VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF ADVANCED SCIENCES

DEPARTMENT OF MATHEMATICS

M.Sc. Business Statistics

(MBS)

Curriculum & Syllabi

(2024–2025 Admitted Students)

VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

Transforming life through excellence in education and research.

MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

- **World class Education**: Excellence in education, grounded in ethics and critical thinking, for improvement of life.
- **Cutting edge Research**: An innovation ecosystem to extend knowledge and solve critical problems.
- **Impactful People**: Happy, accountable, caring and effective workforce and students.
- **Rewarding Co-creations**: Active collaboration with national & international industries & universities for productivity and economic development.
- **Service to Society**: Service to the region and world through knowledge and compassion.

VISION STATEMENT OF SCHOOL OF ADVANCED SCIENCES

To be an internationally renowned science school in research and innovation by imparting futuristic education relevant to the society.

MISSION STATEMENT OF SCHOOL OF ADVANCED SCIENCES

- To nurture students from India and abroad by providing quality education and training to become scientists, technologists, entrepreneurs and global leaders with ethical values for a sustainable future.

- To enrich knowledge through innovative research in niche areas.

- To ignite passion for science and provide solutions for national and global challenges.

M.Sc. Business Statistics

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. Graduates will be practitioners and leaders in their chosen field.

2. Graduates will function in their profession with social awareness and responsibility.

3. Graduates will interact with their peers in other disciplines in their work place and society and contribute to the economic growth of the country.

4. Graduates will be successful in pursuing higher studies in their chosen field.

5. Graduates will pursue career paths in teaching or research.

M.Sc. Business Statistics

PROGRAMME OUTCOMES (POs)

PO_01: Having a clear understanding of the subject related concepts and of contemporary issues.

PO_02: Having problem solving ability to address social issues.

PO_03: Having a clear understanding of professional and ethical responsibility.

PO_04: Having cross cultural competency exhibited by working in teams.

PO_05: Having a good working knowledge of communicating in English.

M.Sc. Business Statistics

PROGRAMME SPECIFIC OUTCOMES (PSOs)

On completion of M.Sc. Business Statistics programme, graduates will be able to

PSO1: To analyse a business problem in industry, academia, or government, and determine the appropriate statistical tests.

PSO2: To use specialist software tools for data storage, analysis and visualization.

PSO3: Able to independently carry out research/investigation to solve practical problems.

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M.Sc. Business Statistics

CREDIT STRUCTURE

Category-wise Credit distribution

Category Credit Detail			
Sl.No.	**Description**	**Credit**	**Maximum Credit**
1	DC - Discipline Core	28	28
2	DE - Discipline Elective	21	21
3	PI - Projects and Internship	20	20
4	OE - Open Elective	6	6
5	SE - Skill Enhancement	5	5
Total Credits		**80**	

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M.Sc. Business Statistics

DETAILED CURRICULUM

Discipline Core									
S.No	Course Code	Course Title	Course Type	Version	L	T	P	J	Credit
1	PMBS501L	Probability and Statistics	Theory Only	1.0	3	0	0	0	3.0
2	PMBS501P	Probability and Statistics Lab	Lab Only	1.0	0	0	2	0	1.0
3	PMBS502L	Data Analysis and Decision Making	Theory Only	1.0	2	0	0	0	2.0
4	PMBS502P	Data Analysis and Decision Making Lab	Lab Only	1.0	0	0	2	0	1.0
5	PMBS503L	Machine Learning	Theory Only	1.0	3	0	0	0	3.0
6	PMBS503P	Machine Learning Lab	Lab Only	1.0	0	0	2	0	1.0
7	PMBS504L	Big Data Analytics and Visualization	Theory Only	1.0	2	0	0	0	2.0
8	PMBS504P	Big Data Analytics and Visualization Lab	Lab Only	1.0	0	0	2	0	1.0
9	PMBS505L	Time Series Analysis and Forecasting	Theory Only	1.0	2	0	0	0	2.0
10	PMBS505P	Time Series Analysis and Forecasting Lab	Lab Only	1.0	0	0	2	0	1.0
11	PMBS506L	Applied Multivariate Analysis	Theory Only	1.0	2	0	0	0	2.0
12	PMBS506P	Applied Multivariate Analysis Lab	Lab Only	1.0	0	0	2	0	1.0
13	PMDS506L	Database Management Systems	Theory Only	1.0	3	0	0	0	3.0
14	PMDS506P	Database Management Systems Lab	Lab Only	1.0	0	0	2	0	1.0
15	PMDS508L	Python Programming	Theory Only	1.0	2	0	0	0	2.0
16	PMDS508P	Python Programming Lab	Lab Only	1.0	0	0	4	0	2.0

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M.Sc. Business Statistics

DETAILED CURRICULUM

Discipline Elective									
S.No	Course Code	Course Title	Course Type	Version	L	T	P	J	Credit
1	PMBS601L	Survey Sampling and Design	Theory Only	1.0	3	1	0	0	4.0
2	PMBS602L	Optimization Modelling	Theory Only	1.0	3	1	0	0	4.0
3	PMBS603L	Actuarial Statistics	Theory Only	1.0	3	0	0	0	3.0
4	PMBS604L	Bio-Statistics	Theory Only	1.0	3	0	0	0	3.0
5	PMBS605L	Social Network Analysis	Theory Only	1.0	3	0	0	0	3.0
6	PMBS606L	Statistical Quality Control	Theory Only	1.0	3	0	0	0	3.0
7	PMDS601L	Artificial Intelligence	Theory Only	1.0	3	0	0	0	3.0
8	PMDS601P	Artificial Intelligence Lab	Lab Only	1.0	0	0	2	0	1.0
9	PMDS603L	Deep Learning	Theory Only	1.0	3	0	0	0	3.0
10	PMDS603P	Deep Learning Lab	Lab Only	1.0	0	0	2	0	1.0
11	PMDS606L	Natural Language Processing	Theory Only	1.0	3	0	0	0	3.0
12	PMDS606P	Natural Language Processing Lab	Lab Only	1.0	0	0	2	0	1.0
13	PMDS610L	Financial Analytics	Theory Only	1.0	2	0	0	0	2.0
14	PMDS610P	Financial Analytics Lab	Lab Only	1.0	0	0	2	0	1.0

Projects and Internship									
S. No	Course Code	Course Title	Course Type	Version	L	T	P	J	Credit
1	PSET695J	Project Work	Project	1.0	0	0	0	0	4.0

Skill Enhancement									
S.No	Course Code	Course Title	Course Type	Version	L	T	P	J	Credit
1	PENG501P	Technical Report Writing	Lab Only	1.0	0	0	4	0	2.0
2	PSTS501P	Qualitative Skills Practice	Soft Skill	1.0	0	0	3	0	1.5
3	PSTS502P	Quantitative Skills Practice	Soft Skill	1.0	0	0	3	0	1.5

Indicative Programme Structure of Master of Science in Business Statistics

First Year

SEMESTER 1				SEMESTER 2			
Course Code	**Course**	**L-T-P**	**C**	**Course Code**	**Course**	**L-T-P**	**C**
PMBS501L	Probability and Statistics	3-0-0	3	PMBS503L	Machine Learning	3-0-0	3
PMBS501P	Probability and Statistics Lab	0-0-2	1	PMBS503P	Machine learning lab	0-0-2	1
PMBS502L	Data Analysis and Decision Making	2-0-0	2	PMBS504L	Big Data Analytics and Visualization	2-0-0	2
PMBS502P	Data Analysis and Decision-Making Lab	0-0-2	1	PMBS504P	Big Data Analytics and Visualization Lab	0-0-2	1
PMDS508L	Python Programming	2-0-0	2	PMBS505L	Time Series Analysis and Forecasting	2-0-0	2
PMDS508P	Python Programming Lab	0-0-4	2	PMBS505P	Time Series Analysis and Forecasting Lab	0-0-2	1
PMDS506L	Data base Management System	3-0-0	3	PMBS601L	Survey Sampling and Design	3-1-0	4
PMDS506P	Data base Management System Lab	0-0-2	1	PMDS610L	Financial Analytics	2-0-0	2
PMDS601L	Artificial Intelligence	3-0-0	3	PMDS610P	Financial Analytics Lab	0-0-2	1
PMDS601P	Artificial Intelligence Lab	0-0-2	1	PMBS697J	Study Oriented project	0-0-0	2
PENG501P	Technical Report Writing	0-0-4	2	PSTS502P	Quantitative Skills Practice	0-0-3	1.5
PSTS501P	Qualitative Skills Practice	0-0-3	1.5		OE1/NPTEL	0-0-0	3
PMBS696J	Study Oriented project	0-0-0	2				
Total Credits			**24.5**	**Total Credits**			**23.5**

Second Year

SEMESTER 3				SEMESTER 4			
Course Code	**Course**	**L-T-P**	**C**	**Course Code**	**Course**	**L-T-P**	**C**
PMBS506L	Applied Multivariate Analysis	2-0-0	2	PMBS699J	Internship II/ Dissertation II	0-0-0	**12**
PMBS506P	Applied Multivariate Analysis Lab	0-0-2	1				
PMBS602L	Optimization Modelling	3-1-0	4				
PMBS603L	Actuarial Statistics	3-0-0	3				
PMBS604L	Bio-Statistics	3-0-0	3				
PMBS698J	Internship I/ Dissertation I	0-0-0	4				
	OE2/NPTEL	0-0-0	3				
Total Credits			20	Total Credits			12

Summer Term **Industry Practice**

Discipline Core

Course Code	Course Title	L	T	P	C
PMBS501L	PROBABILITY AND STATISTICS	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

This course equips students with the knowledge and skills:

1. To understand and apply relevance of Probability and Statistical theory to various data analysis situations.
2. To analyse distributions and apply to real-time data.
3. To compare on testing methods to make inference and modelling techniques for decision making.

Course Outcomes

At the end of the course the student should be able to:

1. Understand the basic probability concepts using real time problems.
2. Learn to apply methods and tools related to random variable and distributions.
3. Learn to demonstrate various methods of associations.
4. Make appropriate decisions using statistical inference.
5. Analyse estimation and relate the testing methods to make inference and modelling techniques for decision making.

Module:1	Introduction to Probability	5 hours
Definitions of probability - Axioms of probability - Conditional probability - Multiplication rule - Theorem of total probability – Baye's theorem - Independence of events.		
Module:2	**Random Variables**	**7 hours**
Random variable – Discrete and continuous - Probability mass function, and probability density function - Cumulative distribution functions – Bivariate random variable- Joint probability distributions - Marginal and conditional distributions - Mathematical expectation – Variance – Covariance - Moments - Moment generating functions.		
Module:3	**Probability Distributions**	**8 hours**
Discrete distributions – Bernoulli - Binomial – Poisson – Geometric; Continuous distributions – Exponential – Gamma - Weibull, Beta, Normal distributions.		
Module:4	**Sampling Distributions**	**5 hours**
Probability and Non-Probability Sampling techniques – Random sampling- Sampling distributions of mean t, f and chi-square test – Central limit theorem.		
Module: 5	**Tests of Statistical Hypotheses**	**7 hours**
Estimation of Parameters - Statistical hypothesis –Critical region -Large sample tests based on normal distribution for single mean – two means - Single proportion – Two proportion - Tests based on t and F distributions for mean and variance.		
Module:6	**Non-Parametric Tests**	**7 hours**
Chi-square test - Contingency table, Goodness of fit - Sign test - Rank sum test - Run test - Mann whitney U test - Kruskal wallis test.		
Module:7	**Correlation and Regression**	**4 hours**
Correlation - partial and multiple correlation - Regression – linear and multiple regression.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours	**45 hours**

Text Book(s)				
1.	Richard A Johnson, “Probability and Statistics for Engineers”, 2018, 9th Edition, Pearson Education Ltd, Malaysia.			
Reference Books				
1.	Ronald E Walpole, Raymond H Myers, Sharaon L Myers and Keying Ye, “Probability Statistics for Engineers and Scientists”, 2011, 9th Edition, Prentice Hall, Delhi.			
2.	Douglas C. Montgomery and George C. Runger, “Applied Statistics and Probability for Engineers”, 2016, 6th Edition, John Wiley & Sons.			
3.	Robert V. Hogg, J.W. McKean, and Allen T. Craig, “Introduction to Mathematical Statistics”, 2012, 7th Edition, Pearson Education, Asia.			
4.	Gupta S C and Kapoor V K, “Fundamentals of Mathematical Statistics”,2002,10th Edition, Sultan Chand and Sons.			
5.	Rohatgi V K and Md. Ehsanes Saleh A K, “An Introduction to Probability and Statistics”, 2001, 2nd Edition, John Wiley & Sons.			
Mode of Evaluation: CAT, Written Assignment, Quiz, FAT and Seminar				
Recommended by Board of Studies		15-02-2024		
Approved by Academic Council		No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
PMBS501P	PROBABILITY AND STATISTICS LAB	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

This course equips students with the knowledge and skills:

1. To enable the students for having experimental knowledge of basic concepts of statistics using R programming.
2. To study the relationship of real-time data and decision making through testing methods using R.
3. To make the students capable to do experimental research using statistics in various engineering problems.

Course Outcomes

At the end of the course the student should be able to:

1. Demonstrate R programming for statistical data.
2. Carry out appropriate analysis of statistical methods through experimental techniques using R.

Indicative Experiments	
1.	Introduction to R software and packages.
2.	Understanding data types; importing/exporting data.
3.	Plotting and visualizing data using graphical representations.
4.	Fitting the following probability distributions: binomial distribution, poisson distribution, exponential distribution, gamma distribution, weibull distribution, normal distribution.
5.	Testing of hypothesis for one sample mean and proportion from real-time problems.
6.	Testing of hypothesis for two sample means and proportion from real-time problems.
7.	Applying the t test for independent and dependent samples.
8.	Applying chi-square test for goodness of fit and contingency test to real dataset.
9.	Correlation, partial and multiple correlations.
10.	Simple linear regression model and multiple linear regression to real dataset.
	Total Laboratory hours **30 hours**

Text Book(s)

1. Christian Heumann, Michael Schomaker and Shalabh, “Introduction to Statistics and Data Analysis - With Exercises, Solutions and Applications in R” 2016, Springer.

Reference Books

1. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, “An Introduction to Statistical Learning with Applications in R”, 2023, 2nd Edition, Springer.
2. Joseph Schmuller, “Statistical analysis with R”, 2017, John wiley and sons Inc., New Jersey.

Mode of Evaluation: Weekly Assessment, FAT and Oral examination

Recommended by Board of Studies	15-02-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
PMBS502L	DATA ANALYSIS AND DECISION MAKING	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

This course equips students with the knowledge and skills:

1. To introduce the fundamentals of data models tools, methods and related topics.
2. To help students to analyse the data and make better decisions in business applications.
3. To emphasis on modelling and evaluating uncertainty in nature of decision-making using with limited information efficiently.

Course Outcomes

At the end of the course the student should be able to:

1. Identify and apply important quantitative methods developed in the fields of statistics and optimization that are commonly used to solve business related problems.
2. Perform skilled statistical data analysis, summarization and interpretation of datasets by use of analytical software.
3. Utilize appropriate methods of optimization on data for the analysis of decision outcomes in business environment.
4. Collections of written resources on quantitative methods that will help successfully meet a broad range of challenges in a business career.
5. Cover the main areas of Operations research and its applications with tools.

Module:1	**Introduction to Data Analytics**	**3 hours**
Introduction to data analysis, steps involving data analysis - Data types and data scale - Formats and repositories.		
Module:2	**Data Technologies**	**4 hours**
Big Data and Cloud Computing - Stages of data Analysis - Predictive analysis - Statistical learning and machine learning.		
Module:3	**Descriptive Analytics**	**4 hours**
Descriptive analysis - Data visualization - Data summarization - Data generation - Exploratory data analysis.		
Module:4	**Predictive Analytics**	**4 hours**
Predictive analysis – Non-linear regression - logistic regression. K-Nearest Neighbours - Cross Validation-Resampling - Feature Selection.		
Module:5	**Prescriptive Analytics**	**5 hours**
Prescriptive analysis - minimum cost network flow problem (MCNFP) – Routing - Random number generation - Concept of simulation and its procedures - Investment management – Introduction to stochastic, transition probability - decision tree analysis - revenue management.		
Module:6	**Decision Making Models**	**4 hours**
Concept of basic linear optimization- Ideas of optimization -Methods and tools for optimization of decision making models - Searching for optimal solutions and applications.		
Module:7	**Optimization Models for Decision Making**	**4 hours**
Introduction to decision making models – Modelling non-linear programming - multi objective programming- goal programming		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours	**30 hours**

Text Book(s)				
1.	S. Christian Albright and Wayne L. Winston, “Business Analytics: Data Analysis & Decision Making”, 2019, 7th edition, Cengage Learning.			
2.	Joao, Mendes. Andre de, Carvalho and Thomas, Horvath, “A General Introduction to Data Analytics”, 2018, First Edition, Wiley.			
Reference Books				
1.	James R. Evans, “Business Analytics”, 2020, 3rd Edition, Pearson.			
2.	Lange, K., “Optimization”, 2010, Springer.			
3.	Winston, W. L., “Operations Research: Applications and Algorithms”, 2003, Cengage Learning.			
Mode of Evaluation: CAT, Written Assignment, Quiz and FAT				
Recommended by Board of Studies		15-02-2024		
Approved by Academic Council		No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
PMBS502P	Data analysis and Decision Making Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. The objective of this course is to provide comprehensive knowledge of programming paradigms required for Data Analytics.

Course Outcomes

At the end of the course the student should be able to:

1. Demonstrate the use of built-in objects of Programming.
2. Demonstrate significant experience with program development environment.
3. Implement numerical programming, data handling and visualization.

Indicative Experiments		
1.	Exploratory data analysis location, variability and data distribution.	
2.	Sampling distributions.	
3.	Statistical experiments – power and sample size.	
4.	Regression model fit and prediction.	
5.	Linear and Logistic Regressions.	
6.	Simulating investment model	
7.	Simulating demand model	
8.	Computations on LPP	
9.	Random Number generation	
10.	Problems solving on multi objective programming	
	Total Lecture hours:	**30 hours**

Text Book(s)

1. Jake VanderPlas, “Python Data Science Handbook - Essential Tools for Working with Data”, 2016, O’Reily Media Inc.
2. Zhang.Y, “An Introduction to Python and Computer Programming”, 2016, Springer Publications.

Reference Books

1. Joel Grus, “Data Science from Scratch First Principles with Python”,2016, O’Reilly Media, 2016.
2. T.R.Padmanabhan, “Programming with Python”, 2016,Springer Publications.

Mode of Evaluation: Assignments and FAT

Recommended by Board of Studies	15-02-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
PMBS503L	Machine Learning	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

This course equips students with the knowledge and skills:

1. To apply quantitative modelling and data analysis techniques to the solution of real-world business problems, and effectively present results using data visualization techniques.
2. To apply principles of Data Science to the analysis of business problems.
3. To understand the importance and significance of Machine Learning: regression.
4. To understand the diverse methods of data classification and mathematical optimization.

Expected Course Outcomes

At the end of the course the student will be able to:

1. Explain in basic terms what Statistical Inference means. Identify probability distributions commonly used as foundations for statistical modelling. Fit a model to data.
2. Comprehend different types of learning.
3. Predict the outcome based on regression.
4. Compute optimal hyperplane and support vectors for data classification.
5. Appreciate clustering as an unsupervised learning method.

Module:1	Introduction to Machine Learning	4 hours

Basis of machine learning including types of learning, overfitting, underfitting, bias and variance, hyperparameter tuning, training versus testing

Module:2	Introduction to data analysis	4 hours

Exploratory Data Analysis – mean, median, mode, quartile deviation, visualizing numeric variables – boxplots histograms, understanding categorical data – binomial and multinomial distributions, understanding numeric data – uniform, normal and chi-square distributions

Module:3	Data Pre-processing	7 hours

Data Cleaning, Missing Values, outliers, Noisy Data; Data Transformation and Discretization - Data Transformation Strategies, Data transformation by Normalization, various methods of Discretization. Dimensionality reduction – PCA (Principal Component Analysis): Preserving the variance – Principal components – Projecting down to d dimensions – Randomized PCA – Kernel PCA.

Module:4	Supervised Machine Learning: Regression	7 hours

Regression -Simple Linear Regression, Multiple Regression, Assessing performance, regularization.

Module:5	Supervised Machine Learning: Classification	7 hours

Decision tree induction, Bayes Classification, Rule Based Classification, Model evaluation and selection, Advanced Classification methods – Bayesian classification, Support Vector Machines. Ensemble methods of classification, gradient boosting.

Module:6	Unsupervised Machine Learning	7 hours

Clustering – K means – Limitations – Clustering for Image Segmentation, k-Medoids; Hierarchical methods - Agglomerative versus Divisive Clustering, Density based methods.

Module:7	Association Rule Mining	7 hours

Association rule mining - Associations, and correlations, Market Basket Analysis, Frequent Itemsets and Association Rules, Mining Methods – The Apriori Algorithm, Generating Association Rules from Frequent Itemsets, Finding Frequent Itemsets without Candidate Generation, FP-Growth, FP-Tree.

Module:8	Contemporary Issues	2 hours

		Total Lecture hours:	**45 hours**
Text Book(s)			
1.	Kevin P. Murphy, “Probabilistic Machine Learning: An Introduction”, 2022, MIT Press.		
2.	Kevin P. Murphy, “Probabilistic Machine Learning: Advanced Topics”, 2023, MIT Press.		
Reference Books			
1.	Marc Peter Deisenroth, A. Aldo Faisal and Cheng Soon Ong,” Mathematics for Machine Learning”, 2020, Cambridge University Press.		
2.	E. Alpaydin, “Introduction to Machine Learning”, 2015, 3rd Edition, MIT Press.		
3.	K. P. Murphy, “Machine Learning: A Probabilistic Perspective”, 2012, MIT Press.		
Mode of Evaluation: CAT, Assignment, Quiz and FAT			
Recommended by Board of Studies		15-02-2024	
Approved by Academic Council		No. 73	Date 14-03-2024

Course Code	Course Title	L	T	P	C
PMBS503P	Machine Learning Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To make the student understand the implementation procedures for the machine learning algorithms using MATLAB /R/Python, Weka (ML software in JAVA).
2. To make them understand modern notions in data analysis-oriented computing and conduct experiments to design a component or a product applying all the relevant standards with realistic constraints.

Course Outcomes

On completion of this course, the students will be able to:

1. Understand the most popular machine learning algorithms
2. Analyse and perform an evaluation of learning algorithms and model selection.
3. Compare the strengths and weaknesses of many popular machine learning approaches
4. Appreciate the underlying mathematical relationships within and across machine learning algorithms and the paradigms of supervised and unsupervised learning.
5. Design and implement various machine learning algorithms in a range of real-world

Indicative Experiments	
1.	Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points.
2.	Implement linear regression using python. Select appropriate data set for your experiment and plot the graphs.
3.	Write a program to construct a Logistic Regression considering classification data.
4.	Implement SVM tool for data Set.
5.	Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
6.	Write a program to implement k-Nearest Neighbour algorithm to classify the data set. Print both correct and wrong predictions.
7.	Implement k-means clustering for classification.
8.	Implementation of Time Series Clustering and alignment algorithms.
9.	Implement Principal Component Analysis (PCA) for dimensionality reduction.
10.	Implement Linear Discriminant Analysis (LDA) for dimensionality reduction.
11.	Implement different types clustering algorithms
12.	Implement association rule mining algorithms→ Apriori Algorithm and FP tree
	Total Laboratory hours: 30 hours

Text Book(s)

1. Tom Mitchell, “Machine Learning”, 2010, McGraw-Hill Education.

Reference Books

1. Christopher Bishop, “Pattern Recognition and Machine Learning”, 2013, Springer.
2. Balas K Natarajan, “Machine Learning”, 2014, Elsevier Science.

Mode of Evaluation: CAT, Assignment, Quiz and FAT

Recommended by Board of Studies	15-02-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
PMBS504L	Big Data Analytics and Visualization	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

This course equips students with the knowledge and skills to:

1. Understand the techniques for Data Analysis and explore the concepts related to Data Analytics.
2. Apply Statistics concepts of Big Data analytics for real world problems.
3. Examine the working of Data Analytic platforms and identify tools for Big Data analytics.

Course Outcomes

After completion of the course students will be able to:

1. To gain knowledge on the fundamentals of data analytics.
2. To apply methods and techniques for Distributed Processing.
3. To Understand Data Modelling concepts in Data Analytics.
4. To delve into Data Aggregation techniques.
5. To analyse Big Data Pattern using visualization.

Module:1	Introduction to Big Data:	2 hours

Introduction, data life cycle, Structuring Big Data, Characteristics of Big Data, Big data applications, Technologies for handling big data – Distributed and Parallel Computing for Big Data, Introducing Hadoop – Hadoop multi node cluster architecture, Introduction to data lake, data cleansing and transformations, Data lake reference architecture, HDFS and MapReduce. HDFS Concepts– MapReduce Execution, Algorithms using MapReduce, Limitations of Hadoop, Overcoming the limitations of Hadoop

Module:2	Apache Spark	6 hours

Apache Spark: Eco system, Components of the Spark unified stack-Spark SQL, Spark Streaming, Spark GraphX, Spark MLLib. Spark context, spark stage, spark executor. Spark Architecture, RDD and RDD Operations-RDD Features and limitations, RDD- Persistence and Cashing mechanism, DAG, spark cluster management, performance tuning, Data Frames and Dataset – In-memory distributed processing using Apache Spark. Spark shell commands.

Module:3	Spark Streaming	6 hours

Streaming Data: Streaming Architectures - Lambda architecture, Kappa architecture, Spark Streaming- Streaming system components, Discretized stream processing, Spark streaming architecture, Transformations on Dstreams, Window operations, Join and output operations, Caching, Checkpointing, Structured Streaming, Managing Distributed Data Flow with Apache Kafka-Kafka Fundamentals, Use case and applications, Architecture, Kafka Topics, Producer and consumer-Producer and consumer configuration and execution, In-Sync Replicas, Kafka Consumer groups

Module:4	NoSQL Databases	5 hours

Types NoSQL Databases, Introduction to MongoDB, Data model design, CRUD operations on MongoDB, Projection, limiting and sorting records, indexing, Aggregation, replication and sharding, Analysing queries

Module:5	HBase	3 hours

Introduction to HBase, HBase data model, regions, HBase Architecture, zookeeper, Dataflow, WAL and Memstore, HFile, CRUD operations, Meta table, Merge and compaction

Module:6	Hive	3 hours

Introduction to Hive – Hive data types, Hive file formats, Hive database and table operations, partitioning, built in operators and functions, Views and indexes, Spark on Hive.

Module:7	Data Visualization	3 hours

Challenges of big data visualization. Building visualizations on Big DataPower BI, Tableau, and Case Studies on applications of Big Data Analytics		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Ulrich Matter, “Big Data Analytics - A Guide to Data Science Practitioners Making the Transition to Big Data”, 2023, 1st Edition, Chapman and Hall/CRC.
Reference Books	
1.	Michael Berthold, David J. Hand, “Intelligent Data Analysis’, 2007, Springer.
2.	Anand Rajaraman and Jeffrey David Ullman, “Mining of Massive Datasets”, 2020, Cambridge University Press, 3rd edition.
Mode of Evaluation: CAT, Assignment, Quiz and FAT	

Recommended by Board of Studies	15-02-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
PMBS504P	Big Data Analytics and Visualization Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

This course equips students with the knowledge and skills:

1. To solve Big Data problems using Map Reduce Technique.
2. To Learn Database Connectivity for Big Data Problems.
3. To design algorithms to data aggregate in Big Data.
4. To Visualize and interpret the results.

Course Outcomes

After completion of the course students will be able to:

1. To gain knowledge on the fundamentals of data analytics.
2. To apply methods and techniques for Distributed Processing.
3. To Understand Data Modelling concepts in Data Analytics.
4. To delve into Data Aggregation techniques.
5. To analyse Big Data Pattern using visualization.

Indicative Experiments	
1.	RDD Operations
2	Map Reduce Programs - Spark
3	Spark MLLib
4	Spark Streaming examples
5	NoSQL Databases query execution
6	MongoDB
7	Hadoop
8	HBase
9	HIVE
10	Data Visualization Programs
	Total Laboratory hours: 30 hours

Text Book(s)

1. Ulrich Matter, “Big Data Analytics - A Guide to Data Science Practitioners Making the Transition to Big Data”, 2023, 1st Edition, Chapman and Hall/CRC.

Reference Books

1. Michael Berthold, David J. Hand, “Intelligent Data Analysis’, 2007, Springer.
2. Anand Rajaraman and Jeffrey David Ullman, “Mining of Massive Datasets”, 2020, Cambridge University Press, 3rd edition.

Mode of Evaluation: Weekly Assessment, FAT and Oral examination

Recommended by Board of Studies	15-02-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
PMBS505L	Time Series Analysis and Forecasting	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

This course equips students with the knowledge and skills:

1. To equip various forecasting techniques and familiarize on modern statistical methods for analysing time series data.
2. To amalgamate the intellectual facts of the time series data to implement in the field projects in a scientific manner.
3. To link time dependent analytical tools and building the models by extracting real time data.

Course Outcomes

On completion of the course students will be able to:

1. Understand the fundamentals of time series analysis
2. Learn and apply an appropriate time series forecasting methods in any given situation.
3. Learn and apply model validation of forecasting techniques.
4. Analyse the time series data and apply variance transformation techniques
5. Analyse the frequency domain time series data.

Module:1	Introduction to Time Series Analysis	3 hours

Graphical display - Classical decomposition model - Components and various decompositions of Time Series Models - Numerical description of time Series: Stationarity - Autocovariance and Autocorrelation functions - Data transformations - Methods of estimation trend - Seasonal and exponential.

Module:2	Smoothing Techniques	3 hours

Moving Averages: Simple – Cantered - Double and weighted moving averages - Single and double exponential smoothing - Holt's and winter's methods - Exponential smoothing techniques for series with trend and seasonality - Basic evaluation of exponential smoothing.

Module:3	Stationary Time Series Models	4 hours

Time series data - Trend, seasonality, cycles and residuals: Stationary - White noise processes - Autoregressive (AR) - Moving average (MA) - Autoregressive and moving average (ARMA) and Autoregressive integrated moving average (ARIMA) processes - Choice of AR and MA periods.

Module:4	Non-stationary Time Series Models	5 hours

Tests for non-stationarity: Random walk: random walk with drift - Trend - Stationarity - General unit root tests: Dickey fuller test - Augmented dickey fuller test. ARIMA models: basic formulation of the ARIMA model and their statistical properties - Autocorrelation function (ACF) - Partial autocorrelation function (PACF) and their standard errors.

Module:5	Forecasting Methods	5 hours

Nature of forecasting, forecasting methods: qualitative and quantitative methods - Steps involved in stochastic model building - Forecasting model evaluation. Model selection techniques: AIC, BIC and AICC Forecasting model monitoring.

Module:6	Transfer Function and Intervention Analysis	4 hours

Transfer function models - Transfer function noise models - Cross correlation function - Model specification - Forecasting with transfer function noise models - Intervention analysis.

Module:7	Spectral Analysis	4 hours

Spectral density function (s. d. f.) and its properties - s. d. f. of AR, MA and ARMA processes - Fourier transformation and periodogram.

Module:8	Contemporary Issues	2 hours

		Total Lecture hours	**30 hours**
Text Book(s)			
1.	Chris Chatfield, Haipeng Xing, “The Analysis of Time Series: An Introduction with R”,2019, Seventh Edition, CRC Press.		
2.	Manu Joseph, “Modern Time Series Forecasting with Python”, 2022, First Edition, Packt Publishing Ltd, United Kingdom.		
Reference Books			
1.	Douglas C. Montgomery, Cheryl L. Jennings, Murat Kulahci, “Introduction to Time Series Analysis and Forecasting”, 2016, Second Ed., Wiley.		
2.	George E. P. Box, Gwilym M. Jenkins, Gregory C. Reinsel, and Greta M. Ljung, “Time Series Analysis: Forecasting and Control”, 2016, Fifth Ed., Wiley.		
3.	Brockwell, P. J., and Davis, R. A., “Introduction to time series and forecasting”, 2016, Third Edition, Springer.		
4.	Terence C. Mills, “Applied Time Series Analysis: A Practical Guide to Modelling and Forecasting”, 2019, Academic Press.		
Mode of Evaluation: CAT, Written Assignment, Quiz and FAT			
Recommended by Board of Studies		15-02-2024	
Approved by Academic Council		No. 73	Date 14-03-2024

Course Code	Course Title	L	T	P	C
PMBS505P	Time Series Analysis and Forecasting Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

This course equips students with the knowledge and skills:

1. To equip various forecasting techniques and familiarize on modern statistical methods for analysing time series data.
2. To amalgamate the intellectual facts of the time series data to implement in the field projects in a scientific manner.
3. To link time dependent analytical tools and building the models by extracting real time data.

Course Outcomes

On completion of the course students will be able to:

1. Understand the fundamentals of time series analysis
2. Apply an appropriate time series forecasting methods in any given situation.
3. Apply model validation of forecasting techniques.
4. Analyse the time series data and apply variance transformation techniques
5. Analyse the frequency domain time series data.

Indicative Experiments	
1.	Visualization of Stationary and Non-stationary time series
2.	Moving Average Time Series Model and Differencing
3.	Exponential smoothing technique (Single, double and triple)
4.	Auto-Regressive Model for Stationary Time Series
5.	Autoregressive Integrated Moving Average for Non- Stationary Time Series
6.	Forecasting With Univariate Models
7.	Forecasting model validations
8.	Transfer Functions and Autoregressive Distributed Lag Modelling
9.	Spectral density function
10.	Analysing the time series data using a real-world case study problem.
	Total Laboratory hours **30 hours**

Text Book(s)

1. Chris Chatfield, Haipeng Xing, “The Analysis of Time Series: An Introduction with R”, 2019, Seventh Edition, CRC Press.

Reference Books

1. Tilman M Davies “The Book of R: A First course in Programming and Statistics”, 2016, Printed in USA.
2. Manu Joseph, “Modern Time Series Forecasting with Python”, 2022, First Edition, Packt Publishing Ltd, United Kingdom.

Mode of Evaluation: Weekly Assessment, FAT and Oral examination

Recommended by Board of Studies	15-02-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
PMBS506L	Applied Multivariate Analysis	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

This course equips students with the knowledge and skills:

1. **To make the student understand the fundamental concepts of Multivariate Data Analysis and formulate real time problems on multivariate model.**
2. **To Prepare for investigation of multivariate data and examine the possible diagnostics in multivariate methods.**
3. **To develop feasible solution of real-life problems, using multivariate methods and techniques.**

Course Outcomes

At the end of the course the student should be able to:

1. **Learn to develop an in-depth understanding of the Multivariate models, methods and techniques.**
2. **Demonstrate the knowledge and skill of multivariate normal distributions, related probability distributions and their applications.**
3. **Perform, handle and manipulate the analysis of discriminant function and logistic regression.**
4. **Apply the method and analysis of principal components, factor analysis and dimension reduction of sample data.**
5. **Investigate the events of clustering and multidimensional scaling presence in sample data.**

Module:1	Introduction to Multivariate Analysis	3 hours

Basic concept and definition of multivariate data and characteristics - Exploratory and descriptive multivariate data analysis - Sample mean vector - sample variance and covariance matrix - sample dispersion matrix - sample correlation matrix – concept and application of generalized variance – Introduction to commonly used multivariate statistical methods.

Module:2	Multivariate Normal Distribution	5 hours

Introduction to multivariate normal distribution - probability density function and moment generating function- singular and non-singular normal distributions - distribution of linear and quadratic form of normal variables - marginal and conditional distributions - Random sampling from multivariate normal distributions - Goodness of fit of multivariate normal distribution - Application of Hoteling T^2 in testing.

Module:3	Multivariate Linear Regression Model	5 hours

Multivariate linear regression - mathematical formulation, model fit - estimation of parameter and validation of model - Concept of MANOVA and MANCOVA - Wishart distribution and its application - Mahalanobis D^2 **application in testing and confidence set construction.**

Module:4	Logistic Regression	4 hours

Logistic Regression model and analysis: regression with a binary dependent variable - representation of the binary dependent variable - estimating the logistic regression model - assessing the goodness of fit of the estimation model - testing for significance of the

coefficients - interpreting the coefficients.		
Module:5	**Multiple Discriminant Analysis**	**4 hours**
Discriminant model and analysis: a two-group discriminant analysis - a three group discriminant analysis - the decision process of discriminant analysis - estimation of the model - assessing overall fit of a model, interpretation of the results - validation of the results		
Module:6	**Principal Components and common Factor Analysis**	**4 hours**
Population and sample principal components - their uses and applications - large sample inferences - graphical representation of principal components – Biplots - the orthogonal factor model - dimension reduction - estimation of factor loading and factor scores - interpretation of factor analysis.		
Module:7	**Structural Equation Modelling**	**3 hours**
Structural equation modelling and its properties - canonical correlation		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours	**30 hours**

Text Book(s)	
1.	**Hardly W.K. and Simor L., "Applied Multivariate Statistical Analysis", 2015, 4th Edition, Springer Verlag.**
2.	**Richard A. Johnson and Dean W. Wichern, "Applied Multivariate Statistical Analysis", 2019, 7th Edition, Prentice Hall India.**
Reference Books	
1.	**Joseph F. Hair, Jr., William C. Black, Barry J. Babin, Rolph E. Anderson and Ronald L. Tatham, "Multivariate Data Analysis", 2014, 7th Edition, Pearson Education India.**
2.	**Rao, C. R. and Rao, M. M., "Multivariate Statistics and Probability", 2014, Elsevier & Academic Press.**
3.	**Kshirsagar, A. M., "Multivariate Analysis", 2006, Marcel Dekkar.**
4.	**Anderson T.W., "An Introduction to Multivariate Statistical Analysis", 2009, 3rd Edition, John Wiley & sons.**

Mode of Evaluation: CAT, Written Assignment, Quiz and FAT			
Recommended by Board of Studies	15-02-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
PMBS506P	Applied Multivariate Analysis Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

This course equips students with the knowledge and skills to:

1. **Conversant with various methods and techniques used in summarization and analysis of multivariate data.**
2. **Develop feasible solution of real-life problems, using multivariate methods and techniques.**

Course Outcomes

At the end of the course the student will be able to:

1. **Understand the functioning of industries and business strategies.**
2. **Apply classical multivariate analysis and techniques which are useful for analysing both designed experiments and observational studies.**
3. **Apply hypotheses tests to analyze multivariate data.**
4. **Evaluate the different multivariate methods.**
5. Analyse and present multivariate data in a clear and professional manner.

Indicative Experiments	
1.	**MLE of mean vector and variance-covariance matrix from the normal population. Generating random numbers from a multivariate normal distribution.**
2.	**Experiment based on Hoteling T^2.**
3.	**Experiment based on Mahalanobis D^2.**
4.	**Fitting a multivariate linear regression model and its interpretation. Error analysis, outliers detection and related tests.**
5.	**Experiment based on the concept of MANOVA.**
6.	**Experiment based on the concept of One Way MANCOVA.**
7.	**Estimation, fitting and validating a logistic regression model.**
8.	**Classification between two normal populations using discriminant analysis.**
9.	Classification using Fisher's test.
10.	**Cluster analysis.**
11.	**Computation of canonical variables and correlation.**
12.	**Lab experiment on Principal Component Analysis.**
13.	**Lab experiment on Factor Analysis.**
14.	**Structural Equation Modelling and related computations.**
	Total Laboratory hours **30 hours**

Text Book(s)

1.	**Johnson, Richard A and. Wichern D.W, "Applied Multivariate Statistical Analysis", 2019, 7th Edition, Prentice-Hall of India Private Ltd., New Delhi.**
2.	**Hardly W.K. and Simor L., "Applied Multivariate Statistical Analysis", 2015, 4th Edition, Springer- Verlag.**

Reference Books

1.	**Anderson, T.W., "An Introduction to Multivariate Statistical Analysis", 2003, Wiley**

	Eastern Ltd.			
2.	**Rao, C.R., "Linear Statistical Inference and its Applications", 1998, Wiley Eastern Ltd.**			
3.	**Weisberg S., "Applied Linear Regression", 2013, 4th Edition, Wiley.**			
4.	**Kollo T., and Rosen D. Von, "Advanced Multivariate Statistical Analysis with Matrices",2005, Springer, New York.**			
Mode of Evaluation: Weekly Assessment, FAT and Oral examination				
Recommended by Board of Studies		15-02-2024		
Approved by Academic Council		No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
PMDS506L	Database Management Systems	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To understand the basic concepts of database, ER Modelling, normalization and query optimization.
2. To comprehend the concepts concurrency control, recovery and indexing.
3. To explore the concepts of NoSQL and main types of NoSQL databases.

Course Outcomes

At the end of the course, students will be able to:

1. Describe the concepts of database, construct entity-relationship (ER) model for the real world problems and transfer data model into database designs.
2. Analyze the fundamental concepts of normalization, transaction, concurrency control and recovery mechanisms.
3. Demonstrate the basic database storage structure and indexing techniques.
4. Organize the detailed architecture and primary benefits using NoSQL Databases.
5. Analyze the major types of NoSQL databases.

Module:1	DATABASE SYSTEMS CONCEPTS AND DATA MODELING	7 hours

Basic concepts of database systems- Entity Relationship Model - Structural Constraints- Relational Model- Relational Model Constraints- Mapping ER model to a Relational Schema and database integrity.

Module:2	DATABASE DESIGN AND QUERY PROCESSING	7 hours

Guidelines for Relational Schema- Functional Dependency- Normalization- Translating SQL Queries into Relational Algebra- Heuristic Query Optimization.

Module:3	TRANSACTION PROCESSING CONCEPTS	6 hours

Introduction to transaction processing- Transaction and system concepts -Desirable properties of transactions- Characterizing schedules based on recoverability- Characterizing schedules based on serializability- Test for serializability.

Module:4	CONCURRENCY CONTROL AND PHYSICAL DATABASE DESIGN	6 hours

Lock-based protocols- Techniques for concurrency control- Recovery concepts- File organization- and Indexing.

Module:5	NOSQL	6 hours

Database revolutions: First generation, second generation, third generation- Managing transactions and data integrity- ACID and BASE for reliable database transactions- Speeding performance by strategic use of RAM, SSD, and disk, Brewer's CAP theorem.

Module:6	KEY VALUE DATA STORES	6 hours

Essential features of key value databases- Key-Value architecture- Designing structured values- Limitations of key-value databases - Design patterns for key-value databases and Case study for Key-Value databases.

Module:7	NOSQL DATA MODEL	5 hours

Aggregate models- Document data model- Key- value data model- Columnar data model and Graph based data model.

Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours	**45 hours**

Text Book(s)	
1	Raghu Ramakrishnan, Johannes Gehrke, Database Management Systems, 2015, 4th Edition, Tata McGraw Hill.
Reference Book(s)	
1	Henry F Korth, Abraham Silberschatz, S. Sudharshan, Database System Concepts, 2006, 5th Edition, McGraw Hill.
2	R. Elmasri and S. B. Navathe, Fundamentals of Database Systems, 2016, 7th Edition, Addison Wesley.
3	Guy Harrison, Next Generation database: NoSQL New SQL and Big Data, 2015, 1st Edition, Apress.
4	Daniel G. McCreary and Ann M. Kelly, Making Sense of NoSQL, 2013, Manning publisher.

Mode of Evaluation: CAT, Assignment, Quiz and FAT			
Recommended by Board of Studies	15-02-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course code	Course Title	L	T	P	C
PMDS506P	DATABASE MANAGEMENT SYSTEMS LAB	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To understand the concepts of SQL commands.
2. To comprehend the concepts of PL/SQL.
3. To explore the concepts of NoSQL using MongoDB.

Course Outcomes

At the end of the course the student should be able to:

1 Perform SQL and PL/ SQL queries.
2 Implement the MongoDB methods, insert, update, delete operations in a NoSQL database

Indicative Experiments

1	Basic SQL Commands (DDL, DML, DCL ,TCL and Constraints)
2	Operators, Views and Functions
3	Joins and Subqueries
4	PL/SQL Introduction and Control Structures
5	Exception handling
6	Functions and Procedures
7	Cursors and Triggers
8	Basics of MongoDB, Methods and operators
9	Working with documents and collections
10	Indexing in MongoDB
	Total Laboratory hours **30 hours**

Text Book(s)

1	Manu sharma, MongoDB Complete Guide, 2021, BPB Publications.
2	David Hows, Peter Membrey , Eelco Plugge, DUPTim Hawkins, The Definitive Guide to MongoDB: A complete guide to dealing with Big Data using MongoDB, 2015, Aress.

Reference Book(s)

1	Rick Copeland, MongoDB Applied Design Patterns: Practical Use Cases with the Leading NoSQL Database, 2013, O'Reilly.
2	Amit Phaltankar, Juned Ahsan, Michael Harrison and Liviu Nedov, MongoDB Fundamentals, A hands-on guide to using MongoDB and Atlas in the real world, 2020, Packt Publishing.

Mode of evaluation	Assignment and FAT		
Recommended by Board of Studies	15-02-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
PMDS508L	PYTHON PROGRAMMING	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To introduce the basic building blocks of algorithmic problem-solving.
2. To introduce core programming basics using Python language.
3. To introduce the data structures of Python and their applications.
4. To introduce the modules for data manipulation and visualization.

Course Outcomes

At the end of the course, the students will be able to

1. Classify various algorithmic approaches and categorize the appropriate data representation,
2. Build programs using control structures,
3. Develop solutions to problems using ordered and un-ordered collection of data types.
4. Utilize the in-built functions and modules and develop user defined functions and modules.
5. Demonstrate array operations, mathematical analysis and graphical representation of data.

Module:1	Algorithmic Problem Solving	2 hours

Building blocks of algorithms: Statements, state, control flow, functions, Developing an Algorithm, Flowchart and Pseudo code.

Module:2	Introduction to Python	3 hours

Introduction to Python - Indentation, variables, reserved words, basic data types: Integer, Floating point, Complex and Boolean; Operators and their precedence, Expressions, Mutability, Built-in Functions, and Importing from Packages.

Module:3	Control Structures	4 hours

Decision Making and Branching: if, if-else, nested if, multi-way if-elif statements;
Looping: while-loop, for-loop, else clauses in loops, nested loops, break, continue and pass statements.

Module:4	Data Collections	4 hours

Strings: Comparison, Formatting, Slicing, Splitting, Stripping, Regular Expressions: Matching,Search and replace patterns; Lists, Tuples, Sets and Dictionaries – Operations, List Comprehension.

Module:5	Functions and Modules	5 hours

User-defined functions- parameters and arguments, namespaces and scope rules, Lambda function; Recursive functions, Generator Functions, Decorators. Built-in modules, User-Defined modules,

Module:6	Multidimensional Data Handling and Visualisation	5 hours

NumPy arrays – 1-d, multi-dimensional arrays and matrices. Difference between lists and arrays. Mathematical operations with arrays. Slicing arrays; Boolean masks; Broadcasting in NumPy. Python Plotting: matplotlib – Basic Plotting. Logarithmic Plots. Plots with multiple axes; interactive functions for 3d plotting.

Module:7	**Scientific Data Analysis**	**5 hours**
SciPy – Introduction, scipy.stats, scipy.integrate, scipy.optimize, scipy.interpolate. Pandas – Introduction. Series, DataFrame and Panel. Slicing the data. Reading and writing CSV, XLS and JSON files. Working with missing data, categorical data. Data visualization with Pandas.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours	**30 hours**

Text Book(s)	
1	Eric Matthes, Python Crash course: A Hands-On, Project-Based Introduction to Programming, 2023, 3rd edition, William Pollock.
Reference Book(s)	
1	Martic C Brown, Python: The Complete Reference, 2018, 4th Edition, McGraw Hill Publishers.
2	Wes McKinney, Python for Data Analysis, 2022, 3rd Edition, O'Reilly Media.

Mode of Evaluation: CAT, Assignment, Quiz and FAT			
Recommended by Board of Studies	15-02-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course code	Course Title	L	T	P	C
PMDS508P	PYTHON PROGRAMMING LAB	0	0	4	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. Explore problem-solving skills using Python programming and find solutions for real-time problems.
2. Acquire object-oriented programming skills in Python.

Course Outcomes

At the end of the course, the students will be able to

1. understand and comprehend the basic programming constructs of Python programming.
2. implement control statements for altering the sequential execution of programs in solving problems.
3. solve real-time problems using modular programming concepts.
4. develop programs for statistical processing of data using NumPy, Matplotlib, Scipy, and Pandas.

Indicative Experiments

1	Build applications using Operators and Expressions.
2	Build applications using Conditional IF-ELIF-ELSE statements).
3	Build applications using Looping (for, while loops).
4	Manipulations using Strings, Lists, Tuple, Sets and Dictionaries.
5	Create user-defined function Python scripts.
6	Create user-defined modules and import them into the programs.
7	Create data applications using array and matrix manipulations.
8	Build basic data visualizations using Matplotlib and interpret them.
9	Build programs to analyze the time series data using the SciPy module.
10	Build programs to manipulate the data and analyze it by Pandas module.
	Total Laboratory Hours **60 hours**

Text Book (s)

1	Reema Thareja, Python Programming using Problem Solving Approach, 2023, 2nd Edition, Oxford University Press.

Reference Book (s)

1	John Hunt, Advanced Guide to Python 3 Programming, 2023, 2nd Edition, Springer Cham.

Mode of evaluation: Assignment and FAT

Recommended by Board of Studies	15-02-2024		
Approved by Academic Council	No.73	Date	14-03-2024

Discipline Elective

Course Code	Course Title	L	T	P	C
PMBS601L	Survey Sampling and Design	3	1	0	4
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

This course equips students with the knowledge and skills to:

1. Understand the core concepts of survey sampling, including population, sample, and sampling techniques.
2. Learn various sampling methods such as simple random sampling, stratified random sampling, and systematic sampling.
3. Estimate population parameters like mean and proportion, and analyze variance in sample data.
4. Gain proficiency in designing randomized experiments, including concepts like randomization, replication, and block designs.

Course Outcomes

After completion of the course students will be able to:

1. Articulate the fundamental concepts of survey sampling, including population, sample, and various sampling techniques.
2. Apply different sampling methods such as simple random sampling, stratified random sampling, and systematic sampling to obtain representative samples.
3. Estimate population parameters such as mean and proportion using sample data, and understanding the variance associated with these estimates.
4. Analyze variance in sample data and interpret the results using techniques like analysis of variance (ANOVA) with one-way and two-way classifications
5. Develop the skills necessary to design randomized experiments, including the implementation of randomization, replication, and block designs to control for variables.

Module:1	Sampling Basics	5 hours

Concept of sampling - Need for sampling-Population and sample - Sampling unit and sample frame - Types of Population - Basic properties of the population - Sample survey and census - Principal steps in a Sample survey - Notion of sampling error.

Module:2	Simple Random Sampling	5 hours

Simple Random Sampling with and without replacement - Estimation of Population mean and proportion and their variances - Determination of sample size.

Module:3	Stratified Random Sampling	5 hours

Stratified sampling - Principles of stratification - Estimation of population mean and its variance Allocation techniques - Estimation of gain due to stratification.

Module:4	Systematic Sampling	4 hours

Systematic sampling - Estimation of population mean and its sampling variance - Circular systematic sampling - Comparison of systematic - simple random and stratified random sampling - Cluster sampling with equal-sized clusters - Estimation of population mean and variance.

Module:5	Fundamentals of Experimental Design	8 hours

Basic Principles for designing statistical experiments: Randomization - Replication and local control techniques - Determination of experimental units and notion of experimental error - Analysis of variance with one-way and two-way classifications - Models and Methods of analysis- Completely Randomized Design (CRD) and Randomized Block Design (RBD)

Module:6	Basic Experimental Design	8 hours

-Models and estimates of parameters and their standard error - Analysis of data arising from such designs - Analysis when one or two observations are missing. Latin Square Design (LSD) - Model Estimation of parameters - Method of analysis - Missing Plot technique in LSD.		
Module:7	**General Factorial Designs**	**8 hours**
Main Effect -Interaction effect – Yates Table for 2^2 and 2^3 Factorial Experiments - Statistical Analysis of 2^2 and 2^3 Factorial Experiments-Fractional Factorial Design-Response Surface Methodologies.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours	**45 hours**

Text Book(s)	
1.	Hanif M., Qaiser Shahbaz M. and Munir Ahmad, “Sampling Techniques: Methods and Applications”, 2018, Nova Science Publishers.
2.	Montgomery, C.D, “Design of Experiments”, 2012, 8th Edition, John Wiley and Sons.
Reference Books	
1.	Gupta S.C. and Kapoor V.K., “Fundamentals of Applied Statistics”,2000, Sultan Chand.
2.	Das M N and Giri N C., “Design and Analysis of Experiments”, 2017, New Age Publishers.
3.	Des Raj and P Chandhok, “Sample Survey Theory”, 1998, Narosa Publishers.
Mode of Evaluation: CAT, Assignment, Quiz and FAT	

Recommended by Board of Studies	15-02-2024		
Approved by Academic Council	No.73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
PMBS602L	Optimization Modelling	3	1	0	4
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

This course equips students with the knowledge and skills:

1. To emphasize the application of Operations Research for solving industrial problems.
2. To understand the meaning, purpose, and tools of Operations Research.
3. To use optimization techniques to enhance systems and to manage enterprise resources using current tools, frameworks and reusable resources.

Course Outcome

At the end of the course the student will be able to:

1. Apply operations research techniques like L.P.P, scheduling and sequencing in industrial optimization problems.
2. Solve allocation problems using various OR methods.
3. Analyse various OR models like Inventory, Replacement, Queuing, Decision etc., and apply them for optimization.
4. Understand the concepts of integer linear programming.
5. Gain knowledge on current topics and advanced techniques of Operations Research in a wide range of applications in industries.

Module:1	Linear Programming Models	9 hours

An overview and scope of Operations Research and Introduction to Linear Programming (LP) - Illustration of LP Problems - Formulation exercises on LP Problems - Graphical Method of solving LPP - Simplex Method – Unboundedness - Multiple Optimum Solutions - Degeneracy - Artificial Variables: Big-M Method - Sensitivity Analysis.

Module:2	Transportation and Assignment Models	9 hours

Introduction: Transportation Problem – Balanced – Unbalanced - Methods of basic feasible solution - Optimal solution - MODI method. Assignment problem - Hungarian Method.

Module:3	Integer programming	8 hours

Integer Programming Problem (IPP) – Gomary's cutting plane algorithm - Mixed IPP Branch and Bound technique.

Module:4	Dynamic programming	7 hours

Dynamic programming problem (DPP) – Bellman's principle of optimality - General formulation - computation methods and application of DPP - Solving LPP through DPP approach.

Module:5	Game Theory	8 hours

Formulation of games Two-person zero-sum games n persons zero-sum games Pure and mixed strategy games Saddle point Dominance method Graphical method for solving mixed strategy game.

Module:6	Non-Linear Programming	9 hours

Non-linear programming problem Kuhn Tucker conditions Quadratic Programming Problem (QPP) - Convex programming.

Module:7	Queuing Models	8 hours

Queuing theory - Basic characteristics of queuing models - Arrival and service distribution – Markovian queues – Birth and Death processes – Single and multiple server queueing models – Little's formula - Queues with finite waiting rooms – Queues with impatient customers: Balking and reneging. Finite source models - M/G/1: GD/∞ /∞– Pollaczek-Khintchine formula.

Module:8	Contemporary Issues	2 hours

	Total Lecture hours		**60 hours**
Text Book(s)			
1.	Hamdy Taha, “Operations Research”,2019, 10th edition, Prentice Hall India.		
2.	P. K. Gupta and D. S. Hira, “Operations Research”, 2007, S. Chand & co.		
Reference Books			
1.	S.D. Sharma, “Operations Research”, 2000, Nath & Co., Meerut.		
2.	J K Sharma, “Operations Research Theory & Applications”,2007, 3rd Edition, Macmillan India Ltd, 2007.		
3.	P. Sankara Iyer, “Operations Research”, 2008, Tata McGraw-Hill.		
4.	E.K.P. Chong, and S.H. Zak, “An Introduction to Optimization”, 2008, 3rd Edn., Wiley Interscience.		
5.	Hillier FS and Libermann G J “Introduction to Operations Research”, 2017, 10th Edition, McGraw Hill.		
Mode of Evaluation: CAT, Assignment, Quiz and FAT			
Recommended by Board of Studies	15-02-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
PMBS603L	Actuarial Statistics	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

This course equips students with the knowledge and skills:

1. To understand different introductory concepts in Actuarial science.
2. To help the students for taking decision for life policies.
3. To link and analyse the various probabilistic models for Actuarial statistical applications.

Course Outcomes

At the end of the course the student should be able to:

1. Understand the fundamental advantages and apply essential of life policies.
2. Apply an appropriate model for construction of life tables.
3. Able to construct the life tables of the policy holders.
4. Learn and apply the general insurance techniques.
5. Apply the stochastic approach to determine the annuity benefits.

Module:1	Basic Deterministic Model	4 hours

Cash flows - discount function - interest and discount rates - balances and reserves - internal rate of return - The life table: Basic definitions – probabilities - construction of life tables - life expectancy.

Module:2	Life Annuities	6 hours

Introduction - calculating annuity premium - immediate annuity - annuity due - guaranteed payments - deferred annuities - accumulated and present values of annuity.

Module:3	Fractional Durations	6 hours

Life annuities paid monthly - immediate annuities - fractional period premium and reserves - reserves at fractional durations - Continuous payments: Continuous annuities - force of discount - force of mortality - Insurance payable at the moment of death - premiums and reserves.

Module:4	The General Insurance	9 hours

Principles of insurances - Types of assurance: Temporary assurance - Pure endowment - Endowment assurance and Whole life assurance - Expression for present value of assurance benefits under Temporary assurance - Pure endowment - Endowment assurance and Whole life assurance - Simple problem.

Module:5	Multiple Life Contracts	6 hours

Joint life status - joint annuities and insurances - last survivor annuities and insurances - moment of death insurances. The general two life annuity and insurance contracts - contingent insurances.

Module:6	Multiple Decrement Theory	6 hours

Basic model, insurances - Determination of the models from the forces of decrement - Expenses & Profits: Profit measurement; Variable Annuities - Pension Plans.

Module:7	Stochastic Approach to Life Policies	6 hours

Stochastic approach to insurance and annuity benefits, deferred contracts, Stochastic approach to reserves and premiums, variance formula.

Module:8	Contemporary Issues	2 hours
	Total Lecture hours	45 hours

Text Book(s)

1. Promislow, S.D., “Fundamentals of Actuarial Mathematics”, 2015, 3rd Edition, John Willey& Sons, NY.

Reference Books				
1.	Neill, A., “Life contingencies”, 1977, Heinemann, London.			
2.	Donald D.W.A., “Compound Interest and Annuities”, 1970, Heinemann, London.			
3.	Hooker, P.F. and Longley Cook, L.H., “Life and other Contingencies”, 1953, Volume I and Volume II (1957) Cambridge University Press.			
Mode of Evaluation: CAT, Assignment, Quiz and FAT				
Recommended by Board of Studies		15-02-2024		
Approved by Academic Council		No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
PMBS604L	Bio-Statistics	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

This course equips students with the knowledge and skills to:

1. Acquire the knowledge and the role of clinical research, statistical & sequential designs and randomization techniques in bio-statistics for medical and biological studies.
2. Provide a foundation on bioassays for medical problems.
3. Use the epidemiological measures and study designs in bio-statistics.
4. Explore the ROC curve and its properties in medical science, public health and others.
5. Analyse the survival analysis, life tables and applications of bio-statistical methods for acquiring the statistical results accurately and effectively.

Expected Course Outcomes

After completion of the course students will:

1. Remember the concepts of clinical trials, bio-statistical methods, statistical & sequential designs and randomization techniques in medical and biological studies.
2. Understand the bioassays models for medical problems.
3. Apply the epidemiological measures and study designs for bio-medical data.
4. Utilize the ROC curve analysis for the health sciences and biological studies.
5. Analyse the bio-medical problems through the survival analysis, life tables and bio-statistical methods effectively.

Module:1	Introduction to Biostatistics	5 hours

Basics of Biostatistics- Statistical Methods in Clinical Trials – Introduction to Clinical Trial and its Phases I, II, III and IV – Blinding in Clinical Trials: Single, Double and Triple Blindings.

Module:2	Statistical Designs and Randomization	6 hours

Statistical Designs: Fixed Sample Trials, Simple Randomized & Stratified Randomized Crossover Designs – Sequential Designs: Longitudinal, Cross-Sectional & Cohort Sequential Designs – Randomization: Dynamic & Permuted Block Randomizations (Stratified).

Module:3	ROC Curve Analysis	7 hours

Sensitivity – Specificity – ROC Curve – Properties of ROC Curve – Slope of ROC Curve – Area Under ROC Curve (AUC) – Bi-Normal ROC Curve – Kullback-Leibler Divergence (KLD) – KLD Expressions for Bi-Normal ROC Model.

Module:4	Epidemiological Measures and Designs	7 hours

Measures of Disease Frequency – Incidence – Prevalence – Relative Risk – Proportion, rate and ratio– Epidemiological Study Designs: Cross-Sectional, Case Control & Cohort Study Designs – Concept of Bias – Information Bias and Selection Bias.

Module:5	Bioassays	6 hours

Biological Assays: Introduction – Direct & Indirect Assays – Parallel-Line Assay – Slope-Ratio Assay – Quantile-Response Assay – Dose-Response Relationships – Qualitative and Quantitative Responses – Estimation of Median Effective Dose.

Module:6	Survival Analysis	6 hours

Basics of Survival Analysis – Survival, Hazard and Cumulative hazard Functions- Concept of Censorship – Different Types of Censoring –-Survival Data – Comparison of Survival Curves – Kaplan-Meier's Method- Log-Rank Test – Life Table-Construction of a Life Table – Modified Life Table.

Module:7	Semi-Parametric Regression Model	6 hours

Cox Proportional Hazards Model and Its Characteristics – Evaluating the Proportional Hazards Assumption: Graphical Approach (Goodness of fit)- Time dependent analysis-Assessing survival curves between groups (KM Approach) – Stratified Cox Procedure - Extended Cox Proportional Hazards Model for Time-Dependent Variables.

Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours	**45 hours**

Text Book(s)	
1.	W.W. Daniel and C.L. Cross, “Bio-Statistics: A Foundation for Analysis in the Health Sciences”, 2018, 11th Edition, John Wiley & Sons, USA.
2.	W.J. Krzanowski and D.J. Hand, “ROC Curves for Continuous Data”, 2009, CRC Press, New York.
Reference Books	
1.	E.T. Lee and J.W. Wang, “Statistical Methods for Survival Data Analysis”, 2013, 4th Edition, Wiley, USA.
2.	J.P. Klein and M.L. Moeschberger, “Survival Analysis: Techniques for Censored and Truncated Data”, 2003, 2nd Edition, Springer, New York.
3.	N.P. Jewell, “Statistics for Epidemiology”, 2004, CRC Press, New York.
4	David G. Kleinbaum and Mitchel Klein, “Survival Analysis: a self-learning text”,2012, Third Edition, Springer.

Mode of Evaluation: CAT, Assignment, Quiz and FAT			
Recommended by Board of Studies	15-02-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
PMBS605L	Social Network Analysis	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

This course equips students with the knowledge and skills:

1. To provide a comprehensive introduction to Social Network Analysis (SNA), covering fundamental concepts, ethical considerations, and practical applications.
2. To pre-process and manage network data efficiently using Python, conduct advanced mining and analysis, and integrate statistical methods for robust insights.
3. To design impactful network visualizations and exploring SNA applications in business contexts. through real-world case studies and exposure to cutting-edge trends,
4. To develop the skills to solve crucial business problems using data-driven approaches.

Course Outcomes

At the end of the course the student should be able to:

1. Identify and explain major SNA theories and their applicability to business scenarios.
2. Demonstrate proficiency in importing, cleaning, and transforming and analysing network data.
3. Create graph representations of social networks and utilize them for different tasks and use techniques to extract deeper insights from network data.
4. Conduct hypothesis testing on network data using statistical methods (MDS, QAP) and interpret the results in the context of business problems.
5. Design effective network visualizations tailored for business audiences utilizing interactive tools and its ethical considerations.

Module:1	Introduction to Social Network Analysis	5 hours

Overview of major SNA theories like social capital - homophily and network effects - Types of Social Networks: Explore business - oriented networks (collaboration, communication, supply chains) - Network Components and Measures: Understand nodes - edges – attributes – communities - and key network metrics (degree, centrality).

Module:2	Data Pre-processing and Management for Social Networks	7 hours

Techniques for importing data from various sources (CSV, Excel, APIs) using Python - Network Data Transformation: Normalize, create new attributes and manipulate data with Pandas and NetworkX - Matching and Converting Attributes: Match attributes across datasets and convert to matrices using Python libraries – Node - based Metrics and Ranking: Calculate centrality measures (degree, closeness, betweenness) and ranking algorithms - Advanced Network Mining Techniques: Introduction to more advanced mining techniques (link prediction, network embedding).

Module:3	Social Networks as Graphs	7 hours

Introduction to graph theory concepts using NetworkX - Random Graph Models: Explore Erdös-Rényi - power law, preferential attachment models using NetworkX generators - Network Mining Fundamentals: Analyze real-world business networks with NetworkX (e.g., identifying influential nodes, communities) - Potential Biases: Identify and address potential biases in social network data (sampling, measurement).

Module:4	Community Detection and Analysis	7 hours

Identify and analyze communities within networks using NetworkX algorithms (Louvain, Leiden) -

Advanced Network Mining Techniques: Introduction to link prediction and network embedding with Python libraries - Network Dynamics: Analyze network evolution and dynamics over time using dynamic network analysis techniques.		
Module:5	**Statistical Methods for SNA**	**6 hours**
Apply multidimensional scaling (MDS) - QAP and other statistical tests using scikit-learn - Hypothesis Testing with Network Data: Formulate and test hypotheses about network structures using statistical methods - Network Measures as Variables: Use network measures as independent and dependent variables in research related to business problems.		
Module:6	**Network Visualization**	**6 hours**
Explore node-edge diagrams - matrix representations and hybrid approaches with Matplotlib and NetworkX-Visualizing Business Networks: Effectively communicate network insights through visualizations tailored for business audiences - Interactive Visualization Tools: Utilize interactive Python libraries (Gephi, Plotly) for dynamic exploration of network data and other tools.		
Module:7	**Applications and Ethical Considerations**	**5 hours**
Explore applications in marketing – finance - human resources and other business domains - Case Studies and Real-world Examples: Analyze real-world business case studies demonstrating SNA applications - Ethical Considerations in SNA: Discuss privacy - bias and responsible use of social network data in business contexts - Future Directions and Emerging Trends: Explore cutting-edge developments and future directions in SNA relevant to business.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours	**45 hours**

Text Book(s)	
1.	Stephen P Borgatti, Martin G. Everett, Jeffrey C. Johnson, “Analyzing Social Networks”, 2018, Second Edition, SAGE.
2.	Ioannis Pitas, “Graph-Based Social Media Analysis”, 2015, First Edition, Chapman & Hall/CRC.
Reference Books	
1.	Garry L. Robins, “Doing Social Network Research: Network-based Research Design for Social Scientists”, 2015, First Edition, SAGE.
2.	Peter Mika, “Social Networks and the Semantic Web”, 2007, First Edition, Springer.
3.	Borko Furht, “Handbook of Social Network Technologies and Applications”, 2010, First Edition, Springer.
4.	Mohammad Gouse Galety, Chiai Al Atroshi, Bunil Kumar Balabantaray, Sachi Nandan Mohanty, “Social Network Analysis: Theory and Applications”, 2022, First Edition, Wiley.
5.	Magnus Lie Hetland, “Python Algorithms: Mastering Basic Algorithms in the Python Language”, 2014, Second Edition, Apress.

Mode of Evaluation: CAT, Written Assignment, Quiz and FAT			
Recommended by Board of Studies	15-02-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
PMBS606L	Statistical Quality Control	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

This course equips students with the knowledge and skills:

1. To Understand and analyse how to apply different advanced control charts for industrial applications.
2. To get a knowledge to apply performance methodologies for various applications.
3. They are able to construct different sampling plans using OC function and AOQL functions.
4. To link and analyse the various sampling schemes to find the plan for quality inspection.

Course Outcomes

On the successful completion of the course, student will be able to:

1. Understand the fundamental advantages and apply essential of Control charts.
2. Apply appropriate Charts for the industrial experiments.
3. Apply some standard distributions for construction of sampling plans.
4. Able to construct the AOQL plans for normal inspection scheme.
5. Learn and apply six sigma methodology for Industrial applications.

Module:1	Statistical Process Control	7 hours

Quality control-Control charts for mean and range- control charts for fractional defectives and number of defectives – control charts for number of defects per unit- CUMSUM chart with V-Mask – Weighted moving average charts- Exponentially weighted moving average charts.

Module:2	Process Capability Analysis	5 hours

Process Capability analysis: Meaning - Estimation technique for capability of a process Capability Indices: Process capability ratios - Cp; Cpk, Cpm, Cmk, Cpc: Process capability analysis using a control chart - Process capability analysis using design of experiments.

Module:3	Acceptance Sampling Plans	5 hours

Acceptance sampling terminologies attribute sampling plan by attributes - Single sampling plan and Double sampling plan - OC, ASN, AOQ, AOQL and ATI curves MILSTD -105E Tables.

Module:4	Variable Sampling Plans	6 hours

Acceptance sampling variables for process parameter - Sequential and cluster Sampling Methods - Sampling variables for proportion non-conforming method - K method.

Module:5	Double Sampling Plans	6 hours

Double specification limits - M-method, Double sampling by variables - MILSTD-414 Tables Continuous Sampling plan- CSP-1, CSP-2, CSP-3, Wald and Wolfowitz SP-A.

Module:6	Attribute Sampling Plans	7 hours

Producers risk - Consumers Risk - designing single sampling plan for stipulated Producers and consumers risk - OC curves under Normal - Tightened and reduces inspection – Single - Double and Multiple sampling plans in AQL systems.

Module:7	Six Sigma Methodologies	7 hours

Concept of six sigma - methods of six sigma - DMAIC methodology - DFSS methodology - six sigma control chart – Gauge R and R analysis.

Module:8	Contemporary Issues	2 hours
	Total Lecture hours	45 hours

Text Book(s)

1.	Eugene L. Grant Richard S. Leavenworth, “Statistical Quality Control”, 2017, 7 edition, McGraw Hill Education.		
2.	Douglas C. Montgomery, “Introduction to Statistical Quality Control”, 2013, Seventh Edition, John Wiley and Sons, New York.		
Reference Books			
1.	Edward G. Schilling, Dean V. Neubauer, “Acceptance Sampling in Quality Control”, 2017, Second Edition, Taylor & Francis.		
2.	Poornima M. Charantimath, “Total quality Management”, 2017, 3rd Edition, Pearson India Limited.		
Mode of Evaluation: CAT, Assignment, Quiz and FAT			
Recommended by Board of Studies	15-02-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
PMDS601L	ARTIFICIAL INTELLIGENCE	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To sketch an overview of artificial intelligence (AI) principles and approaches.
2. To develop a basic understanding of the building blocks of AI as presented in terms of intelligent agents: Search, Knowledge representation, inference, logic, and learning.
3. To demonstrate the applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.

Course Outcome

At the end of the course, the students will be able to:

1. Gain knowledge of artificial intelligence principles and its foundations, representation and learning.
2. Illustrate the construction of learning and expert system.
3. Formalize a given problem in the language/framework of different AI methods.
4. Apply different search techniques for solving real world complex problems and select the most appropriate solution by comparative evaluation.
5. Attain the capability to represent various real life problem domains using logic-based techniques and use this to perform inference or planning.

Module:1	Introduction to AI	2 hours

Philosophy of artificial intelligence, Definitions - Evolution of AI - Applications of AI, Classification of AI- Intelligent Agents: Agents and Environment-Nature of Environment-Structure Environment

Module:2	Intelligent Agents	4 hours

Rational Agents, Mapping from Sequences to Actions, Properties of Environments, Structure of Intelligent Agents, Types of Agents: Simple Reflex Agents, Goal Based Agents, Utility Based Agents

Module:3	Searching Strategies	8 hours

Problem Solving Agent - Blind Search- Performance measures - Informed Search: Introduction to Heuristics-Variants of heuristic search-uniform cost, A*, Greedy - Overview of Hill Climbing – Simulated Annealing – Genetic Algorithms – Adversarial Search – Minimax, Alpha beta pruning - Constraint Satisfaction Problem.

Module:4	Knowledge Representation and Reasoning	8 hours

Logical Agents-Knowledge-Based Agents- The Wumpus World- Logic- Propositional Logic-Propositional Theorem Proving- First Order Logic- Syntax and Semantics of First-Order Logic, using First order logic, Knowledge Engineering in First-Order Logic. Inference in First Order Logic- Unification and Lifting, Propositional vs. First order logic-Forward Chaining, Backward chaining, resolution.

Module:5	**Uncertainty and Knowledge Reasoning**	**7 hours**
Probabilistic Reasoning - Representing Knowledge in an Uncertain Domain, The Semantics of Bayesian Networks, Efficient Representation of Conditional Distributions, Relational and First-Order Probability Models.		
Module:6	**Design of Expert System**	**9 hours**
Introduction to Expert system, Basic concepts, Structure of expert systems, the human element in expert systems, How expert systems works, Problem areas addressed by expert systems, Expert systems success factors, Types of expert systems, Expert systems and the internet interacts web.		
Module:7	**Applications of Artificial Intelligence**	**5 hours**
AI in Business - Health care – Robotics - Social media - Defence – Cyber security.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours	**45 hours**

Text Book(s)	
1	Elaine Rich, Kevin Knight, Artificial Intelligence, 2019, 3/Edition, Tata McGraw Hill.
2	Deepak Khemani, A First Course in Artificial Intelligence, 2017, 1/Edition, Tata McGraw Hill Education.
Reference Book (s)	
1	Stuart Russel and Peter Norvig, Artificial Intelligence, 2016, 3rd Edition, Pearson.
2	N.P. Padhy, Artificial Intelligence and Intelligent Systems, 2005, Oxford University Press.
3	Ivan Bratko, PROLOG Programming, 2020, 4th Edition, Pearson Education.

Mode of Evaluation: CAT, Assignment, Quiz and FAT			
Recommended by Board of Studies	15-02-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course code	Course Title	L	T	P	C
PMDS601P	ARTIFICIAL INTELLIGENCE LAB	0	0	2	1
Pre-requisite	NIL	Syllabus Version			
		1.0			

Course Objectives

1. Understand the implementation procedures for the machine learning algorithms using Matlab /R/Python, Weka (Machine Learning software in JAVA).
2. Understand modern notions in data analysis-oriented computing and conduct experiments to design a component or a product applying all the relevant standards with realistic constraints.

Course Outcomes

At the end of the course, the students will be able to:

1. Apply appropriate data sets to the Machine Learning algorithms.
2. Identify and apply Machine Learning algorithms to solve real world problems.

List of Challenging Experiments

1	Facts, objects, predicates and variables in PROLOG.
2	Rules and Unification in PROLOG.
3	Arithmetic operators, simple input/output and compound goals in PROLOG.
4	Recursion in PROLOG.
5	Lists in PROLOG.
6	String operations in PROLOG. Implement string operations like substring, string position, palindrome etc.
7	Write a prolog program to implement all set operations (Union, intersection, complement etc in PROLOG.
8	Solving Missionaries and cannibals problems and Water Jug Problem, 8-Queens Problem, Travelling Salesman Problem
9	Wampus Problem using Logic, Monkeys and Bananas Problem using Logic.
10	Development of Medical Expert system with a Recommendation system
	Total Laboratory hours **30 hours**

Text Book(s)

1	Daume, H., A Course in Machine Learning, 2015, Alanna Maldonado.
2	Elaine Rich and Kevin Knight, Artificial Intelligence, 2019, 3rd Edition, Tata McGraw Hill.

Reference Book(s)

1	Christopher Bishop, Pattern Recognition and Machine Learning, 2013, Springer.
2	Balas K Natarajan, Machine Learning, 2014, Elsevier Science.
3	Tom Mitchell, Machine Learning, 2010, McGraw-Hill Education.

Mode of assessment	Digital Assignment and FAT		
Recommended by Board of Studies	15.02.2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
PMDS603L	DEEP LEARNING	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To introduce the fundamentals of neural networks and types of neural networks.
2. To introduce Recurrent Neural Networks, Convolutional Neural Networks and its variants.
3. To develop and train deep neural networks.
4. To introduce complex learning models and deep learning models.
5. To introduce the internal structure of LSTM and GRU and the differences between them.

Course Outcomes

On completion of the course, students will be able to

1.Understand the fundamentals of deep learning and build deep learning models.
2. Apply the most appropriate deep learning method in any given situation.
3. Analyse neural network models in data-intensive real-time problems.
4. Create efficient generative models.
5. Learn and apply convolutional and recurrent neural network techniques.

Module:1	Neural Networks	7 hours

Introduction to neural networks, biological neuron, Idea of Computational Units, McCulloch-Pitts Unit and Thresholding Logic, Linear Perceptron, Perceptron Learning Algorithm, Convergence theorem for Perceptron Learning Algorithm, Linear separability, feed-forward network, input, hidden and output layers, organization and architecture of neural networks, linear and nonlinear networks.

Module:2	Training Algorithms for Feed Forward Networks	7 hours

Cost functions, Back-propagation algorithms, Learning the weights, gradient descent algorithm, Unit saturation, heuristics to avoid local optima, accelerated algorithms, Multilayer Perceptron, Empirical Risk Minimization, regularization methods.

Module:3	Convolutional Neural Networks	6 hours

Architectures, Properties of CNN representations: invertibility, stability, invariance, convolution, pooling of layers, CNN and Tensor Flow, Difficulty of training deep neural networks, Greedy layer-wise training, LeNet and AlexNet Architectures.

Module:4	Optimization Methods for Neural Networks	6 hours

Adagrad, Adadelta, RMS Prop, ADAM, NAG, Second order methods for training, Saddle point problem in Neural Networks, Dropout, Drop Connect, Batch Normalization.

Module:5	Recurrent Neural Networks	6 hours

RNN, LSTM, GRU, Encoder-Decoder Architectures, Auto encoders, Variational autoencoders, Bidirectional LSTMs, Bidirectional RNNs.

Module:6	Deep Generative Learning Models	8 hours

Dynamic Memory Models, Reinforcement learning, Restrictive Boltzmann Machines

(RBMs), Introduction to MCMC and Gibbs Sampling, gradient computation in RBMs, Deep Boltzmann Machine, Deep Belief Networks, Generative adversarial networks.		
Module:7	**Advanced Deep Neural Networks**	**3 hours**
Variational autoencoders, multitask deep learning, multi-view deep learning.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours	**45 hours**

Text Book(s)	
1	Bengio, Yoshua, Ian Goodfellow and Aaron Courville, Deep Learning, 2016, MIT Press.
2	Aston Zhang, Zachary C. Lipton, Mu Li and Alexander J. Smola, Dive into Deep Learning, December 2023, 1st Edition, Cambridge University Press.
Reference Book(s)	
1	Raúl Rojas, Neural Networks: A Systematic Introduction, 1996, 2nd Edition, Springer.
2	Nikhil Buduma and Nikhil Lacascio, Fundamentals of Deep Learning, 2017, O'Reilly Publishers.

Mode of Evaluation: CAT, Assignment, Quiz and FAT			
Recommended by Board of Studies	15-02-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course code	Course Title	L	T	P	C
PMDS603P	DEEP LEARNING LAB	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To enable the students for having experimental knowledge of implementing neural network algorithms using python programming.
2. To make students capable to do classification of images using deep learning algorithms.
3. To enable the students to implement various deep learning networks like Adaline, Madalin.

Course Outcomes

At the end of the course the student should be able to:

1. Do Feature Extraction from Image and Video Data
2. Implement Image segmentation and Instance segmentation in Images.
3. Implement image recognition and image classification using a pretrained network.
4. Implement Analysis on Traffic Information Dataset
5. Do classification and feature extraction using autoencoders.

Indicative Experiments

1	Implementation of different activation functions to train Neural Network.
2	Implementation of different Learning Rules.
3	Implementation of Perceptron Algorithm.
4	Implementation of various neural networks.
5	Implementation of Optimization Methods for Neural Networks
6	Implementation of Image recognition and Image classification using a pretrained network.
7	Implementation of autoencoders.
	Total Laboratory Hours **30 hours**

Text Book (s)

1	Josh Patterson and Adam Gibson, Deep Learning: A Practitioner's Approach, 2017, O'Reilly Media.
2	Vinita Silaparasetty, Deep Learning Projects using Tensor Flow 2, 2018, Apress.

Reference Book (s)

1	Francois Chollet, Deep Learning with Python, 2017, Manning Press.
2	Jojo Mollayil, Learn Keras for Deep Neural Networks, 2018, Apress.

Mode of Evaluation: Assignment and FAT.

Recommended by Board of Studies	15-02-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
PMDS606L	Natural Language Processing	3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

1. To introduce the fundamental concepts and techniques of Natural language Processing for analyzing words based on Morphology and CORPUS.
2. To examine the NLP models and interpret algorithms for classification of NLP sentences by using both the traditional, symbolic and the more recent statistical approach.
3. To get acquainted with the algorithmic description of the main language levels that includes morphology, syntax, semantics, and pragmatics for information retrieval and machine translation applications.

Course Outcomes

At the end of the course, the students will be able to:

1. Understand the fundamental concepts of natural language processing.
2. Understand the text pre-processing and corpora.
3. Analyze the words and perform POS tagging.
4. Distinguish between the syntactic and semantic correctness of the natural language.
5. Develop simple language models using NLTK.

Module:1	Introduction to NLP	5 hours

Introduction to various levels (stages) of natural language processing, Ambiguities, varieties and computational challenges in processing natural languages. Introduction to Real life applications of NLP such as spell and grammar checkers, information extraction, information retrieval, question answering, and machine translation.

Module:2	Text processing	6 hours

Text pre-processing, challenges, tokenization, sentence segmentation, regular expressions, words, text normalization, minimum edit distance, introduction to corpora, corpora analysis.

Module:3	Language modelling	6 hours

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

Module:4	Morphological analysis and POS tagging	7 hours

Parts of speech and morphology, Inflectional and Derivation Morphology, Morphological Analysis, FSA and Generation using finite state transducers. Introduction to POS tagging, HMM, Viterbi decoding for HMM.

Module:5	Syntactic analysis	6 hours

Ambiguities in syntactic parsing, context free grammar, CYK parsing, shallow parsing and chunking, dependency parsing, statistical parsing and PCFG

Module:6	Semantic analysis	7 hours

Semantics, Lexical Semantics, Word senses, Relations between senses, Word Sense Disambiguation, Word similarity, WordNet, Thesaurus based word similarity, Thematic

Roles, Semantic Role Labelling with CRFs.		
Module:7	**NLTK with Python**	**6 hours**
Tokenizing Text and WordNet Basics- Replacing and Correcting Words- Part-of Speech Tagging- Extracting Chunks- Text Classification – Named Entity Recognition.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours	**45 hours**

Text Book(s)	
1	Daniel Jurafsky and James H. Martin, Speech and Language Processing, 2017, 3rd edition, Prentice Hall.
2	Chris Manning and Hinrich Schütze, Foundations of Statistical Natural Language Processing, 2016, MIT Press.
Reference Book(s)	
1	James Allen “Natural Language Understanding, 2012, 8th Edition, Pearson Publication.
2	Vajjala, Sowmya, Bodhisattwa Majumder, Anuj Gupta and Harshit Surana. Practical natural language processing: A comprehensive guide to building real-world NLP systems, 2020, O'Reilly Media.

Mode of Evaluation: CAT, Assignment, Quiz and FAT			
Recommended by Board of Studies	15-02-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course code	Course Title	L	T	P	C
PMDS610L	FINANCIAL ANALYTICS	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To learn to model financial time series using linear ARMA type time series.
2. To study and analyze to test and model heteroscedastic effects using ARCH /GARCH type time series.
3. To learn how to test for unit root and construct ARMA models.

Course Outcomes

At the end of the course, the student will be able to:

1. Understand the deep knowledge of financial data and properties
2. Understand and apply the financial time series analysis
3. Apply and Analyse the Volatility models to financial data.
4. Perform cross-validation of various financial models developed.
5. Forecast future observations on financial data.

Module:1	**Financial data and their properties**	**5 hours**
Asset Returns – Bond Yields and Prices – Implied Volatility – Examples and Visualization offinancial data – Multivariate returns.		
Module:2	**Linear models for financial time series**	**5 hours**
Simple autoregressive models – Simple moving average models – Simple ARMA models – Unit Root non-stationarity – Exponential smoothing.		
Module:3	**Seasonal and Long memory models**	**4 hours**
Seasonal models – Regression models with time series errors – Long memory models.		
Module:4	**Asset Volatility and Volatility models**	**4 hours**
Characteristics of Volatility – Structure of a model – Testing for ARCH Effect – ARCH Model– GARCH Model – GARCH-M Model – Exponential GARCH Model – Threshold GARCHmodel – Stochastic volatility model – alternative approaches.		
Module:5	**Applications of Volatility Models**	**4 hours**
GARCH Volatility Term structure – Option pricing and hedging – Time-Varying Correlationsand Betas – Minimum Variance Portfolios – Prediction.		
Module:6	**High-Frequency Financial Data**	**3 hours**
Nonsynchronous trading – Bid-ask spread of trading prices – Empirical characteristics oftrading data – Models for price changes.		
Module:7	**Value at Risk**	**3 hours**
Risk measure and Coherence – Risk metrics –Extreme value approach to Value at Risk –Peak over thresholds.		
Module:8	**Contemporary Issues**	**2 hours**

	Total Lecture hours		**30 hours**
Text Book(s)			
1	Sinem Derindere Köseoğlu, Financial Data Analytics Theory and Application, 2022, Springer.		
Reference Book(s)			
1	Statistical Analysis of Financial Data in S Plus, by R Carmona, April 2004, Springer.		
2	Ruey S. Tsay, An Introduction to Analysis of Financial Data with R, 2013, Wiley.		
3	Ruey S. Tsay, Analysis of Financial Time Series, 2010, 3rd edition, Wiley.		
Mode of Evaluation: CAT, Assignment, Quiz and FAT			
Recommended by Board of Studies	15-02-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course code	Course Title	L	T	P	C
PMDS610P	Financial Analytics Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To enable the students for having experimental knowledge of basic concepts of financial analytics.
2. To make students capable of using important models for analyzing financial data.
3. To enable students learn about different time series model.

Course Outcomes

At the end of the course the student should be able to:

1. Utilize important models to analyse market data.
2. Utilize time series models for forecasting.
3. Utilize models to predict volatility.
4. Measure risk assessment.

Indicative Experiments

1	Calculation of Bond values, Bond yields
2	Visualization of financial data- charts, graphs, maps, info-graphics, diagrams and virtual dashboards
3	Executing Moving Average Models (MA models): 1st and 2nd order
4	Executing ARMA model for weakly stationary stochastic time series
5	Single Exponential Smoothing, Double Exponential Smoothing
6	Regression Models with Time Series Errors- regression model with ARIMA errors
7	Engle's ARCH Test- to assess the significance of ARCH effects
8	GARCH model, GARCH M model- to predict the volatility of returns on financial assets
9	Minimum Variance Portfolio
10	Coherent risk measure- Back-testing, POT approach
	Total Lecture Hours **30 Hours**

Text Book (s)

1	Mark J. Bennett & Dirk L. Hugen, Financial Analytics with R, 2016, Cambridge University Press.
2	Yves Hilpisch, Python for Finance- Mastering Data-Driven Finance, 2019, O'Reilly Media.

Reference Book(s)

1	R Carmona, Statistical Analysis of Financial Data in S Plus, April 2004, Springer.
2	Ruey S. Tsay An Introduction to Analysis of Financial Data with R, 2013, Wiley.

Mode of assessment: Assignment and FAT

Recommended by Board of Studies	15-02-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Skill Enhancement

Course Code	Course Title	L	T	P	C
PENG501P	Technical Report Writing	0	0	4	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To develop writing skills for preparing technical reports
2. To analyze and evaluate general and complex technical information
3. To enable proficiency in drafting and presenting reports

Course Outcomes

At the end of the course, the student will be able to

1. Construct error free sentences using appropriate grammar, vocabulary and style
2. Apply the advanced rules of grammar for proofreading reports
3. Interpret information and concepts in preparing reports
4. Demonstrate the structure and function of technical reports
5. Improve the ability of presenting technical reports

Indicative Experiments

1.	**Basics of Technical Communication** General and Technical communication, Process of communication, Levels of communication
2.	**Vocabulary& Editing** Word usage: confusing words, Phrasal verbs Punctuation and Proof reading
3.	**Advanced Grammar** Shifts: Voice, Tense, Person, Number Clarity: Pronoun reference, Misplace and unclear modifiers
4.	**Elements of Technical writing** Developing paragraphs, Eliminating unnecessary words, Avoiding clichés and slang Sentence clarity and combining
5.	**The Art of condensation** Steps to effective precis writing, Paraphrasing and summarizing
6.	**Technical Reports:** Meaning, Objectives, Characteristics and Categories
7.	**Formats of reports and Prewriting**: purpose, audience, sources of information, organizing the material
8.	**Data Visualization** Interpreting Data Graphs - Tables – Charts - Imagery - Info graphics
9.	**Systematization of Information:** Preparing Questionnaire Techniques to Converge Objective-Oriented data in Diverse Technical Reports
10.	**Research and Analyses:** Reference styles, Synchronize Technical Details from Magazines, Articles and e-content

11..	**Structure of Reports**
	Title – Preface – Acknowledgement - Abstract/Summary – Introduction - Materials and Methods – Results – Discussion - Conclusion - Suggestions/Recommendations
12.	**Writing the Report:** First draft, Revising, Thesis statement, Developing unity and coherence
13.	**Writing scientific abstracts:** Parts of the abstract, Revising the abstract Avoiding Plagiarism, Best practices for writers
14.	**Supplementary Texts** Appendix – Index – Glossary – References – Bibliography - Notes
15	**Presentation** Presenting Technical Reports Planning, creating and digital presentation of reports
	Total Laboratory hours : 60 hours
Text Book(s)	
1.	Raman, Meenakshi and Sangeeta Sharma, (2015).Technical Communication: Principles and Practice, Third edition, Oxford University Press, New Delhi.
Reference Books	
1.	Aruna, Koneru, (2020). English Language Skills for Engineers. McGraw Hill Education, Noida.
2.	Rizvi,M. Ashraf (2018)Effective Technical Communication Second Edition. McGraw Hill Education, Chennai.
3.	Kumar, Sanjay and Pushpalatha, (2018). English Language and Communication Skills for Engineers, Oxford University Press.
4.	Elizabeth Tebeaux and Sam Dragga, (2020).The Essentials of Technical Communication, Fifth Edition, Oxford University Press.

Mode of Evaluation : Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test			
Recommended by Board of Studies	19-05-2022		
Approved by Academic Council	No. 70	Date	24-06-2023

Course Code	Course Title	L	T	P	C
PSTS501P	Qualitative Skills Practice	0	0	3	1.5
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To develop the quantitative ability for solving basic level problems.
2. To improve the verbal and professional communication skills.

Course Outcomes:

At the end of the course, the student will be able to

1. Execute appropriate analytical skills
2. Solve problems pertaining to quantitative and reasoning ability
3. Learn better vocabulary for workplace communication
4. Demonstrate appropriate behavior in an organized environment

Module:1	**Business Etiquette: Social and Cultural Etiquette; Writing Company Blogs; Internal Communications and Planning: Writing press release and meeting notes**	**9 hours**

Value, Manners- Netiquette, Customs, Language, Tradition, Building a blog, Developing brand message, FAQs', Assessing Competition, Open and objective Communication, Two way dialogue, Understanding the audience, Identifying, Gathering Information,. Analysis, Determining, Selecting plan, Progress check, Types of planning, Write a short, catchy headline, Get to the Point –summarize your subject in the first paragraph., Body– Make it relevant to your audience.

Module: 2	**Time Management Skills**	**3 hours**

Prioritization, Procrastination, Scheduling, Multitasking, Monitoring, Working under pressure and adhering to deadlines

Module:3	**Presentation skills – Preparing presentation; Organizing materials; Maintaining and preparing visual aids; Dealing with questions**	**7 hours**

10 Tips to prepare PowerPoint presentation, Outlining the content, Passing the Elevator Test, Blue sky thinking, Introduction , body and conclusion, Use of Font, Use of Color, Strategic presentation, Importance and types of visual aids, Animation to captivate your audience, Design of posters, Setting out the ground rules, Dealing with interruptions, Staying in control of the questions, Handling difficult questions

Module:4	**QuantitativeAbility-L1–Number properties; Averages; Progressions; Percentages; Ratios**	**11 hours**

Number of factors, Factorials, Remainder Theorem, Unit digit position, Tens digit position, Averages, Weighted Average, Arithmetic Progression, Geometric Progression, Harmonic Progression, Increase & Decrease or successive increase, Types of ratios and proportions

Module: 5	**Reasoning Ability – L1 – Analytical Reasoning**	**8 hours**

Data Arrangement (Linear and circular & Cross Variable Relationship), Blood Relations, Ordering / ranking / grouping, Puzzle test, Selection Decision table		
Module: 6	**Verbal Ability – L1 – Vocabulary Building**	**7 hours**
Synonyms & Antonyms, One word substitutes, Word Pairs, Spellings, Idioms, Sentence completion, Analogies		
	Total Lecture hours:	**45 hours**

Reference Books

1	Kerry Patterson, Joseph Grenny, Ron Mcmillan and Al Switzler, (2017), 2nd Edition, Crucial conversatins: Tools for Talking when stakesare High McGraw-Hill contemporary, Bangalore.
2.	Dale Carnegie,(2016).How to Win Friends and Influence People. Gallery Books, New York.
3.	Scott Peck. M, (2003). Road Less Travelled. Bantam Press, New York City.
4.	SMART, (2018). Place Mentor, 1st edition. Oxford University Press, Chennai.
5.	FACE, (2016). Aptipedia Aptitude Encyclopedia. Wiley publications, Delhi.
6.	ETHNUS, (2013). Aptimithra. McGraw – Hill Education Pvt .Ltd, Bangalore.

Websites:

1.	www.chalkstreet.com
2.	www.skillsyouneed.com
3.	www.mindtools.com
4.	www.thebalance.com
5.	www.eguru.ooo

Mode of Evaluation: Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test

Recommended by Board of Studies	19-05-2022		
Approved by Academic Council	No.70	Date	24-06-2023

Course Code	Course Title	L	T	P	C
PSTS502P	Quantitative Skill Practice	0	0	3	1.5
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To develop the students' advanced problem solving skills
2. To enhance critical thinking and innovative skills

Course Outcomes:

At the end of the course, the student will be able to

1. Create positive impression during official conversations and interviews
2. Demonstrate comprehending skills of various texts
3. Improve advanced level thinking ability in general aptitude
4. Develop emotional stability to tackle difficult circumstances

Module:1	**Resume skills – Resume Template; Use of power verbs; Types of resume; Customizing resume**	**2 hours**

Structure of a standard resume, Content, color, font, Introduction to Power verbs and Write-up, Quiz on types of resume, Frequent mistakes in customizing resume, Layout-Understanding different company's requirement, Digitizing career portfolio

Module: 2	**Interview skills – Types of Interview; Use of power verbs; Types of resume; Customizing resume**	**3 hours**

Structured and unstructured interview orientation, Closed questions and hypothetical questions, Interviewers' perspective, Questions to ask/not ask during an interview, Video interview¸ Recorded feedback, Phone interview preparation, Tips to customize preparation for personal interview, Practice rounds

Module:3	**Emotional Intelligence - L1 – Transactional Analysis; Brain storming; Psychometric Analysis; SWOT analysis**	**12 hours**

Introduction, Contracting, ego states, Life positions, Individual Brainstorming, Group Brainstorming, Stepladder Technique, Brain writing, Crawford's Slip writing approach, Reverse brainstorming, Star bursting, Charlette procedure ,Round robin brainstorming, Skill Test, Personality Test, More than one answer, Unique ways, SWOT analysis

Module:4	**Quantitative Ability - L3–Permutation - Combinations; Probability; Geometry and menstruation; Trigonometry; Logarithms; Functions; Quadratic Equations; Set Theory**	**14 hours**

Counting, Grouping, Linear Arrangement, Circular Arrangements, Conditional Probability, Independent and Dependent Events, Properties of Polygon, 2D & 3D Figures, Area & Volumes, Heights and distances, Simple trigonometric functions, Introduction to logarithms, Basic rules of logarithms, Introduction to functions, Basic rules of functions, Understanding Quadratic Equations, Rules & probabilities of Quadratic Equations, Basic concepts of Venn Diagram

Module:5	**Reasoning ability - L3 – Logical reasoning; Data Analysis and Interpretation**	**7 hours**
Syllogisms, Binary logic, Sequential output tracing, Crypto arithmetic, Data Sufficiency, Data interpretation-Advanced, Interpretation tables, pie charts & bar chats		
Module:6	**Verbal Ability - L3 – Comprehension and Critical reasoning**	**7 hours**
Reading comprehension, Para Jumbles, Critical Reasoning (a) Premise and Conclusion,(b) Assumption & Inference, (c) Strengthening & Weakening an Argument		
	Total Lecture hours:	**45 hours**

Reference Books

1.	Michael Farra and JIST Editors,(2011).Quick Resume & Cover Letter Book: Write and Use an Effective Resume in Just One Day. Jist Works, Saint Paul, Minnesota.
2.	Flage Daniel E, (2003).The Art of Questioning: An Introduction to Critical Thinking. Pearson, London.
3.	David Allen, (2015).Getting Things done: The Art of Stress-Free productivity. Penguin Books, New York City.
4.	SMART, (2018). Place Mentor 1st edition. Oxford University Press, Chennai.
5.	FACE, (2016).Aptipedia Aptitude Encyclopedia. Wileypublications, Delhi.
6.	ETHNUS, (2013).Aptimithra. McGraw-Hill Education Pvt Ltd, Bangalore.

Websites:

1.	www.chalkstreet.com
2.	www.skillsyouneed.com
3.	www.mindtools.com
4.	www.thebalance.com
5.	www.eguru.ooo

Mode of Evaluation: Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test

Recommended by Board of Studies	19-05-2022		
Approved by Academic Council	No.70	Date	24-06-2023