculty of Engineering, Goa University.
2. The Principals of affiliated Engineering Colleges.

Copy to,

1. The Director, Directorate of Technical Education, Govt. of Goa
2. The Chairperson, BoS in Computer Engineering.
3. The Controller of Examinations, Goa University.
4. The Assistant Registrar Examinations (Prof.), Goa University.
5. Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.

MASTER OF ENGINEERING (DATA SCIENCES)
RC 2024-25

TWO YEAR PROGRAMME STRUCTURE						
Semester I						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	DEN-500	Mathematical Foundation for Data Science	4	0	0	4
2	DEN-501	Python for Data Science and Analytics	3	0	0	3
3	DEN-502	Python for Data Science and Analytics Lab	0	0	1	1
4	DEN-503	Statistical Methods using R	3	0	0	3
5	DEN-504	Statistical Methods using R Lab	0	0	1	1
Programme Specific Elective (PSE) Courses						
6	DEN-531	Database Technologies for Data Science	3	1	0	4
OR						
7	DEN-532	Cloud Computing for Data Science	3	1	0	4
Research Specific Elective (RSE) Courses						
8	REC-561	Engineering Research & Publications	3	1	0	4
OR						
9	REC-562	Literature Review & Technical Writing for Engineers	3	1	0	4
		TOTAL	**16**	**2**	**2**	**20**
Semester II						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	DEN-505	Big Data Systems	3	0	0	3
2	DEN-506	Big Data Systems Lab	0	0	1	1
3	DEN-507	Digital Marketing Analytics	3	0	0	3
4	DEN-508	Digital Marketing Analytics Lab	0	0	1	1
5	DEN-509	Data Visualization and Modeling	3	0	0	3
6	DEN-510	Data Visualization and Modeling Lab	0	0	1	1
Programme Specific Elective (PSE) Courses						
7	DEN-533	Neural Networks	3	0	0	3
8	DEN-534	Neural Networks Lab	0	0	1	1
OR						
9	DEN-535	Business Intelligence	3	0	0	3
10	DEN-536	Business Intelligence Lab	0	0	1	1
Research Specific Elective (RSE) Courses						
11	REC-563	Statistics and Data Analysis for Engineering Research	2	0	0	2
12	REC-564	Statistics and Data Analysis Lab	0	0	2	2
OR						
13	REC-565	Statistical Techniques for Engineering Research	2	0	0	2
14	REC-566	Probability & Statistical Analysis Lab	0	0	2	2
		TOTAL	**14**	**0**	**6**	**20**

Issued on: 27/01/2024

Semester III						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	**DEN-600**	Machine Learning for Data Sciences	**3**	**0**	**0**	**3**
2	**DEN-601**	Machine Learning for Data Sciences Lab	**0**	**0**	**1**	**1**
3	**DEN-602**	Deep Learning for Data Science	**3**	**0**	**0**	**2**
4	**DEN-603**	Deep Learning for Data Science Lab	**0**	**0**	**1**	**2**
Programme Specific Elective (PSE) Courses						
5	**DEN-631**	Information Retrieval	**3**	**0**	**0**	**3**
6	**DEN-632**	Information Retrieval Lab	**0**	**0**	**1**	**1**
OR						
7	**DEN-633**	Cyber Security and Threat Analysis	**3**	**0**	**0**	**3**
8	**DEN-634**	Cyber Security and Threat Analysis Lab	**0**	**0**	**1**	**1**
Research Specific Elective (RSE) Courses						
9	**DEN-661**	Web Mining	**2**	**0**	**0**	**2**
10	**DEN-662**	Web Mining Lab	**0**	**0**	**2**	**2**
OR						
11	**DEN-663**	Recommender Systems	**2**	**0**	**0**	**2**
12	**DEN-664**	Recommender Systems Lab	**0**	**0**	**2**	**2**
General Elective (GE) Courses						
13	**GEC-681**	Sustainability Principles & Practices	**3**	**0**	**0**	**3**
14	**GEC-682**	Sustainability Principals Lab	**0**	**0**	**1**	**1**
OR						
15	**GEC-683**	Project Management	**3**	**0**	**0**	**3**
16	**GEC-684**	Project Management Lab	**0**	**0**	**1**	**1**
		TOTAL	**14**	**0**	**6**	**20**
Semester IV						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
General Elective (GE) Courses						
1	**GEC-685**	Financial Management	**4**	**0**	**0**	**4**
OR						
2	**GEC-686**	Entrepreneurship	**4**	**0**	**0**	**4**
Dissertation/Internship						
3	**DEN-698**	Dissertation	**0**	**0**	**0**	**16**
OR						
4	**DEN-699**	Internship	**0**	**0**	**0**	**16**
		TOTAL	**4**	**0**	**0**	**20**

THREE YEAR PROGRAMME STRUCTURE						
Semester I						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	DEN-500	Mathematical Foundation for Data Science	**4**	**0**	**0**	**4**
Programme Specific Elective (PSE) Courses						
2	DEN-531	Database Technologies for Data Science	**3**	**1**	**0**	**4**
OR						
3	DEN-532	Cloud Computing for Data Science	**3**	**1**	**0**	**4**
Research Specific Elective (RSE) Courses						
4	REC-561	Engineering Research & Publications	**3**	**1**	**0**	**4**
OR						
5	REC-562	Literature Review & Technical Writing for Engineers	**3**	**1**	**0**	**4**
		TOTAL	**10**	**2**	**0**	**12**
Semester II						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	DEN-505	Big Data Systems	**3**	**0**	**0**	**3**
2	DEN-506	Big Data Systems Lab	**0**	**0**	**1**	**1**
Programme Specific Elective (PSE) Courses						
3	DEN-533	Neural Networks	**3**	**0**	**0**	**3**
4	DEN-534	Neural Networks Lab	**0**	**0**	**1**	**1**
OR						
5	DEN-535	Business Intelligence	**3**	**0**	**0**	**3**
6	DEN-536	Business Intelligence Lab	**0**	**0**	**1**	**1**
Research Specific Elective (RSE) Courses						
7	REC-563	Statistics and Data Analysis for Engineering Research	**2**	**0**	**0**	**2**
8	REC-564	Statistics and Data Analysis Lab	**0**	**0**	**2**	**2**
OR						
9	REC-565	Statistical Techniques for Engineering Research	**2**	**0**	**0**	**2**
10	REC-566	Probability & Statistical Analysis Lab	**0**	**0**	**2**	**2**
		TOTAL	**8**	**0**	**4**	**12**

Issued on: 27/01/2024

Semester III						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	DEN-501	Python for Data Science and Analytics	**3**	**0**	**0**	**3**
2	DEN-502	Python for Data Science and Analytics Lab	**0**	**0**	**1**	**1**
3	DEN-503	Statistical Methods using R	**3**	**0**	**0**	**3**
4	DEN-504	Statistical Methods using R Lab	**0**	**0**	**1**	**1**
Programme Specific Elective (PSE) Courses						
5	**DEN-631**	Information Retrieval	**3**	**0**	**0**	**3**
6	**DEN-632**	Information Retrieval Lab	**0**	**0**	**1**	**1**
OR						
7	**DEN-633**	Cyber Security and Threat Analysis	**3**	**0**	**0**	**3**
8	**DEN-634**	Cyber Security and Threat Analysis Lab	**0**	**0**	**1**	**1**
		TOTAL	**9**	**0**	**3**	**12**
Semester IV						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	DEN-507	Digital Marketing Analytics	**3**	**0**	**0**	**3**
2	DEN-508	Digital Marketing Analytics Lab	**0**	**0**	**1**	**1**
3	DEN-509	Data Visualization and Modeling	**3**	**0**	**0**	**3**
4	DEN-510	Data Visualization and Modeling Lab	**0**	**0**	**1**	**1**
Generic Elective (GE) Courses						
5	**GEC-681**	Sustainability Principles & Practices	**3**	**0**	**0**	**3**
6	**GEC-682**	Sustainability Principals Lab	**0**	**0**	**1**	**1**
OR						
7	**GEC-683**	Project Management	**3**	**0**	**0**	**3**
8	**GEC-684**	Project Management Lab	**0**	**0**	**1**	**1**
		TOTAL	**9**	**0**	**3**	**12**

SEMESTER V						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	**DEN-600**	Machine Learning for Data Sciences	**3**	**0**	**0**	**3**
2	**DEN-601**	Machine Learning for Data Sciences Lab	**0**	**0**	**1**	**1**
3	**DEN-602**	Deep Learning for Data Science	**3**	**0**	**0**	**2**
4	**DEN-603**	Deep Learning for Data Science Lab	**0**	**0**	**1**	**2**
Research Specific Elective (PSE) Courses						
5	**DEN-661**	Web Mining	**2**	**0**	**0**	**2**
6	**DEN-662**	Web Mining Lab	**0**	**0**	**2**	**2**
OR						
7	**DEN-663**	Recommender Systems	**2**	**0**	**0**	**2**
8	**DEN-664**	Recommender Systems Lab	**0**	**0**	**2**	**2**
Semester VI						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Generic Elective (GE) Courses						
1	**GEC-685**	Financial Management	**4**	**0**	**0**	**4**
OR						
2	**GEC-686**	Entrepreneurship	**4**	**0**	**0**	**4**
Dissertation/Internship						
3	**DEN-698**	Dissertation	**0**	**0**	**0**	**16**
OR						
4	**DEN-699**	Internship	**0**	**0**	**0**	**16**
		TOTAL	**4**	**0**	**0**	**20**

Semester I
Programme Specific Core (PSE) Courses
Name of the Programme : Master of Engineering (Data Sciences)
Course code : DEN-500
Title of the course : Mathematical Foundation for Data Science
Number of Credits : 4
Effective from AY : 2024-25

Pre- requisites for the Course:	Basic Understanding of Mathematics	
Course Objectives:	This course will enable students to: 1. Constructing the foundation of Data Science 2. Demonstrate the data pre-processing terms for improving the quality of dataset 3. Gaining hands-on experience with data sciences programming tools	
Units	**Contents**	**No of Hours**
Unit-1	Mathematical concepts for Data Science: Vectors and matrices, Arithmetic symbols, Graphs, Logarithms/exponents, Set theory, Linear algebra. Probability: Basic definitions, Probability, Bayesian versus Frequentist, Compound events, Conditional Probability, The rules of probability, collectively exhaustive events, Bayes theorem, Random variables.	**15**
Unit-2	Data Science: Benefits and uses, Facets of data, Data Science Process: Overview, defining research goals, Retrieving data, Data preparation, Exploratory Data analysis, build the model, presenting findings and building applications, Data Mining, Data Warehousing – Basic Statistical descriptions of Data.	**15**
Unit- 3	Data Pre-processing: Data cleaning, Data integration, Data Reduction, Data Transformation and Data Discretization, Feature Generation and Feature Selection, Feature Selection algorithms: Filters, Wrappers, Decision Trees, Random Forests	**15**
Unit- 4	Importing Matplotlib, Line plots, Scatter plots, visualizing errors, density and contour plots, Histograms, legends, colors, subplots, text and annotation customization, three-dimensional plotting, Geographic Data with Basemap, Visualization with Seaborn.	**15**
Pedagogy:	Inquiry Based Learning, Reflective, Integrative Learning	
References/ Readings:	**Text Books** 1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, “Introducing Data Science”, Manning Publications, 2016. 2. Cathy O’Neil, Rachel Schutt, Doing Data Science, Straight Talk from The Frontline. O’Reilly, 2013. 3. Data Mining: Concepts and Techniques”, Third Edition, Jiawei Han, Micheline Kamber and Jian Pei, 2011. 4. Sinan Ozdemir, “Principles of Data Science: Learn the techniques and math you need to start making sense of your data”, 1st edition, Packt publishing, 2016. 5. Jake VanderPlas, “Python Data Science Handbook”, O’Reilly, 2016.	

	Reference Books 1. Big Data and Business Analytics, Jay Liebowitz, CRC press (2013) 2. Data mining methods,2nd edition, C. Rajan, Narosa (2016) 3. Mark Gardener, "Beginning R - The Statistical Programming Language", John Wiley & Sons, Inc.
Course Outcomes:	After going through this course, the students will be able to: CO 1. Illustrate the basic concepts of data science CO 2. Apply data visualization techniques in data science CO 3. Solve mathematical problems using various arithmetic and more challenging forms of math CO 4. Illustrate the obtaining and sampling data in statistics to quantify and visualize our data.

(Back to Index)

Name of the Programme : Master of Engineering (Data Sciences)
Course code : DEN-501
Title of the course : Python for Data Science and Analytics
Number of Credits : 3
Effective from AY : 2024-25

Pre- requisites for the Course:	Basic programming skills	
Course Objectives:	This course will enable students to: 1. Student will be equipped with essential Python skills for data science and analytics 2. Student will be able to understand cleaning and preprocessing data, apply regression techniques, perform basic statistical analysis and visualization on data using python. 3. Course will enable student to analyze real-world datasets and make data-driven decisions.	
Units	**Contents:**	**No of Hours**
Unit-1	**Basics of Python:** Datatypes in Python, Operators, Input Output, Control Statements, **Functions in Python:** defining function, calling, returning results from a function, returning multiple values, types of arguments, anonymous functions or lambdas. **Classes, Objects and Methods.**	**12**
Unit-2	**NumPy Arrays:** Working with Arrays using NumPy, Creating Arrays with array(), line space , logs pace and arrange() function, Mathematical operations on NumPy Arrays, Indexing, Slicing, Working with Multidimensional arrays, Indexing and Slicing in Multidimensional arrays, Matrices in NumPy, Operations on Matrices: getting Diagonal elements, sorting the Matrix, Transpose, Addition and Multiplication. Random Numbers. **Modules, Packages and Libraries in Python**	**12**
Unit- 3	**Data Analysis Using Pandas:** Series and Data Frame, Viewing Data frame using loc() and iloc(), Operations on Data frames: knowing number of rows and columns, retrieval, display statistical information, sorting data, handling missing data, **Advance Data Analytics using Pandas:** Joining data frames, concatenation of tables, aggregate functions on Data Frames, Writing SQL equivalent Statements in Pandas.	**12**
Unit- 4	**Data Visualization using Matplotlib:** Bar Graph, Histogram, creating a pie chart, creating a line graph, creating scatter plot **Data Visualization using Seaborn:** Datasets, Distribution plot, Count plot, Box Plot, Scatter Plot, Joint Plot, Line Plot, Displaying Scatter Plot with Regression Line, Heat Map.	**09**
Pedagogy:	Inquiry Based Learning, Reflective, Integrative Learning	
References/ Readings:	**Text Books** 1. Dr. R.Nageswara Rao, "Machine Learning in Data Science using Python", Edition :June 2022 , Dreamtech Press,2022 **Reference Books**	

	1. Thomas Nield, “Essential Math for Data Science”, First Edition 2022, June 2022, O’Reilly Media Inc. 2. Dr. R. Nageshwara Rao, “Core Python Programming”, Third Edition, Reprint Edition 2022, Dreamtech Press,2022
Course Outcomes:	After going through this course, the students will be able to: CO 1. Develop a strong understanding of Python programming concepts CO 2. Examine and manipulate datasets effectively using Python libraries such as Pandas and NumPy, applying data transformation and analysis techniques. CO 3. Create informative data visualizations using Matplotlib and Seaborn. CO 4. Illustrate concepts like linear regression and multiple linear regressions.

(Back to Index)

Name of the Programme : **Master of Engineering (Data Sciences)**
Course code : **DEN-502**
Title of the course : **Python for Data Science and Analytics Lab**
Number of Credits : **1**
Effective from AY : **2024-25**

Pre- requisites for the Course:	Basic Programming skills	
Course Objectives:	This course will enable students to: 1. Student will be equipped with essential Python skills for data science and analytics 2. Student will be able to understand cleaning and preprocessing data, apply regression techniques, perform basic statistical analysis and visualization on data using python. 3. Course will enable student to analyze real-world datasets and make data-driven decisions.	
Content:	**List of Programs /Experiments**	**No. of Hours**
	1. Python Program to demonstrate the use of datatypes, operators and Input output 2. Python Program to demonstrate the use of Functions 3. Python Program to demonstrate the use of datatypes, operators and Standard Input output 4. Python Program to demonstrate the use of Functions 5. Python program to demonstrate the use of NumPy arrays 6. Python Program to demonstrate the use of NumPy Matrices 7. Python Program to demonstrate use of Pandas for Data Analysis 8. Python Program to demonstrate the use of Matplotlib 9. Python Program to demonstrate the use of Seaborn 10. Python Program to Demonstrate EDA	**30**
Instructions	Minimum 8 experiments to be performed	
Course Outcomes:	After going through this course, the students will be able to: CO 1. Develop a comprehensive understanding of core Python programming concepts, including syntax, data types, and control structures. CO 2. Effectively examine and manipulate datasets using Python libraries such as Pandas and NumPy, applying data transformation and analysis techniques. CO 3. Create clear and informative data visualizations using libraries like Matplotlib and Seaborn to represent data insights. CO 4. Illustrate and explain the concepts of linear regression and multiple linear regression in the context of data modelling.	

(Back to Index)

Name of the Programme : Master of Engineering (Data Sciences)
Course code : DEN-503
Title of the course : Statistical Methods using R
Number of Credits : 3
Effective from AY : 2024-25

Pre- requisites for the Course:	Basic knowledge of statistical methods used in analytics	
Course Objectives:	This course will enable students to: 1. To analyse the concept of statistical methods. 2. To equip the students to visualize and analyse the data using R 3. To communicate statistical results in correct manner. 4. To understand scientific inference from R	
Units	**Contents:**	**No of Hours**
Unit-1	**R AND RSTUDIO:** Getting started with R - installing R and R studio - getting help - installing and loading packages - simple arithmetic calculations - data structure – expressions - conditional statements – functions – loops - R–markdown - introduction to Statistics - probability and data with R.	**12**
Unit-2	**EXPLORATORY DATA ANALYSIS:** Visualizing numerical data - graphing systems available in R - descriptive Statistics - measures of central tendency and dispersion – correlation - transforming data - exploring categorical variables.	**12**
Unit- 3	**PROBABILITY AND PROBABILITY DISTRIBUTIONS:** Introduction - disjoint events - general addition rule – independence - probability examples - disjoint vs. Independent - conditional probability - probability trees - normal distribution - evaluating the normal distribution - working with the normal distribution - binomial distribution - normal approximation to binomial - working with the binomial distribution.	**12**
Unit- 4	**ESTIMATION:** Introduction to Inference - sampling from population - maximum likelihood estimator - least square estimator - confidence interval (CI) (for a mean) - accuracy vs. Precision - required sample size for mean, CI (for the mean) examples.	**09**
Pedagogy:	Inquiry Based Learning, Reflective, Integrative Learning	
References/ Readings:	**Text Books** 1. Grolemund G., Hands-on programming with R: write your own functions and simulations, O' Reilly Media Inc., 2014. 2. James G., Witten D., Hastie T., & Tibshirani R, An introduction to statistical learning: with Applications in R, Springer, 2013 **Reference Books** 1. Gupta S. C., & Kapoor V. K., Fundamental of Mathematical Statistics, Sultan Chand & Sons, 2018. 2. Peng R. D, Exploratory data analysis with R, Lulu.Com, 2012.	
Course Outcomes:	After going through this course, the students will be able to: CO 1. Develop a comprehensive understanding of R programming	

	language and proficiently use R Studio for data analysis CO 2. Create reports using R markdown CO 3. Analyse data for a given problem CO 4. Apply probability and statistics in real life problem.

(Back to Index)

Name of the Programme : Master of Engineering (Data Sciences)
Course code : DEN-504
Title of the course : Statistical Methods using R Lab
Number of Credits : 1
Effective from AY : 2024-25

Pre- requisites for the Course:	Basic knowledge of statistical methods used in analytics	
Course Objectives:	This course will enable students to: 1. To analyse the concept of statistical methods. 2. To equip the students to visualize and analyse the data using R 3. To communicate statistical results in correct manner. 4. To understand scientific inference from R	
Content:	**List of Programs /Experiments**	**No. of Hours**
	1. R program to illustrate different data structures 2. Defining functions and making report in markdown 3. Loading dataset and visualizing data 4. Producing descriptive statistics measures 5. Computing probabilities in R 6. Functions for probability distributions in R 7. Finding ML estimates and least square estimates 8. Constructing confidence interval 9. Carrying out large sample tests in R 10. Some small samples tests: t-test, paired t-test in R	**30**
Instructions	Minimum 8 experiments to be performed	
Course Outcomes:	After going through this course, the students will be able to: CO 1. Demonstrate a comprehensive understanding of R programming concepts and effectively use R Studio CO 2. Create reports using R markdown CO 3. Analyse data for a given problem CO 4. Apply probability and statistics in real life problems	

(Back to Index)

Programme Specific Elective (PSE) Courses
Name of the Programme : Master of Engineering (Data Sciences)
Course code : DEN-531
Title of the course : Database Technologies for Data Science
Number of Credits : 4
Effective from AY : 2024-25

Pre- requisites for the Course:	Fundamentals of Relational Database Systems and Query language	
Course Objectives:	This course will enable students to: 1. Understanding of the basic concepts and applications of database systems. 2. Understanding and use of data manipulation language to query, update, and manage database. 3. The ability to design and build a simple database system and demonstrate competence with the fundamental tasks involved in modeling, designing, and implementing a DBMS. 4. Familiarity with the basic issues of transaction processing and concurrency control.	
Units	**Contents:**	**No of Hours**
Unit-1	INTRODUCTION: Concept & Overview of DBMS, Data Models, Database Languages, Database Administrator, Database Users, Three Schema architecture of DBMS. Basic concepts, Design Issues, Mapping Constraints, Keys, Entity-Relationship Diagram, Weak Entity Sets, Extended E-R features	**15**
Unit-2	RELATIONAL MODEL AND DATABASE DESIGN SQL and Integrity Constraints, Concept of DDL, DML, DCL. Basic Structure, Set operations, Aggregate Functions, Null Values, Domain Constraints, Referential Integrity Constraints, assertions, views, Nested Subqueries, Functional Dependency, Different anomalies in designing a Database, Normalization: using functional dependencies, Boyce-Codd Normal Form, 4NF, 5NF.	**15**
Unit- 3	DATA WAREHOUSE: THE BUILDING BLOCKS Defining Features, Data Warehouses and Data Marts, Architectural Types, Overview of the Components, Metadata in the Data warehouse, Data Design and Data Preparation: Principles of Dimensional Modeling, Dimensional Modeling Advanced Topics From Requirements To Data Design, The Star Schema, Star Schema Keys, Advantages of the Star Schema.	**15**
Unit- 4	Star Schema: Examples, Dimensional Modeling: Advanced Topics, Updates to the Dimension Tables, Miscellaneous Dimensions, The Snowflake Schema, Aggregate Fact Tables, Families OoStars	**15**
Pedagogy:	Inquiry Based Learning, Reflective, Integrative Learning	
References/ Readings:	**Text Books** 1. Henry F. Korth and Silberschatz Abraham, Database System Concepts, Mc.Graw Hill.	

	2. Thomas Cannolly and Carolyn Begg, Database Systems, A Practical Approach to Design, Implementation and Management", Third Edition, Pearson Education, 007. 3. The Data Warehouse Toolkit: The Complete Guide to Dimensional Modeling, 2nd John Wiley & Sons Inc., New York, USA, 2002. **Reference Books** 1. LiorRokach and OdedMaimon, Data Mining and Knowledge Discovery Handbook, Springer, 2nd edition, 2010. 2. Elmasri Ramez and Navathe Shamkant, Fundamentals of Database System, 7e
Course Outcomes:	After going through this course, the students will be able to: CO 1. Describe fundamental elements of relational database management systems and NoSQL. CO 2. Classify basic concept of relational data model, entity-relationship model, relational database design using normalization, relational algebra and SQL. CO 3. Discuss the basic issues of transaction processing and concurrency control techniques. CO 4. Evaluate query processing and query optimization.

(Back to Index)

Name of the Programme : Master of Engineering (Data Sciences)
Course code : DEN-532
Title of the course : Cloud Computing for Data Science
Number of Credits : 4
Effective from AY : 2024-25

Pre- requisites for the Course:	Basic knowledge of Database, Networking and Operating System	
Course Objectives:	This course will enable students to: 1. Discuss the concepts, characteristics, delivery models and benefits of cloud computing. 2. Explore the key technical, organizational and compliance challenges of cloud computing. 3. Grasp the concepts of virtualization efficiently. 4. Explore the security issues that arise from cloud computing architectures intended for delivering cloud-based enterprise IT services.	
Contents:		**No of Hours**
Unit-1	**Introduction, Cloud Computing**, Cloud Computing delivery models and Defining Attributes. Ethical Issues and Cloud Vulnerabilities, Cloud Computing delivery models and services, Amazon Web Services, Google Clouds, Microsoft Windows Azure and Online Services, Cloud Storage Diversity and Vendor Lock In. Energy use and ecological impact of cloud computing, Major challenges faced by cloud computing.	**15**
Unit-2	**Cloud Applications:** Cloud Application Development and Architectural Styles, Workflow Patterns, Coordination Based on a State Machine Model – The Zookeeper, The MapReduce Programming Model. Clouds for Science and Engineering	**15**
Unit- 3	**Cloud Resource Virtualization:** Performance and Security Isolation in Computer Clouds, Virtual Machines, Full virtualization and Para virtualization, Hardware support for Virtualization. Case study: Xen – a Hypervisor based on Para virtualization. Optimization of network virtualization in Xen 2.0 The Darker Side of Virtualization	**15**
Unit- 4	**Cloud Resource Management and Scheduling:** Policies and mechanisms for resource management. Control Theory and Optimal Resource Management, Stability of two – level resource allocation architecture. Feedback control based on Dynamic Thresholds, Coordination of Autonomic Performance Managers. Scheduling Algorithms for Computer Clouds	**15**
Pedagogy:	Inquiry Based Learning, Reflective, Integrative Learning	
References/ Readings:	**Text Books** 1. Dan C. Marinesu, "Cloud Computing: Theory and Practice", 2013, Elsevier **Reference Books** 1. Rajkumar Buyya, James Broberg, Andrej Goscinki, "Computing Principles and Paradigms", 2014, Wiley. 2. John W. Rittinghouse, James F. Ransome, "Cloud Computing	

	Implementation", 2013, CRC Press
Course Outcomes:	After going through this course, the students will be able to: CO 1. Describe the fundamental concepts of cloud computing, including delivery models and services, with a clear understanding CO 2. Identify the challenges, architectural styles and workflows of cloud computing CO 3. Narrate cloud resource virtualization CO 4. Apply various cloud resource management and scheduling policies and techniques.

(Back to Index)

Research Specific Elective (RSE) Courses
Name of the Programme : Master of Engineering (Data Sciences)
Course code : REC-561
Title of the course : Engineering Research & Publication
Number of credits : 4(3L+1T)
Effective from AY : 2024-25

Pre-requisites for the Course:	Knowledge of research requirements in real life	
Course Objectives:	The course will enable the students to 1. Understand the importance of literature review, defining the research objectives. 2. Explain qualitative and quantitative methods of data analyses and its importance. 3. Classify research publications, select appropriate journals based on research areas. 4. Practice ethics in publication and academic integrity	
Content:		**No of Hours**
Unit -1	**Overview of scientific research in engineering**, foundational and fundamental concepts like types of research and considerations for research in specific domains, motivation to do research, critical thinking, assumptions and hypotheses, basic and applied research, importance of formulation of broad research objectives	**11 + 4T**
Unit -2	**Purpose and Methodology of Literature Search and Review** of the scientific and engineering publications. Sources such as scholarly databases, public domain, open access, current literature, review articles, critical review and gap analysis, defining research objectives	**11 + 4T**
Unit -3	**Quantitative and qualitative Data –** importance of data in research, types of data, data collection techniques, Quantitative methods for analysis of data – statistical tools, mathematical modeling, simulation, experimental data, optimization methods; Qualitative data collection, preparing questioners, rating scale, conducting survey, validation of models.	**12 + 4T**
Unit- 4	**Preparation of Publications-** Elements of research publications, types of publications, writing for journal publications, basic requirements for publication, selection of journals, journal quality indicators, peer review, reply to comments and responses, publication ethics, references, citations, authorship, plagiarism, academic integrity	**11 + 3T**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning , Constructive learning and Collaborative learning	
References/ Readings:	1. Herman Tang, 'Engineering Research-Design, Methods and Publications', John Wiley and Sons, 2021, ISBN:9781119624486. 2. Michael Jay Katz, 'From Research to Manuscript', Springer Publication,	

	2009, ISBN:9781402094668. 3. Rob Dekkers, Lindsey Casey, Peter Langhorne, 'Making Literature Review Work', Springer Publications, 2022, ISBN:9783030900243 4. Meikang Qiu, Han Qiu, Yi Zeng, 'Research & Technical Writing for Science and Engineering', Taylor & Francis Publications, 2022, ISBN:9781003139058.
Course Outcomes:	CO 1. Understand the importance of literature review, defining the research objectives. CO 2. Explain qualitative and quantitative methods of data analyses and its importance. CO 3. Classify research publications, select appropriate journals based on research areas. CO 4. Practice ethics in publication and academic integrity

(Back to Index)

Name of the Programme : Master of Engineering (Data Sciences)
Course code : REC-562
Title of the course : Literature Review & Technical Writing for Engineers
Number of credits : 4(3L + 1T)
Effective from AY : 2024-25

Pre-requisites for the Course:	Basics of Technical writing skills.	
Course Objectives:	The course will enable the students to 1. Understand the importance of literature review and writing a review paper. 2. Explain the method to be followed to write a review paper. 3. Classify data for qualitative and quantitative analysis 4. Demonstrate technical writing for conference.	
Content:		**No of Hours**
Unit -1	**Overview on Literature Review**, difference between objectives of literature review and research objectives; types of literature review, qualitative and quantitative reviews, search strategies, primary and secondary sources, database search strategies, field search, root search, complimentary search, meta-analysis	**12 + 4T**
Unit -2	**Database management of literature reviews**, bibliometric analysis, importance of writing a review paper, reply to comments and responses, publication ethics, references, citations, authorship, plagiarism, academic integrity; public domain, open access, current literature.	**11 + 4T**
Unit -3	**Technical writing on a specific research topic**, structure of the paper, abstract, introduction, experimental, simulation, analysis, discussion, inferences, title, acknowledgment, referencing, presentation of tables, figures, graphs, equations; comparison between technical writing for conference papers and journal paper	**11 + 4T**
Unit- 4	**Importance of data in research**, types of data, data collection techniques, Quantitative methods for analysis of data – statistical tools, mathematical modeling, simulation, experimental data, optimization methods; Qualitative data collection, preparing questioners, rating scale, conducting survey, validation of models.	**11 + 3T**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	1. Rob Dekkers, Lindsey Casey, Peter Langhorne, 'Making Literature Review Work – Multidisciplinary Guide to Systematic Approaches', Springer Publications, 2022, ISBN:9783030900243. 2. Michael Jay Katz, 'From Research to Manuscript', Springer Publication, 2009, ISBN:9781402094668. 3. Herman Tang, 'Engineering Research-Design, Methods and Publications', John Wiley and Sons, 2021, ISBN:9781119624486. 4. Meikang Qiu, Han Qiu, Yi Zeng, 'Research & Technical Writing for	

	Science and Engineering', Taylor & Francis Publications, 2022, ISBN:9781003139058.
Course Outcomes:	After taking this course, student will be able to: CO 1. Understand the importance of literature review and writing a review paper. CO 2. Explain the method to be followed to write a review paper. CO 3. Classify data for qualitative and quantitative analysis CO 4. Demonstrate technical writing for conference.

(Back to Index)

SEMESTER – II
Programme Specific Core (PSC) Courses
Name of the Programme : Master of Engineering (Data Sciences)
Course code : DEN-505
Title of the course : Big Data Systems
Number of Credits : 03 (3L)
Effective from AY : 2024-25

Pre- requisites for the Course:	Basic programming skills	
Course Objectives:	This course will enable students to: 1. Student will be equipped with essentials of Big Data Analytics. 2. Student will be able to understand the appropriate platforms and services for storing and processing Big Data. 3. Course will enable student to implement solutions for big data processing.	
Units	**Contents:**	**No of Hours**
Unit-1	Different Types of Data and Storage for Data: Structured Data (Relational Databases) , Semi-structured data (Object Stores), and Unstructured Data (File systems), What is Big Data: Characteristics of Big Data. Systems perspective - Processing: In-memory vs. (from) secondary storage vs. (over the) network	**12**
Unit-2	Parallel and Distributed Processing: Motivation (Size of data and complexity of processing); Storing data in parallel and distributed systems: Shared Memory vs. Message Passing; Strategies for data access: Partition, Replication, and Messaging.	**12**
Unit- 3	Memory Hierarchy in Distributed Systems: In-node vs. over the network latencies, Locality, Communication Cost. Distributed Systems: Motivation (size, scalability, cost-benefit), Client-Server vs. Peer-to-Peer models, Cluster Computing: Components and Architecture	**12**
Unit- 4	Big Data Lifecycle: Data Acquisition, Data Extraction –Validation and Cleaning, Data Loading, Data Transformation, Data Analysis and Visualization. Case study – Big data application Distributed Computing. Design Strategy: Divide-and-conquer for Parallel / Distributed Systems - Basic scenarios and Implications.	**09**
Pedagogy:		
References/ Readings:	**Text Books** 1. Seema Acharya and Subhashini Chellappan. Big Data and Analytics. Wiley India Pvt. Ltd. Second Edition **Reference Books** 1. DT Editorial Services. Big Data - Black Book. DreamTech. Press. 2016 2. Kai Hwang, Jack Dongarra, and Geoffrey C. Fox. Distributed and Cloud Computing: From Parallel Processing to the Internet of Things. Morgan Kauffman 2011 3. Martin klepmann, Designing Data Intensive applications, O'Reilly Media,	

	Inc. 2017
Course Outcomes:	After going through this course, the students will be able to: CO 1. A comprehensive understanding of the Big Data ecosystem and along with the typical technologies involved. CO 2. Apply concepts from distributed computing and use framework for solving typical big data problems. CO 3. Identify and use appropriate storage / database platforms for Big data storage along with appropriate querying mechanisms / interfaces for retrieval.

(Back to Index)

Name of the Programme : **Master of Engineering (Data Sciences)**
Course code : **DEN-506**
Title of the course : **Big Data Analytics Lab**
Number of Credits : **01(1P)**
Effective from AY : **2024-25**

Pre- requisites for the Course:	Basic Programming skills
Course Objectives:	This course will enable students to: 1. Student will be equipped with essentials of Big Data Analytics 2. Apply appropriate preprocessing techniques for analysing big data. 3. Course will enable student to analyze real-world data and apply appropriate techniques
List of Programs /Experiments	
	1. Data Preprocessing with Python 2. Perform EDA on a large dataset using statistical methods and visualizations to identify trends and patterns. 3. Implement a classification model (e.g., Logistic Regression) on a large dataset using Spark's MLlib library. 4. Use natural language processing (NLP) techniques to analyze sentiments in a large text dataset 5. Use Hadoop's MapReduce framework to count the frequency of words in a large text file. 6. Use Spark's GraphX to analyze graph data 7. Use Hadoop's MapReduce to filter a large dataset based on specific criteria 8. Time Series Analysis with Spark
Instructions	**Minimum 6 experiments to be performed**
Course Outcomes:	After going through this course, the students will be able to: CO 1. Ability to clean and pre-process large datasets for analysis. CO 2. Apply statistical methods and visualization tools to explore data. CO 3. Implement and evaluate Big Data Analytics algorithms on large datasets. CO 4. Optimize and scale data processing using distributed platforms

(Back to Index)

Name of the Programme : Master of Engineering (Data Sciences)
Course code : DEN-507
Title of the course : Digital Marketing Analytics
Number of Credits : 3(3L)
Effective from AY : 2024-25

Pre- requisites for the Course:	Basic knowledge of Data Analytics	
Course Objectives:	This course will enable students to: 1. Identify the elements of digital marketing 2. Evaluate strategic approaches for using digital platforms for digital marketing 3. Study various analytics and goals for successful digital marketing. 4. Identify different digital marketing measurement and benchmark techniques and search analysis.	
Units	**Contents:**	**No of Hours**
Unit-1	**Understanding Digital Analytics Concepts**: Three things every practitioner should know, Owned Social Metrics, Earned Social Media Metrics, Demystifying Web Data, Paid Searches, Organic Searches, Aligning Digital and Traditional Analytics. **Search Analytics:** Understanding basics of Search, Search Analytics Use Cases, Google Trends, YouTube Trends, Google Ad Words Keyword Tool, Paid tools for collecting Insights through Search Data	**12**
Unit-2	**Audience Analysis:** What it is, Audience analysis Use cases, Tool types and analysis techniques. **Content Analysis:** Content Audit Checklist, Real Time Analytics, Optimizing Content Distribution, Analysing Content Consumption, learning agendas, Classifying Results for Content Analysis.	**12**
Unit- 3	**Tools of the Trade**: Social Media Listening Tools, Understanding Social Media Engagement Software **Engagement Analysis**: SMES, Robust Analysis Dashboards, Scheduling Content, Posting and Uploading Media Content, Geo-targeting posts, Post Tagging.	**12**
Unit- 4	**Digital Marketing Measurement:** Challenges of Digital media Measurement, Measurement Fundamentals, Benchmark Research, Strategy Development, Tactical Elements, Measurement Practices, Developing Measurement Reporting Cadence.	**9**
Pedagogy:	Inquiry Based Learning, Reflective, Integrative Learning	
References/ Readings:	**Text Books** 1. Chuck Hemann and Ken Burbary, "Digital Marketing Analytics", 2013, Que Publications **Reference Books** 1. Damian Ryan and Calvin Jones, "Marketing Strategies for Engaging the Digital Generation", 3rd Edition, Kogan Page Ltd. 2. Gauri Ghule, Shraddha Habbu and Nitin Sakhare, "Digital Marketing", First Edition, Nirali Prakashan Publication.	

Course Outcomes:	After going through this course, the students will be able to: CO 1. Understand & compare digital and traditional analytics. CO 2. Identify and describe various tools for Search and Content Analytics. CO 3. Evaluate various Social Media Engagement software CO 4. Understand Digital Marketing Measurements and Benchmarks

(Back to Index)

Name of the Programme : Master of Engineering (Data Sciences)
Course Code : DEN-508
Title of the course : Digital Marketing Analytics Lab
Number of Credits : 1(1P)
Effective from AY : 2024-25

Pre- requisites for the Course:	Basic knowledge of Data Analytics
Course Objectives:	This course will enable students to: 1. Identify the elements of digital marketing 2. Evaluate strategic approaches for using digital platforms for digital marketing 3. Study various analytics and goals for successful digital marketing. 4. Identify different digital marketing measurement and benchmark techniques and search analysis.
	List of Programs / Experiments 1. Compare two versions of a webpage, email, ad or any digital asset to see which one performs better in terms of conversions, click through rates etc. 2. Content Analysis: Analyze the performance of different content (blog posts, videos, infographics etc.) to quantify and analyze the presence, meanings, and relationships of such certain words, themes, or concepts. 3. Keyword Analysis: Analyze the performance of different keywords for search engine marketing campaigns (e.g., Google Ads) to identify high-performing keywords and optimize bidding strategy. 4. Social Media Engagement Analysis: Measure the engagement metrics (likes, shares, comments, etc.) of social media posts to understand what type of content generates the most engagement 5. Tools: study of Google Analytics for website performance and audience demographics. 6. Tools: study of Facebook Analytics for engagement metrics, ad performance and audience demographics. 7. Tools: Google Tag Manager to manage and deploy tracking tags (such as Google Analytics tags) on websites. 8. Study of any Social Media Engagement software.
Instructions	All 8 Experiments to be performed
Course Outcomes:	After going through this course, the students will be able to: CO 1. Examine and differentiate between digital and traditional analytics methods. CO 2. Identify and describe various tools for Search and Content Analytics. CO 3. Evaluate various Social Media Engagement software CO 4. Analyse and apply digital marketing measurements and benchmarks

(Back to Index)

Name of the Programme : Master of Engineering (Data Sciences)
Course code : DEN-509
Title of the course : Data Visualization and Modeling
Number of Credits : 3 (3L)
Effective from AY : 2024-25

Pre- requisites for the Course:	Basic understanding of data	
Course Objectives:	This course will enable students to: 1. To learn, understand and practice Data Visualization & Modeling 2. Evaluate strategic approaches for using digital platforms for digital marketing 3. Discover best practices of data visualization for different types of data. 4. To solve the real time problems of data science.	
Contents:		**No of Hours**
Unit-1	Basic Data Analytics: Need of Data analytic lifecycle, Key roles for successful analytic projects. Phases of Data analytic lifecycle: Discovery, Data Preparation, Model Planning, Model Building, Communicating Results, Operationalization. Linear regression: Simple linear regression, introduction to multiple linear regressions.	**12**
Unit-2	Statistical hypothesis generation and testing, Chi-Square test, t-Test, Analysis of variance and covariance, Classification: logistic regression, decision trees, SVM., Naïve Bayesian,classifiers, text analysis. Ensemble methods: bagging, random forests, boosting. Clustering: K-means, K-medoids, Hierarchical clustering. Association Rules, Apriori algorithm.	**12**
Unit-3	Power BI for Data Visualization and Dashboard Creation: Power BI for Data Visualization and Dashboard Creation: Introduction to Power BI: Interface, data connection, roles. - Creating Basic Visualizations: Bar charts, line charts, scatter plots. - Building Interactive Dashboards: Design principles, combining visualizations. - Effective Data Storytelling using Power BI.	**12**
Unit-4	Introduction to Tableau Desktop: Connecting to Data,Customizing a Data Source, Filtering Data,Sorting Data,Creating Groups in Data,Creating Hierarchies in Data, Working with Date Fields: Discrete and Continuous Time, Working with Date Fields: Custom Dates, Working with Multiple Measures: Dual Axis and Combo Charts,Working with Multiple Measures: Combined Axis Charts, Showing Relationships between Numerical Values, Mapping Data Geographically, Using Crosstabs: Totals and Aggregation	**09**
Pedagogy:	Inquiry Based Learning, Reflective, Integrative Learning	
References/ Readings:	**Text Books** 1. Chuck Hemann and Ken Burbary, “Digital Marketing Analytics”, 2013, Que Publications 2. Jack A. Hyman, “Microsoft Power BI For Dummies”,January 2023. ISBN: 978-9353645778	

	Reference Books 1. Hastie, T., Tibshirani, R., Friedman, J. (2009). The elements of statistical learning: datamining, inference and prediction. Springer. 2. Richard O. Duda, Peter E. Hart, and David G. Stork. 2000. Pattern Classification (2nd Edition). Wiley- Interscience, New York, NY, USA. 3. Christopher M. Bishop. 2006. Pattern Recognition and Machine Learning (Information Science and Statistics). Springer-Verlag, Berlin, Heidelberg.
Course Outcomes:	After going through this course, the students will be able to: CO 1. Understand the key techniques and theory behind data visualization CO 2. Use effectively the various visualization structures (like tables, spatial data, tree and network etc.) CO 3. Evaluate information visualization systems and other forms of visual presentation for their effectiveness CO 4. Design and build data visualization systems

(Back to Index)

Name of the Programme : Master of Engineering (Data Sciences)
Course code : DEN-510
Title of the course : Data Visualization and Modelling Lab
Number of Credits : 1 (1P)
Effective from AY : 2024-25

Pre- requisites for the Course:	Basic understanding of Data
Course Objectives:	This course will enable students to: 1. Analyse various datasets using classification and clustering data models. 2. Understand the fundamental syntax of R. 3. Create well designed visualization using data visualization tools like R 4. Create well designed visualization using data visualization tools like Python
	List of Programs / Experiments 1. Introduction to Tableau/Power BI and Aggregation Methods in Tableau/Power BI. 2. Visual Encodings and Basic Dashboards in Tableau/Power BI. 3. Interactive Plots in Python. 4. Hierarchical and Topographical Data Visualizations in Tableau/Power BI. 5. Calendar Heat maps and Flow Data Visualizations in Python. 6. Time Series Data Visualization in Python. 7. Dashboards, Actions and Story Telling in Tableau/Power BI. 8. Types of charts in tableau, Interactive: visualization in tableau, beautiful visualization in tableau, Tips for More Effective and Engaging 9. Excel: Statistical Capabilities-Average, Mean, Stand Deviation, Median, Graphs Scatter Plot, Bar Graphs.
	Perform at least 8 Experiments
Course Outcomes:	After going through this course, the students will be able to: CO 1. Explain the fundamental concepts of data visualization CO 2. Understand the types of transformation the data has undergone to improve the effectiveness of visualization CO 3. Apply basic algorithms in data visualization CO 4. Create visualization using Tableau and PowerBI

Programme Specific Elective (PSE) Courses
Name of the Programme : Master of Engineering (Data Sciences)
Course code : DEN-533
Title of the course : Neural Networks
Number of Credits : 3 (3L)
Effective from AY : 2024-25

Pre- requisites for the Course:	Knowledge of basic mathematics and programming	
Course Objectives:	This course will enable students to: 1. An understanding of building blocks of Neural Networks. 2. An understanding of the various parameters and options involved in the implementation of a multilayer neural network. 3. An Understanding of the main factors involved in learning and generalization in neural networks. 4. Have a broad knowledge in Fuzzy logic principles and will be able to determine different methods of Deffuzification.	
Units	**Contents:**	**No of Hours**
Unit-1	Basics of Artificial Neural Networks: Characteristics of Neural Networks, Historical Development of Neural Network Principles, Artificial Neural Networks: Terminology, Models of Neuron, Topology, Basic Learning Laws. Activation and Synaptic Dynamics: Introduction, Activation Dynamics Models, Synaptic Dynamics Models, Learning Methods.	**11**
Unit-2	Feedforward Neural Network: Introduction, Analysis of Pattern Association Networks, Analysis of Pattern Classification Networks. Feedback Neural Networks: Introduction, Analysis of Linear Auto associative FF Networks, Analysis of Pattern Storage Networks.	**11**
Unit- 3	Introduction about Fuzzy set theory: Fuzzy versus Crisp, Crisp and fuzzy sets, Crisp and Fuzzy relations.	**11**
Unit- 4	Fuzzy Systems: Crisp Logic, Predicate Logic, Fuzzy logic, Fuzzy rule based system, De-fuzzification Methods, Applications.	**12**
Pedagogy:	Inquiry Based Learning, Reflective, Integrative Learning	
References/ Readings:	**Text Books** 1. B. Yegnanarayana - Artificial neural network PHI Publication.2005 2. S. 2. Raj sekaran, Vijayalakshmi Pari - Neural networks, Fuzzy logic and Genetic Algorithms 3. Bishop, C. M. Neural Networks for Pattern Recognition. Oxford University Press. 1995. 4. Neural Networks,Fuzzy Logic and Genetic Algorithms, by S.Rajasekaran and G.A. Vijayalakshmi Pai. 5. Neuro-Fuzzy Systems, Chin Teng Lin, C. S. George Lee, PHI. **Reference Books** 1. Kevin L. Priddy, Paul E. Keller – Artificial neural networks: An Introduction - SPIE Press, 2005 2. Build_Neural_Network_With_MS Excel_sample by Joe choong.	
Course	After going through this course, the students will be able to:	

Outcomes:	CO 1. List out the basic principles, techniques, and applications of neural network CO 2. Explain the principles and structure of multi-layer neural networks CO 3. Illustrate the working of shallow neural network CO 4. Understand the building blocks of Radial Basis Function Networks

(Back to Index)

Name of the Programme : **Master of Engineering (Data Sciences)**
Course code : **DEN-534**
Title of the course : **Neural Network Lab**
Number of Credits : **1 (1P)**
Effective from AY : **2024-25**

Pre- requisites for the Course:	Knowledge of mathematics especially linear algebra, probability and calculus
Course Objectives:	1. Identify appropriate data structures and algorithms for a given contextual problem and develop programs to design and implement applications. 2. Design and manage the large databases and develop their own databases to solve real world problems and to design, build, manage networks and apply wireless techniques in mobile based applications. 3. Design a variety of computer-based components and systems using computer hardware, system software, systems integration process and use standard testing tools for assuring the software quality.
	1. Generate the activation functions- Logistic, Hyperbolic, Identity that are used in Neural networks 2. Program for perceptron net for an AND function with bipolar inputs and targets 3. Generate Or function with bipolar inputs and targets using Adaline network 4. Generate XOR function for bipolar inputs and targets using Madaline network 5. Find the weight matrix of an auto associative net to store the vector (1 1 -1 -1). Test the response by presenting same pattern. 6. Find weight matrix in Bipolar form for BAM network on binary i/p o/p pairs 7. Write a program to implement classification of linearly separable Data with a perceptron 21 7 8. To study Long Short-Term Memory for Time Series Prediction.
	Perform All 6 Experiments
Course Outcomes:	After going through this course, the students will be able to: CO 1. Understand the characteristics and types of artificial neural network and remember activation functions. CO 2. Apply learning algorithms on perceptron and apply back propagation learning on Neural Network. CO 3. Apply different types of auto encoders with dimensionality reduction and regularization. CO 4. Generate and OR function using Adaline network.

(Back to Index)

Name of the Programme : Master of Engineering (Data Sciences)
Course code : DEN-535
Title of the course : Business Intelligence
Number of Credits : 3(3L)
Effective from AY : 2024-25

Pre- requisites for the Course:	Basic understanding of analytical and problem-solving skills	
Course Objectives:	This course will enable students to: 1. Explain the Business Intelligence, Analytics and Decision Support system 2. Elaborate the technologies for Decision making, Automated decision systems 3. Explain sentiment analysis techniques 4. Illustrate Multi-criteria Decision making systems, predictive modelling techniques	
Contents:		**No of Hours**
Unit-1	**Business intelligence:** Effective and timely decisions, Data, information and knowledge, The role of mathematical models, Business intelligence architectures, Ethics and business intelligence **Decision support systems:** Definition of system, Representation of the decision-making process, Evolution of information systems, Definition of decision support system, Development of a decision support system	**11**
Unit-2	**Mathematical models for decision making:** Structure of mathematical models, Development of a model, Classes of models **Data mining:** Definition of data mining, Representation of input data, Data mining process, Analysis methodologies **Data preparation:** Data validation, Data transformation, Data reduction	**11**
Unit-3	**Classification**: Classification problems, Evaluation of classification models, Bayesian methods, Logistic regression, Neural networks, Support vector machines. **Clustering**: Clustering methods, Partition methods, Hierarchical methods, Evaluation of clustering models	**11**
Unit-4	**Business intelligence applications:** Marketing models: Relational marketing, Sales force management. **Logistic and production models**: Supply chain optimization, Optimization models for logistics planning, Revenue management systems. **Data envelopment analysis:** Efficiency measures, Efficient frontier, The CCR model, Identification of good operating practices	**12**
Pedagogy:	Inquiry Based Learning, Reflective, Integrative Learning	
References/ Readings:	**Text Books** 1. Carlo Vercellis , "Business Intelligence: Data Mining and Optimization for Decision Making" 1st edition, Wiley, 2009.Authors Names , "BookTitle", Version/Edition details, Publication house details **Reference Books** 1. Efraim Turban, Ramesh Sharda, Dursun Delen "Decision support and	

	Business Intelligence Systems", 9th edition, Pearson, 2011. 2. U. Dinesh Kumar ,Business Analytics :The Science of Data-Driven Decision Making, 2ed, November 2021
Course Outcomes:	After going through this course, the students will be able to: CO 1. Analyse Business Intelligence, Analytics and Decision Support CO 2. Explain the technologies for Decision making CO 3. Explore and explain various sentiment analysis techniques CO 4. Illustrate Multi-criteria Decision making systems, predictive modelling Technique

(Back to Index)

Name of the Programme : Master of Engineering (Data Sciences)
Course code : DEN-536
Title of the course : Business Intelligence Lab
Number of Credits : 1 (1P)
Effective from AY : 2024-25

Pre- requisites for the Course:	Basic understanding of data analysis techniques
Course Objectives:	1. To equip students with foundational knowledge in business intelligence and decision support systems, enabling them to develop effective decision-making tools and data-driven strategies in a business context. 2. To develop proficiency in mathematical modelling, data mining, and data preparation techniques, fostering the ability to handle, analyse, and interpret large datasets for meaningful insights. 3. To enhance skills in supervised and unsupervised learning models, with a focus on implementing classification and clustering algorithms for real-world applications. 4. To prepare students for applying advanced data science methods in business intelligence applications, such as supply chain optimization, marketing analytics, and operational efficiency analysis.
	List of Programs / Experiments 1. Building a Basic Decision Support System (DSS) 2. Business Intelligence Dashboard Creation 3. Development of Mathematical Models for Decision-Making 4. Data Mining Workflow with Real-World Dataset 5. Classification Model for Customer Segmentation 6. Clustering Analysis on Customer Purchase Data 7. Optimization for Supply Chain Management 8. Efficiency Measurement Using Data Envelopment Analysis (DEA)
	Perform All 8 Experiments
Course Outcomes:	After going through this course, the students will be able to: 1. Design and develop decision support systems and business intelligence dashboards that support effective and ethical decision-making within an organizational setting. 2. Build, evaluate, and apply mathematical models and data mining techniques for analyzing and interpreting complex datasets, addressing real-world business challenges. 3. Implement and assess various machine learning algorithms for classification and clustering tasks, demonstrating an understanding of model evaluation and performance metrics. 4. Apply data science methodologies to optimize business processes in areas like supply chain management, marketing analytics, and efficiency measurement, delivering data-driven solutions to enhance organizational performance.

(Back to Index)

Research Specific Elective (RSE) Courses
Name of the Programme : Master of Engineering (Data Sciences)
Course Code : REC-563
Title of the Course : Statistics and Data Analysis for Engineering Research
Number of Credits : 2
Effective from AY : 2024-25

Pre-requisites for the Course:	Basic Knowledge of Statistics	
Course Objectives:	The course will enable the students to 1. Explain the different types of data and parameter estimations 2. Explain standard probability distributions 3. Select the appropriate parameter estimation & distribution method 4. Co-relate different Hypotheses	
Content:		**No of Hours**
Unit -1	**Data Analysis:** Types of data, data collection techniques, Quantitative methods for analysis of data – statistical tools, experimental data, Qualitative data collection, questioners, rating scale, conducting survey. Statistical Modeling and Graphical Diagnostics - Scatter Plot, Stem-and-Leaf Plot, Histogram, Box Plot **Correlation and Regression Modeling:** Basic concept and numericals.	**9**
Unit -2	**Probability distributions and Sampling distributions:** Basic introduction to Bernoulli, Binomial and Normal distribution. Basic introduction to Sampling distributions- Normal, t-distribution, Chi-square and F- distributions.	**7**
Unit -3	**Parameter estimation:** Point Estimation – Concept, unbiased estimator, method of maximum likelihood. Parameter estimation of standard distributions- Binomial and Normal. Confidence Interval Estimation - Concept, Confidence interval on mean of single normal population with variance known, Confidence interval on the ratio of variances of two normal distributions	**7**
Unit- 4	**Tests of Hypotheses:** Introduction, Type I and type II errors, significance level and power of the test, Test of hypotheses - on mean of single normal population with variance known, on variance of single normal population.	**7**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	1. D. V Thiel, 'Research Methods for Engineers', Cambridge Press, 2014, ISBN:978-110-70-3-488 2. T. Mustafy, T. U Rahman, 'Statistics & Data Analysis for Engineers and Scientists', Springer, 2024, ISBN:9789819946600. 3. D. C. Montgomery, C. G. Runger, 'Applied Statistics and Probability for Engineers', 6th Edition, Wiley India, 2016, ISBN 0-471-20454-4	

	4. R. E. Walpole, R. H. Myers, S. L. Myers, K. E. Ye; Probability and Statistics for Engineers and Scientists ,9th Edition, Pearson Education India, 2013, ISBN 978-0-321-62911-1 5. J. Schmuller, Statistical Analysis with Excel for Dummies, 5th Edition, John Wiley & Sons, 2022.
Course Outcomes:	After taking this course, student will be able to: CO 1. Explain the different types of data and probability distributions. CO 2. Select the appropriate parameter estimation & distribution method CO 3. Apply estimators for the given situations. CO 4. Evaluate Hypotheses based on the statistical considerations.

(Back to Index)

Name of the Programme : Master of Engineering (Data Sciences)
Course Code : REC-564
Title of the Course : Statistics and Data Analysis Lab
Number of Credits : 2
Effective from AY : 2024-25

Pre-requisites for the Course:	Basic Knowledge of Statistics	
Course Objectives:	The course will enable the students to 1. Apply the different types of data and parameter estimations 2. Analyze standard probability distributions 3. Demonstrate parameter estimation & distribution methods 4. Co-relate different Hypotheses	
Content:		**No of Hours**
	Using open-source software like libreoffice or any proprietary software perform following experiments: 1. Obtain measures of central tendency and dispersion. 2. Obtain Quartiles, Percentiles and prepare Box-and-Whisker Diagram 3. Develop Pie chart, Bar Chart, Histogram and Stem-and-Leaf Plot, 4. Develop_correlation using Pearson's Correlation Coefficient and showing Scatter Diagrams and Trendlines 5. Develop Linear and Nonlinear Regression Models 6. Obtain probability values involving probability distributions – Binomial and Normal 7. Obtain values of Normal, t-distribution, Chi-square and F-statistic. 8. Develop confidence interval for single population and two populations with variance known. 9. Develop confidence interval on the ratio of variances of two normal distributions. 10. Perform test of hypotheses on mean/variance of single/ two population(s).	**60**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	1. D. V Thiel, 'Research Methods for Engineers', Cambridge Press, 2014, ISBN:978-110-70-3-488 2. T. Mustafy, T. U Rahman, 'Statistics & Data Analysis for Engineers and Scientists', Springer, 2024, ISBN:9789819946600. 3. D. C. Montgomery, C. G. Runger, 'Applied Statistics and Probability for Engineers', 6th Edition, Wiley India, 2016, ISBN 0-471-20454-4 4. R. E. Walpole, R. H. Myers, S. L. Myers, K. E. Ye; Probability and Statistics for Engineers and Scientists ,9th Edition, Pearson Education India, 2013, ISBN 978-0-321-62911-1 5. J. Schmuller, Statistical Analysis with Excel for Dummies, 5th Edition,	

	John Wiley & Sons, 2022.
Course Outcomes:	After taking this course, student will be able to: CO 1. Apply the different types of data and parameter estimations CO 2. Analyze standard probability distributions CO 3. Demonstrate parameter estimation & distribution methods CO 4. Co-relate different Hypotheses

(Back to Index)

Name of the Programme : **Master of Engineering (Data Sciences)**
Course Code : **REC-565**
Title of the Course : **Statistical Techniques for Engineering Research**
Number of Credits : **2**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basic knowledge of Statistics and Probability	
Course Objectives:	The course will enable the students to 1. Understand the importance of statistical methods for research 2. Select the appropriate factorial design method for a given set of experimental plan. 3. Apply basic probability theorems and draw relevant inferences. 4. Analyze suitable probability model for given set of data	
Content:		**No of Hours**
Unit-1	**Overview on Statistical methods**, collection of data, one dimensional and two-dimensional statistical analysis, computation of central tendency and dispersion for grouped and ungrouped data, correlation preliminary, understanding variability in data.	**6**
Unit-2	**Design of Experiments**, Preparation of experimental plan, full factorial design, fractional factorial design, identification of parameters and levels, randomization, replication, blocking, interaction; numerical; Optimization methods for two parameters.	**9**
Unit-3	**Probability Preliminary**: Introduction to Probability, definition, Sample Space, Events, Conditional Probability, Theorem on total probability, Bayes' theorem. Random Variable: Introduction, Discrete and Continuous distribution, Characteristics- Mean, Variance and distribution function.	**8**
Unit-4	**Probability and Sampling Distribution**: Bernoulli, Binomial, Exponential, Normal, distribution. Mean, variance and distribution function, important properties, approximations and applications. Statistic and Sampling Distribution: Population and Sample. Statistic, Sampling distributions- Normal, t-distribution, Chi-square and F- distributions.	**7**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	1. Tahvir Mustafy, Tauhid U Rahman, 'Statistics & Data Analysis for Engineers and Scientists', Springer, 2024, ISBN:9789819946600. 2. Jiju Antony, 'Design of Experiments for Engineers & Scientists', Elsevier, 2023, ISBN 978-044-315-1736 3. Douglas Montgomery, 'Design and Analysis of Experiments', Wiley India, Eighth Edition, 2013, 9788126540501 4. J. Ravichandran, Probability and Statistics for Engineers, Wiley India, 2010, ISBN: 9788126523504	

	5. R. Johnson, Probability and Statistics for engineers, Eighth Edition, Prentice Hall of India, New Delhi, 2015, ISBN 978-1-292-17601-7 6. J. Schmuller, Statistical Analysis with Excel for Dummies, 5th Edition, John Wiley & Sons, 2022.
Course Outcomes:	After taking this course, student will be able to: CO 1. Understand the importance of statistical methods for research CO 2. Select the appropriate factorial design method for a given set of experimental plans. CO 3. Apply basic probability theorems and draw relevant inferences. CO 4. Analyze suitable probability model for given set of data

(Back to Index)

Name of the Programme : Master of Engineering (Data Sciences)
Course Code : REC-566
Title of the Course : Probability & Statistical Analysis Lab
Number of Credits : 2
Effective from AY : 2024-25

Pre-requisites for the Course:	Basic knowledge of Statistics and Probability	
Course Objectives:	The course will enable the students to 1. Apply basic probability theorems and draw relevant inferences. 2. Analyze suitable probability model for given set of data 3. Demonstrate factorial design methods 4. Synthesize fractional and full factorial experimental design data	
Content:		**No of Hours**
	Using open-source software like libreoffice or any proprietary software perform following experiments: 1. Obtain probability values involving discrete probability distributions - Bernoulli, Binomial. 2. Obtain probability values involving continuous probability distributions - Exponential and Normal distributions. 3. Obtain values of Normal, t-distribution, Chi-square and F-statistic. 4. Obtain values of Mean, Variance and distribution function of Bernoulli and Binomial distribution. 5. Obtain values of Mean, Variance and distribution function of Exponential and Normal distributions. 6. Obtain values of central tendency of grouped and ungrouped data. 7. Obtain values of dispersion of grouped and ungrouped data. 8. Analyse experimental output using full factorial design. 9. Analyse experimental output using fractional factorial design. 10. Analyse a full case study in involving full factorial design or fractional factorial design.	**60**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	1. Tahvir Mustafy, Tauhid U Rahman, 'Statistics & Data Analysis for Engineers and Scientists', Springer, 2024, ISBN:9789819946600. 2. Jiju Antony, 'Design of Experiments for Engineers & Scientists', Elsevier, 2023, ISBN 978-044-315-1736 3. Douglas Montgomery, 'Design and Analysis of Experiments', Wiley India, Eighth Edition, 2013, 9788126540501 4. J. Ravichandran, Probability and Statistics for Engineers, Wiley India, 2010, ISBN: 9788126523504 5. R. Johnson, Probability and Statistics for engineers, Eighth Edition, Prentice Hall of India, New Delhi, 2015, ISBN 978-1-292-17601-7 6. J. Schmuller, Statistical Analysis with Excel for Dummies, 5th Edition,	

	John Wiley & Sons, 2022.
Course Outcomes:	After taking this course, student will be able to: CO 1. Apply basic probability theorems and draw relevant inferences. CO 2. Analyze suitable probability model for given set of data CO 3. Demonstrate factorial design methods CO 4. Synthesize fractional and full factorial experimental design data

(Back to Index)