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. /2024/633 Date: 07.11.2024

CIRCULAR

The University has notified Ordinance OA-43 governing the Master of Engineering Degree and Post-Graduate Engineering Certificate from the Academic Year 2024-2025 onwards.

The Syllabus of Semester I of the **Master of Engineering (Data Sciences)** Programme approved by the Academic Council in its meeting held on 22nd August 2024 is 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: 2024.11.07 15:04:46 +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**

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				
		TOTAL	**10**	**1**	**1**	**12**

Issued on: 07/11/2024

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)