Amritanagar, Coimbatore – 641 112, Tamil Nadu, India

M.Sc., APPLIED STATISTICS AND DATA ANALYTICS

Curriculum and Syllabus

(Academic Year 2026– 2027 onwards)

M.Sc., APPLIED STATISTICS AND DATA ANALYTICS
(Academic Year 2026 – 2027 onwards)

Program Outcomes

PO1 **Knowledge in Statistics and Data Analytics:** Understand the basic concepts, fundamental principles and the scientific theories related to Statistics and Data Analytics.

PO2 **Abstract thinking**: Ability to absorb and understand the abstract concepts that lead to various advanced theories in mathematics and Statistics.

PO3 **Modelling and solving**: Ability in modelling and solving problems by identifying and employing the appropriate existing theories and methods.

PO4 **Advanced theories and methods**: Understand advanced theories and methods to design solutions for complex statistical problems in Data Science.

PO5 **Applications in Engineering and Sciences**: Understand the role of statistics and apply the same to solve the real life problems in various fields of study.

PO6 **Modern software tool usage**: Acquire the skills in handling scientific tools towards solving problems and solution analysis in Data Science.

PO7 **Environment and sustainability**: Understand the significance of preserving the environment towards sustainable development.

PO8 **Ethics**: Imbibe ethical, moral and social values in personal and social life leading to highly cultured and civilized personality. Continue to enhance the knowledge and skills in applied statistics and data analytics for constructive activities and demonstrate highest standards of professional ethics.

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

PO10 **Communication**: Develop various communication skills such as reading, listening, speaking and discussing which will help in expressing ideas and views clearly and effectively.

PO11 **Project management and Research**: Demonstrate knowledge, understand the scientific and management principles and apply these to one's own work, as a member/ leader in a team to manage projects and multidisciplinary research environments. Also use the research-based knowledge to analyse and solve advanced problems in data sciences.

PO12 **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

M.Sc., APPLIED STATISTICS AND DATA ANALYTICS

Curriculum

(effective from the academic year 2026 - 2027)

Semester I

Course code	Course	L T P	Credit
26ASD501	Data Structures and Algorithms	3 0 2	4
26ASD502	Introduction to Data Analytics with R Programming	3 0 2	4
26ASD503	Linear Algebra	3 0 2	4
26ASD504	Optimization Techniques	3 1 0	4
26ASD505	Probability Theory and Estimation	3 0 2	4
26ASD506	Python Programming	3 0 2	4
22ADM501	Glimpses of Indian Culture	2 0 1	P/F
	Total		**24**

Semester II

Course code	Course	L T P	Credit
26ASD511	Big Data Analytics	3 0 2	4
26ASD512	Database Management	3 0 2	4
26ASD513	Data Mining & Ware Housing	3 1 0	4
26ASD514	Machine Learning	3 0 2	4
26ASD515	Multivariate Statistics and Regression Analysis	3 0 2	4
26ASD516	Statistical Inference and Design of Experiments	3 0 2	4
	Amrita Value Programme	1 0 0	1
25AVP501	Mastery Over Mind	1 0 2	2
26CUL500	Integrated Amrita Meditation Technique	0 0 2	1
	Total		**28**

Semester III

Course code	Course	L T P	Credit
26ASD601	SQC and Reliability Theory	3 0 2	4
26ASD602	Deep Learning	3 0 2	4
	Elective I	3 0 0	3
	Elective II	3 0 0	3
	Elective II	3 0 0	3
	Total		**17**

Semester IV

Course code	Course	L T P	Credit
26ASD699	Dissertation		10
	Total		**10**

Total credits for the programme: 78

ELECTIVES

Course code	Course	L T P	Credit
26ASD631	Business Analytics	2 0 2	3
26ASD632	Categorical Data Analysis	2 0 2	3
26ASD633	Cloud Computing	2 0 2	3
26ASD634	Computational Biology	2 0 2	3
26ASD635	Computer Aided Drug Designing	2 0 2	3
26ASD636	Demography and Actuarial Statistics	2 0 2	3
26ASD637	Healthcare Analytics	2 0 2	3
26ASD638	Market Analytics	2 0 2	3
26ASD639	Mining of Massive Datasets	2 0 2	3
26ASD640	Official Statistics	2 0 2	3
26ASD641	Parallel and Distributed Systems	3 0 0	3
26ASD642	Pattern Recognition	3 0 0	3
26ASD643	Queuing Theory	2 0 2	3
26ASD644	Reinforcement Learning	2 0 2	3
26ASD645	Social Network Analytics	2 0 2	3
26ASD646	Software Engineering and Testing	3 0 2	4
26ASD647	Special Distribution Functions	2 0 2	3
26ASD648	Survival Analysis	2 0 2	3
26ASD649	Thinking with Data	2 0 2	3
26ASD650	Time Series	2 0 2	3
26ASD651	Natural Language Processing & Large Language Models	3 0 0	3

**Amrita Value Programme			
22ADM502	Vedanta in day-to-day life	1-0-0	1
22AVP506	Message of Swami Vivekananda	1-0-0	1
22AVP508	Indian Arts and Literature	1-0-0	1
22AVP510	Appreciation of Kerala Mural Arts Forms	1-0-0	1
22AVP501	Message of Śrī Mātā Amritanandamayi Devi	1-0-0	1
22AVP502	Insights from the Ramayana	1-0-0	1
22AVP503	Insights from the Mahabharata	1-0-0	1
22AVP504	Insights from the Upanishads	1-0-0	1
22AVP505	Insights from Bhagavad Gita	1-0-0	1
22AVP512	Ancient Indian Science and Technology	1-0-0	1
22AVP507	Great Spiritual Teachers of India	1-0-0	1
22AVP509	Yoga and Meditation 1	1-0-0	1

Evaluation Pattern:

S.No	Course Type	Theory / Lab	Mid Term marks	CA marks	End Semester marks
1	Theory / Theory with Lab courses	Theory	30	30	40
3	Lab courses (0- 0- 2- 1)	Lab	-	60	40

Semester I

26ASD501 **Data Structures and Algorithms** **3 0 2 4**

Course Outcomes	
CO1	Understand the various basic data types and trees.
CO2	Gain knowledge about standard data structures like Stack, Queue, list - array, linked list
CO3	Know the importance of priority queue - Heaps; heap-based implementations; applications of heaps - sorting; Search Tree - Binary search tree
CO4	To understand the basic concepts of time complexity and classes of time complexity.
CO5	To gain knowledge about same graph algorithms like shortest path algorithm and minimal spanning tree al

Unit – I: Abstraction - Abstract data types, Data Representation, Elementary data types, Basic concepts of data Structures, Types of Data Structures: Arrays, Structures, Union, Pointers, Storage Allocation: Static and Dynamic Allocation. Mathematical preliminaries - big-Oh notation; efficiency of algorithms; notion of time and space complexity; performance measures for data structures. ADT array - Computations on arrays. **(11Hrs)**

Unit – II: ADT Stack, Queue, list - array, linked list, cursor-based implementations of linear structures. ADT Tree - tree representation, properties traversal of trees; ADT- Binary Trees – properties and algorithms. **(10Hrs)**

Unit – III: ADT Priority Queue - Heaps; heap-based implementations; applications of heaps - sorting; Search Tree - Binary search tree; balanced binary search trees - AVL tree; Applications of Search Trees - TRIE; 2-3-4 tree; concept of B-Tree. ADT Dictionary - array based and tree based implementations; hashing - definition and application. **(12Hrs)**

Unit – IV: Sorting and Searching Algorithms: Merge Sort, Quick-Sort, Insertion Sort, Bin Sort, Bucket-Sort and Radix-Sort Selection Sort, Comparison of Sorting Algorithms. Introduction to time complexity. Bio-O, worst case complexity, polynomial classifications. Satisfiability, NP Complete and NP Hard (Definitions only). **(11Hrs)**

Unit – V: Graphs algorithms: ADT- Data structure for graphs - Graph traversal- Transitive Closure- Directed Acyclic graphs - Weighted graphs – Shortest Paths - Minimum spanning tree – Greedy Methods for MST. Travelling salesman problem. **(11Hrs)**

Text Books:

1. Goodrich M T, Tamassia R and Michael H. Goldwasser, *Data Structures and Algorithms in Python++*, Wiley Publication, 2013.
2. Tremblay J P and Sorenson P G, *An Introduction to Data Structures with Applications*, Second Edition, Tata McGraw-Hill, 2002.

References:

1. Goodrich M T and Tamassia R, *Data Structures and Algorithms in Java*, Fifth edition, Wiley Publication, 2010.
2. Mark Allen Weiss, *Data structures and algorithm analysis in C*, 2nd edition, Pearson Education, 2013.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	2	2				1	1
CO2	3	3	3	2	2	2	2				1	1
CO3	3	3	3	2	2	3	2				1	1
CO4	3	2	3	2	2	2	2				1	1
CO5	2	2	2	1	1	2	1				1	1

26ASD502 Introduction to Data Analytics with R Programming 3 0 2 4

Course Outcomes	
CO1	Understanding the fundamentals of R software
CO2	Exploring and implementing graphical visualization using R
CO3	Exploring and implementing basic Statistics using R
CO4	Understanding correlation and regression and visualising them using R
CO5	Exploring statistical inference concepts through point and interval estimation methods using R.

Unit – I: R Programming Basics: Introduction to R and R Studio - R scripts - Data types and variables - Vectors and vector indexing - Matrices and basic matrix operations - Lists and data frames – Factors - Sorting and ordering - Conditional statements (if, if-else) - Loops (for, while, repeat) - Defining functions - Vectorization and functionals. **(12Hrs)**

Unit – II: Data Handling and Visualization: Data collection and classification - sampling methods (basic concepts) - creating datasets in R - importing and exporting data (CSV/Excel) - data cleaning and preprocessing - handling missing values and merging of datasets. Bar chart - pie chart – histogram - frequency polygon - box plot - stem-and-leaf plot - 2D/3D plotting. **(12Hrs)**

Unit – III: Descriptive Statistical Analysis: Measures of central tendency - Mean, Median, Mode - Measures of dispersion Range - Mean Absolute Deviation, Quartile Deviation, Variance, and Standard Deviation - Skewness and Kurtosis for grouped and ungrouped data Generating random samples from standard distributions - Bernoulli, Poisson, Normal, Exponential**.**
(12Hrs)

Unit – IV: Curve fitting and interpolation - Fitting of straight lines and curves - Correlation, Regression, fitting of simple linear lines, polynomials and logarithmic functions - Interpolation and extrapolation methods - Binomial expansion, Newton and Gauss methods. **(12Hrs)**

Unit – V: Point estimation – Method of Moments, Maximum Likelihood Estimation. Interval estimation- Confidence interval for one mean, difference of two means, single proportion, difference of two proportions, single variance, ratio of two variances. **(12Hrs)**

Text Books:

1. Rafael A. Irizarry, *Introduction to Data Science: Data Analysis and Prediction Algorithms with R*, CRC Press, 2019.
2. *An Introduction to R, Notes on R: A Programming Environment for Data Analysis and Graphics.* W. N. Venables, D.M. Smith and the R Development Core Team. Version 3.0.1, 2013.

References:

1. Douglas C. Montgomery and George C. Runger, *Applied Statistics and Probability for Engineers*, John Wiley and Sons Inc., 2005.
2. John Hopcroft and Ravi Kannan, *Foundations of Data Science*, eBook, Publisher, 2013.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	2					3	2
CO2	3	3	3	2	2	2					3	2
CO3	3	3	3	2	2	3					3	2
CO4	3	2	3	2	2	3					3	2
CO5	2	2	2	2	3	3					3	2

26ASD503 **Linear Algebra** **3 0 2 4**

Course Outcomes	
CO1	To understand the axioms in the definition of a vector space, subspaces, basis, dimension; To learn to change the basis.
CO2	To understand and compute inner products, the length of a vector, angle and distance between vectors, orthogonal complement, projection and orthonormal basis from any arbitrary basis. To learn the least square principle.
CO3	To understand the concepts of linear transformations and matrices for linear transformations.
CO4	To understand the concepts of eigen values, eigen vectors and diagonalization.
CO5	To learn to decompose matrices using various techniques.

Unit – I: General Vector Spaces: Real Vector Spaces - Sub Spaces - Linear Independence – Coordinates and Basis – Dimension-Change of Basis. **(10Hrs)**

Unit – II: Inner Product Spaces: Inner Products – Angles, Length and Distance-Orthogonality-Orthogonal Complements – Orthogonal Projections -Orthogonal Basis- Gram Schmidt Process - Least Square Principle**. (Case Study)** **(15Hrs)**

Unit – III: Linear Transformations: General Linear Transformation – Kernel and Range of a Linear Transformation - Compositions and Inverse of Linear Transformation - Matrices of Linear Transformations – Positive Definite Matrices - Symmetric and Skew Symmetric Matrices-Matrix Norm. **(15 Hrs)**

Unit – IV: Eigen values and Eigen vectors: Problems in Eigen Values and Eigen Vectors, Orthogonal Diagonalization, Quadratic Forms, Diagonalizing Quadratic Forms. **(10Hrs)**

Unit – V: LU, QR and Singular Value decompositions. **(10Hrs)**

Text Books:

1. Howard Anton and Chris Rorres, *Elementary Linear Algebra with Supplemental Applications*, 11th Edition, John Wiley & Sons, Inc., 2016.
2. Gilbert Strang, *Introduction to Linear Algebra*, 5th Edition, Wellesley-Cambridge Press, 2016.

Reference:

1. Kenneth Hoffmann and Ray Kunze, *Linear Algebra* Second Edition, Prentice Hall, 1971.
2. Mike Cohen, *Practical Linear Algebra for Data Science*, O'Reilly Media, Inc., Publisher, 2022.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3		2						2	3
CO2	3	3	3	2	2	3					3	3
CO3	3	3	3	2	2	2					2	2
CO4	3		3	3	3	3					3	3
CO5	3		3	2	2	3					2	2

26ASD504 Optimization Techniques 3 1 0 4

Course Outcomes	
CO1	Comprehend the formulation and solution methods of Linear Programming Problems.
CO2	Analyze the characteristics of single variable optimization techniques
CO3	Apply the concepts of optimization techniques to solve unconstrained multivariable optimization problems through direct search methos,
CO4	Analyze various gradient-based methods of solving unconstrained multivariable optimization techniques.
CO5	Analyze the methods of equality and inequality constrained nonlinear optimization problem and evolutionary algorithms.

Unit – I: Lines and hyperplanes, convex sets, convex hull – Introduction to LPP: Formulation of a Linear Programming Problem. Solving Linear Programming Problem: Graphical Method; Simplex method, Big-M method, Duality, Dual simplex method, Integer Linear Programming. **(12Hrs)**

Unit – II: Introduction to optimization: classical optimization, Optimality criteria, Necessary and sufficient conditions for existence of optimum point. Fundamental Region Elimination Rules to eliminate a region. One dimensional Search methods: Golden search method, Fibonacci method, Newton's Method, Secant Method. **(12Hrs)**

Unit – III: Unconstrained Multivariable optimization: Introduction, Necessary and sufficient conditions for existence of extreme point. Conditions for local minimization. Direct search methods: unidirectional search, box evolutionary search method. **(10Hrs)**

Unit – IV: Gradient-based methods: Introduction, the method of steepest descent, Newton's Method, the Conjugate Direction Algorithm, and the Conjugate Gradient Algorithm for unconstrained optimization problems. **(10Hrs)**

Unit – V: Nonlinear Equality Constrained Optimization: Introduction, Problem Formulation with equality constraints, Lagrange Multiplier Method. Nonlinear Inequality Constrained Optimization: Kuhn-Tucker conditions. Specific Search Algorithms: Hill Climbing, Simulated Annealing, Genetic Algorithms, Ant Colony Optimization. **(12Hrs)**

Text Books:

1. Edwin K.P. Chong, Stanislaw H. Zak, *An Introduction to Optimization*, 2nd edition, Wiley, 2013.
2. Kalyanmoy Deb, *Optimization for Engineering Design Algorithms and Examples*, Prentice Hall of India, New Delhi, 2004.
3. S.S. Rao, *Optimization Theory and Applications*, Second Edition, New Age International (P) Limited Publishers, 1995.

References:

1. Mokhtar S. Bazarra, Hamit D Sherali, C.M. Shetty, *Nonlinear programming Theory and applications*, 2nd edition, Wiley , 2004.
2. Mohan C. Joshi and Kannan M. Moudgalya, *Optimization: Theory and Practice*, Narosa Publishing House, New Delhi, 2004 (Reference)
3. Bertsimas, Dimitris, and John Tsitsiklis. *Introduction to Linear Optimization*. Belmont, MA: Athena Scientific, 1997.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	2					1	1
CO2	3	3	3	2	2	2					1	1
CO3	3	3	3	2	3	2					1	1
CO4	3	2	3	2	2	2					1	1
CO5	2	2	2	1	2	1					1	1

26ASD505 Probability Theory and Estimation 3 0 2 4

Course Outcomes	
CO1	Understand the basics of probability, random variables and distribution functions.
CO2	Know the importance of two dimensional random variables and correlation studies
CO3	Gain knowledge about standard statistical distributions and their properties
CO4	To gain knowledge point estimation and properties
CO5	To gain knowledge about sampling distributions interval estimations

Unit – I: Review of probability concepts: Conditional probability- Bayes theorem. Random Variable and Distributions: Introduction to random variable – Discrete and continuous random variables and its distribution functions - Mathematical Expectations – Moment generating function and Characteristic function. **(12Hrs)**

Unit – II: Two dimensional random variables: Joint, marginal and conditional probability distributions for discrete and continuous case - Stochastic Independence - Expectations - Conditional mean and variance - Correlation and introduction to Regression. **(12Hrs)**

Unit – III: Standard distributions - Binomial, Poisson, Geometric, Uniform, Exponential, Gamma, Normal. Mean, variance and applications of these distributions - Chebyshev's theorem and Central Limit theorem. **(12Hrs)**

Unit – IV: Point estimation: Properties, Methods of estimating a point estimator – Maximum Likelihood Estimator - Method of Moments, Sampling distributions: t, F and Chi Square distribution – mean and variance. **(12Hrs)**

Unit – V: Interval estimation: Confidence interval for one mean, difference of two means, single variance, ratio of two variances. **(12Hrs)**

Text Books:

1. Douglas C. Montgomery and George C. Runger, *Applied Statistics and Probability for Engineers*, John Wiley and Sons Inc., 2013.
2. Ravichandran, J: *Probability and Statistics for Engineers*, First Reprint Edition, Wiley India, 2012.

References:

1. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, *Probability and Statistics for Engineers and Scientists,* 8th Edition, Pearson Education Asia, 2007.
2. Hoel, P.G., Port, S.C., and Stone, C.J., *Introduction to Probability Theory*, Universal Book Stall, New Delhi, 1998.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	1					3	2
CO2	3	3	3	2	2	1					3	2
CO3	3	3	3	2	2	1					3	2
CO4	3	2	3	2	2	1					3	2
CO5	3	2	3	1	1	1					3	2

26ASD506 **Python Programming** **3 0 2 4**

Course Outcomes	
CO1	Understand the basic data types, operators, expressions, conditions and looping statements
CO2	Understand and apply data structure concepts and function calls in Python.
CO3	Familiarise with functions, modules, packages and libraries in Python
CO4	Execute the Python programme for data cleaning and reading data from different file formats.
CO5	Understand and apply various Data Visualization plots

Unit I – Introduction to Python Programming

Introduction: History of Python, Need of Python Programming, Applications Basics of Python Programming, Running Python Scripts, Installing Python on Your Computer, Using the Terminal Command Prompt, IDLE, and Other IDEs, Variables, Assignment, Keywords, Input-Output, Indentation.Types, Operators and Expressions: Types - Integers, Strings, Booleans; Operators-Arithmetic Operators, Comparison (Relational) Operators, Assignment Operators, Logical Operators, Bitwise Operators, Membership Operators, Identity Operators, Expressions and order of evaluations Control Flow- if, if-elif-else, for, while, break, continue, pass .Case Study: An Investment Report and Approximating Square Roots. **(12Hrs)**

Unit II – Data Structures and Comprehensions

Data Structures: Lists - Operations, Slicing, Methods; Tuples, Sets, Dictionaries, Sequences Comprehensions. Case Study: Nondirective Psychotherapy. **(12 Hrs)**

Unit III – Functions, Modules and File Handling

Functions: Defining Functions, Calling Functions, Passing Arguments, Keyword Arguments, Default Arguments, Variable-length arguments, Anonymous Functions, Fruitful Functions (Function Returning Values), Scope of the Variables in a Function - Global and Local Variables. Modules: Creating modules, import statement, from. Import statement, name spacing. Python packages: Introduction to PIP, Installing Packages via PIP, Using Python Packages. Text Files: Text Files and Their Format, Writing Text to a File, Writing Numbers to a File, Reading Text from a File, Reading Numbers from a File, Accessing and Manipulating Files and Directories on Disk. Case Study: Gathering Information from a File System. **(12Hrs)**

Unit IV – Data Gathering, Cleaning and Regular Expressions

Data Gathering and Cleaning: Cleaning Data, Checking for Missing Values, Handling the Missing Values, Reading and Cleaning CSV Data, Merging and Integrating Data, Reading Data from the JSON Format. Regular expressions: Character matching in regular expressions, Extracting data using regular expressions, Combining searching and extracting and Escape character. Case Study: Detecting the e-mail addresses in a text file. **(12Hrs)**

Unit V – Data Visualization

Popular Libraries for Data Visualization in Python: Matplotlib, Seaborn, Plotly, Geoplotlib, and Pandas. Data Visualization: Direct Plotting, Line Plot, Bar Plot, Pie Chart, Box Plot, Histogram Plot, Scatter Plot, Seaborn Plotting System, Strip Plot, Box Plot, Swarm Plot, Joint Plot, Matplotlib Plot, Line Plot Bar Chart, Histogram Plot, Scatter Plot, Stack Plot and Pie Chart. **(12Hrs)**

Text Books:

1. Chun, W. (2006). *Core python programming*. Prentice Hall Professional.
2. Embarak, O. (2018). *Data Analysis and Visualization Using Python: Analyze Data to Create Visualizations for BI Systems*. Apress.
3. Lambert, K. A. (2011). *Fundamentals of Python: First Programs*. Cengage Learning.
4. Severance, C. (2013). *Python for informatics: Exploring information*. Create Space.
5. https://www.w3schools.com/python
6. Mark Lutz. (2025). *Learning Python*. Orielly.
7. Vamsi Kurama. *(2017). Python Programming: A Modern Approach*, Pearson.
8. VanderPlas, J. (2016). *Python data science handbook: Essential tools for working with data.* " O' Reilly Media, Inc.".

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	2	2	2					3	2
CO2	2	3	2	2	2	2	2					3	2
CO3	2	3	1	2	2	3	3					3	2
CO4	2	2	1	2	2	2	3					3	2
CO5	2	2	1	2	2	2	3					3	2

Semester II

26ASD511 **Big Data Analytics** **3 0 2 4**

Course Outcomes	
CO1	To Familiarize the concepts of Big Data
CO2	To Understand the aspects of managing, cleaning and sampling of Data
CO3	To Understand Hadoop architecture and implement Map Reduce concept
CO4	To Manage and querying No SQL databases
CO5	Understanding and executing HDFS using PIG and HIVE

Unit – I: Introduction to Big Data: Types of Digital Data-Characteristics of Big Data – Evolution of Big Data – Definition of Big Data – Challenges with Big Data - 3Vs of Big Data. **Big Data Analytics:** Definition of big data analytics, Classification of analytics - Data Science - Terminologies in Big Data – CAP and BASE Theorems. **(12Hrs)**

Unit – II: Hadoop: Introduction – Hadoop distributions, RDBMS VS HADOOP – Hadoop Components – Architecture – HDFS, HDFS daemons, Name node, data node, File read and write operations, HDFS Commands. Hadoop 2 (YARN): Architecture - Interacting with Hadoop Eco systems. **(12Hrs)**

Unit – III: MapReduce: Introduction – Mapper – Reducer – Combiner – Partitioner – Searching – Sorting Compression. **(10Hrs)**

Unit – IV: NoSQL: Types of Databases, SQL vs. NOSQL. **No SQL databases**: Mongo DB: Introduction – Features - Data types - Mongo DB Query language - CRUD operations – Functions: Count – Sort – Limit – Skip – Arrays- Aggregate. **(12Hrs)**

Unit – V: Hive: Introduction – Architecture - data type – HQL (Database and Table Manipulation, DDL, DML, View, Joins), User defined functions. **Pig:** Features – Anatomy - Pig on Hadoop - Pig Philosophy - Pig Latin overview - Data types - Running pig - Execution modes of Pig - HDFS commands - Relational operators - Eval Functions - Complex data type - Piggy Bank - User defined Functions. **(14Hrs)**

Text Books:

1. Seema Acharya, Subhashini Chellappan, *Big Data and Analytics*, Wiley Publication, 2015.
2. Judith Hurwitz, Alan Nugent, Dr. Fern Halper, Marcia Kaufman, *Big Data for Dummies*, John Wiley & Sons, Inc., 2013.

Reference:

1. Data Science and big data analytics : *Discovering, analyzing , visualizing and presenting data*, EMC Education Services, John Wiley 2015
2. Tom White, *Hadoop: The Definitive Guide*, O'Reilly Publications, 2011.
3. Kyle Banker, *Mongo DB in Action*, Manning Publications Company, 2012.
4. Russell Bradberry, Eric Blow, *Practical Cassandra A developers Approach*, Pearson Education, 2014.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	2	2	2					2	2
CO2	2	2	2	2	2	2	2					2	2
CO3	2	2	2	2	2	3	2					2	2
CO4	2	2	1	2	2	2	2					1	2
CO5	1	2	1	1	1	2	2					1	2

26ASD512 **Database Management** **3 0 2 4**

Course Outcomes	
CO1	Understand the basics database systems, relational models and database schema
CO2	Gain knowledge about various database design processes and entity relationship models
CO3	To understand the intermediate SQL and advanced SQL queries
CO4	To understand the normal forms, database decomposition and functional dependencies
CO5	To understand Transaction management and concurrency control in DBMS

Unit – I: Introduction to DBMS: Database System Vs File system, Database systems applications, Purpose of database systems - Data models. Relational models: Structure of relational databases – database schema keys – schema diagrams. **(10Hrs)**

Unit – II: Relational Query Languages – fundamental relational algebra operations – additional relational algebra operations. Introduction to SQL – Background – SQL data definition –structure of SQL queries – set operations – null values - aggregate functions – modifications to the database. **(12Hrs)**

Unit – III: Database design - overview of the design process – the entity-relationship model – constraints – entity-relationship diagrams – reduction to relation schemas - Entity-relationship design issues – weak entity sets – extended E-R features. **(11Hrs)**

Unit – IV: Intermediate SQL: Nested subqueries - Join expression – Views – Transaction Management – ACID properties of Transactions – Concurrency control – integrity constraints – authorization. Advanced SQL – functions and procedures – triggers. **(11Hrs)**

Unit – V: Relational database design – features of good relational designs – atomic domains and normal forms - 1NF, 2NF, 3NF, 4NF and BCNF – decomposition using functional dependencies - functional dependency theory. **(11Hrs)**

Text Books:

1. Silberschatz. A., Korth, H. F. and Sudharshan, S. *Database System Concepts*, 7th Edition, TMH, 2019.
2. Elmasri, R. and Navathe, S. B. *Fundamentals of Database Systems*, 5th Edition, Addison Wesley, 2016

References:

1. Date, C. J. *An Introduction to Database Systems*, 8th Edition, Addison Wesley, 2003.
2. Ramakrishnan, R. and Gehrke, J. *Database Management Systems*", 3rd Edition, McGrawHill, 2003.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	1					2	1
CO2	2	2	2	2	2	1					2	1
CO3	2	2	2	2	2	1					2	1
CO4	2	2	1	2	2	1					1	1
CO5	1	2	1	1	1	1					1	1

26ASD513 **Data Mining and Warehousing** **3 1 0 4**

Course Outcomes	
CO1	To understand the concepts of Data Mining and KDD
CO2	To mine the data by using association rule mining
CO3	To familiarize with cluster and outlier analysis
CO4	Learn to analyse multimedia and complex data
CO5	To understand the concepts of Data Warehousing

Unit – I: Data Mining: Data Mining Functionalities – KDD – Data Preprocessing – Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization and Concept Hierarchy Generation – Architecture of a Typical Data Mining Systems – Classification of Data Mining Systems – Measures of Similarity and Dissimilarity. **(11Hrs)**

Unit – II: Association Rule Mining: Efficient and Scalable Frequent Item set Mining Methods – APRIORI Algorithm – FP-Growth – Mining Various Kinds of Association Rules – Association Mining to Correlation Analysis – Constraint-Based Association Mining – Market Basket Analysis. **(10Hrs)**

Unit – III: Cluster Analysis: Types of Data in Cluster Analysis – A Categorization of Major Clustering Methods – Hierarchical methods – Density-Based Methods – Grid Based Methods – Model-Based Clustering Methods – Clustering High-Dimensional Data – Constraint-Based Cluster Analysis – Outlier Analysis. **(12Hrs)**

Unit – IV: Mining Object, Spatial, Multimedia, Text and Web Data: Multidimensional Analysis and Descriptive Mining of Complex Data Objects – Spatial Data Mining – Multimedia Data Mining – Text Mining – Mining the World Wide Web – Page Ranking – HITS Algorithm. **(10Hrs)**

Unit – V: Warehousing and Business Analysis: Data warehousing Components – Building a Data warehouse – Data Warehouse Architecture – DBMS Schemas for Decision Support – Data Extraction, Cleanup, and Transformation Tools – Metadata – reporting – Query tools and Applications – Online Analytical Processing (OLAP) – OLAP and Multidimensional Data Analysis. **(12Hrs)**

Text Books:

1. Jiawei Han, Jian Pei, and Hanghang Tong, *Data Mining: Concepts and Techniques*, 4th ed., Morgan & Claypool, 2022.
2. Bhatia, Parteek, *Data mining and Data Warehousing: Principles and Practical Techniques*. Cambridge University Press, Ist Edition, 2019.

References:

1. M. Kantardzic, *Data Mining: Concepts, Models, Methods, and Algorithms*, 2nd edition, Wiley-IEEE Press, 2011.
2. Alex Berson and Stephen J. Smith, *Data Warehousing, Data Mining & OLAP*, Tata McGraw – Hill Edition, Tenth Reprint 2007.
3. G. K. Gupta *Introduction to Data Mining with Case Studies*, Easter Economy Edition, Prentice Hall of India, 2006.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	1	1					2	1
CO2	3	2	2	2	2	2					2	1
CO3	3	2	2	2	2	3					2	1
CO4	3	2	2	2	2	3					2	1
CO5	3	2	2	2	2	3					2	1

26ASD514 **Machine Learning** **3 0 2 4**

Course Outcomes	
CO1	To be able to formulate machine learning problems corresponding to different applications.
CO2	Exploring and implementing supervised learning through regression and decision tree learning.
CO3	Understand the instance-based learning and classification methods.
CO4	Understand the Ensemble learning methods.
CO5	Exploring and implementing unsupervised learning algorithms.

Unit – I: Introduction: Well-Posed Learning Problems, designing a Learning System, A Concept Learning Task, Concept Learning as Search, Find-S: Finding a Maximally Specific Hypothesis, Version spaces and the Candidate-Elimination algorithm, Inductive Bias. Validation Metrics. Introduction to types of learning: Supervised learning, Semi-Supervised Learning, Unsupervised learning and Reinforcement Learning. **(12Hrs)**

Unit – II: Classification and Regression: Learning a class from training, linear, Nonlinear, Multi Class and Multi Label classification. Regression: Simple Linear Regression, Multiple linear regression, Logistic Regression. Decision Tree learning: Introduction, Decision tree representation, Appropriate problems for decision tree learning, The basic decision tree learning algorithm, Issues in decision tree learning, classification and regression Trees (CART). **(12Hrs)**

Unit – III: Bayesian Learning: Naïve Bayes classifier. Instance-Based Learning: K-Nearest Neighbour Learning, Radial Basis Functions, Support Vector Machines: The Margin and Support Vectors, linear and Nonlinear Kernels. **(12Hrs)**

Unit – IV: CrossValidation (CV) and resampling. Ensemble Learning: Ensemble Learning Model Combination Schemes, Maximum Voting, Averaging, Weighted Averaging, Bagging: Random Forest Trees, Boosting: Gradient Boosting, Adaptive Boosting, Extreme Gradient Boosting, XG Boosting and Adaboost, Stacking.

Unit – V: Unsupervised Learning: Clustering: K-means/Kernel K-means. Dimensionality Reduction: Principal Component Analysis (PCA) and kernel PCA. Matrix Factorization and Matrix Completion. Expectation Maximization, Gaussian Mixture Models, Case Study. **(12Hrs)**

Text Books:

1. Tom M. Mitchell, *Machine Learning*, McGraw Hill, 1997.
2. Ethem Alpaydin, *Introduction to Machine Learning*, MIT Press, Prentice Hall of India, 3rd Edition, 2014.
3. Stephen Marsland, *Machine Learning: An Algorithmic Perspective*, Taylor & Francis (CRC), 2014.
4. Peter Flach, *Machine Learning*, Cambridge University Press, 2012.

References:

1. Haroon D, Python *Machine Learning Case Studies*, Apress, 2017.
2. Harrington, P, *Machine learning in action*, Manning Publications Co., 2012.
3. Richard O. Duda, Peter E. Hart and David G. Stork, *Pattern classification*, John Wiley & Sons, 2001.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	3					2	2
CO2	3	3	3	2	2	3					2	2
CO3	2	3	3	2	2	3					2	2
CO4	2	2	3	2	2	3					2	2
CO5	2	2	3	2	2	3					2	2

26ASD515 Multivariate Statistics and Regression Analysis 3 0 2 4

Course Outcomes	
CO1	To understand the basics of Multivariate Data and Multivariate Normal Distributions
CO2	To apply Multivariate Techniques for Classification of Distributions
CO3	To understand the concept of PCA and Factor Analysis
CO4	To gain knowledge on Simple Linear Regression, Estimation and testing of Model Parameters
CO5	To gain knowledge on Multiple Linear and Polynomial Regression and Estimation of Model Parameters and testing the significance of regression

Unit – I: The organization of Data: Descriptive Statistics. Graphical Techniques. Distance. The Multivariate Normal Distribution-Introduction. The Multivariate Normal Density and its Properties. The sampling Distribution of $\bar{X}$ and S. **(11Hrs)**

Unit – II: Classification for two populations: Classification with two Multivariate Normal populations, Fisher's Discriminant Functions for discriminating several populations. **(11Hrs)**

Unit – III: Principal Components Analysis, Dimensionality reduction, Factor Analysis- Factor Loadings using Principal Component Analysis. **(11Hrs)**

Unit – IV: Simple Linear Regression- Properties, Least Squares Estimation of parameters, Hypothesis Tests in Simple Linear Regression, Test for Significance of Regression using ANOVA. Coefficient of determination**.** **(11Hrs)**

Unit – V: Multiple Linear Regression: Estimation of model parameters. Polynomial Regression Models. Test for Significance of Regression using ANOVA. Coefficient of determination. **(11Hrs)**

Text Books:

1. Richard A. Johnson, Dean W. (2007). Wichern *Applied Multivariate Statistical Analysis*. Sixth Edition. Pearson Prentie Hall.
2. Douglas C. Montgomery and Elizabeth A. Peck and G. Geoffrey Vining (2012). *Introduction to Linear Regression Analysis,* Fifth Edition, John Wiley& Sons, Inc.

References:

1. Anderson, T. W. (2009): *An Introduction to Multivariate Statistical Analysis*. Third Edition Wiley.
2. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye (2007). *Probability and Statistics for Engineers and Scientists*, Eighth Edition, Pearson Education Asia.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	1					3	3
CO2	3	3	3	2	3	1					3	3
CO3	3	3	3	2	3	1					3	3
CO4	3	2	3	2	2	1					3	2
CO5	3	2	3	2	2	1					3	2

26ASD516 Statistical Inference and Design of Experiments 3 0 2 4

Course Outcomes	
CO1	To understand the concept of testing of hypothesis of various parameters using single sample and apply to engineering, science, and business problems
CO2	To understand statistical inference for two samples and apply to engineering, science and business problems
CO3	To know to apply goodness of fit test and nonparametric tests
CO4	To develop experiments and analyse the variance to conclude on the parameters of the population involved.
CO5	To construct factorial experiments and to use for various real time problems

Unit – I: Tests of Hypotheses for a Single Sample- Tests of Statistical Hypotheses, One-Sided and Two-Sided Hypotheses, P-Values in Hypothesis Tests, General Procedure for Hypothesis Tests, Tests on the Mean of a Normal Distribution, Variance Known- Tests on the Mean of a Normal Distribution, Variance Unknown- Tests on the Variance and Standard Deviation of a Normal Distribution. (**11Hrs)**

Unit – II: Statistical Inference for Two Samples -Inference on the Difference in Means of Two Normal Distributions, Variances Known- Inference on the Difference in Means of two Normal Distributions, Variances Unknown- Paired t-Test- Inference on the Variances of Two Normal Distributions. **(11Hrs)**

Unit – III: Goodness of Fit Tests –Distribution based Fitting- Categorical Data Analysis - Tests of Independence in Contingency Tables. Nonparametric Procedures -The Sign Test, The Wilcoxon Signed-Rank Test. **(11Hrs)**

Unit – IV: Design and Analysis of Single-Factor Experiments: The Analysis of Variance Designing Engineering Experiments, Completely Randomized Single-Factor Experiment, The Random-Effects Model, Randomized Complete Block Design. Latin Square Design. **(11Hrs)**

Unit – V: **De**sign of Experiments with Several Factors-Introduction, Factorial Experiments, Two Factor Factorial Experiments, General Factorial Experiments, 2k Factorial Designs. **(11Hrs)**

Text Books:

1. Douglas C. Montgomery and George C. Runger, *Applied Statistics and Probability for Engineers*, (2005) John Wiley and Sons Inc.
2. Ravichandran, J., *Probability and Statistics for Engineers*, First Reprint Edition, Wiley India, 2012.

References:

1. Amir D Aczel, Soundarapandian Jayavel, *Complete Business Statistics*, Boston : McGraw-Hill/Irwin, 2009
2. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, *Probability and Statistics for Engineers and Scientists*, 8th Edition, Pearson Education Asia, 2007.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	1					3	2
CO2	3	3	3	2	2	1					3	2
CO3	3	3	3	2	3	1					3	2
CO4	3	2	3	2	2	1					3	2
CO5	3	2	3	1	2	1					3	2

Semester III

26ASD601 **SQC and Reliability Theory** **3 0 2 4**

Course Outcomes	
CO1	Understand the fundamental concepts of quality control and develop variable and attribute control charts
CO2	Construct and interpret EWMA and CUSUM charts, and analyse process capability along with Six Sigma quality metrics.
CO3	Acquire knowledge of acceptance sampling methods and evaluate their characteristics and performance.
CO4	Understand the basic concepts of reliability and its associated properties
CO5	Analyse reliability distributions and evaluate the reliability of systems and maintenance strategies.

Unit – I: Basic concept of quality control, process control and product control, Statistical process control, theory of control charts, Shewhart control charts for variables: X-bar, R and s charts – Shewhart control charts for attributes: p, np, c, u charts, modified control charts.

Unit – II: Performance of control charts – operating characteristic (OC) curves and average run lengths (ARL) of control charts, moving average control charts, EWMA charts, CUSUM charts, – two sided and one-sided procedures – V – mask technique, process capability analysis, process capability indices – Cp and Cpk, Six Sigma quality metrics.

Unit – III: Acceptance sampling plans for attributes, single sampling plans, double sampling plans - performance of the sampling plans- operating characteristic (OC) curves, acceptable quality level – lot tolerance proportion defective (LTPD), average outgoing quality (AQL) and average time for inspection (ATI) –curves based on these characteristics.

Unit – IV: Introduction to Reliability and its needs; Different Approaches to Reliability Analysis, Application Areas, State Variable, Time to Failure, Failure Rate Function, Hazard rate function - Mean Time to Failure, Relationship between the Functions F(t), f'(t), R(t), and z(t), Bath tub curve, Mean time to failure, Residual time.

Unit – V; Parametric life distributions including Exponential, Weibull, and Gamma models, their properties, characterization, and parameter estimation with model fitting. Application of Reliability Block Diagrams and Fault Tree Analysis for system reliability evaluation, including quantitative analysis of independent component systems and non-repairable systems. Reliability analysis of repairable systems with emphasis on maintenance strategies such as preventive and corrective maintenance, downtime analysis, and system availability assessment.

Text Books:

1. Montgomery D. C., *Introduction to Statistical Quality Control*, 8th edition, Wiley, (2024).
2. Ravichandran, J., *Probability and Statistics for Engineers*, Wiley India, (2023).
3. Schilling E. G., *Acceptance Sampling in Quality Control*, Marcel Dekker, 3rd edition, CRC Press, (2017).
4. Marvin Rausand, Anne Barros and Arnljot Hoyland, *System Reliability Theory: Models, Statistical Methods and Applications*, 3rd edition, John Wiley & Sons Inc., (2020).

References:

1. Verma A. K., Srividya A. and Karanki D. R., *Reliability and Safety Engineering*, Springer, (2016).
2. Besterfield D. H., *Quality Control*, 9th edition, Pearson Education, (2013).

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2						3	1
CO2	3	2	2	2	2						3	1
CO3	3	2	2	2	2						3	1
CO4	3	2	1	2	2						3	1
CO5	2	2	2	2	2						2	1

26ASD602 **Deep Learning** **3 0 2 4**

Course Outcomes	
CO1	To understand the theoretical foundations, algorithms, and methodologies of Neural Networks.
CO2	To design, implement, and evaluate deep learning models for real-world applications.
CO3	To analyze model performance and apply appropriate optimization and regularization techniques.
CO4	To explore modern deep learning architectures including CNNs, RNNs, Transformers, and Generative Models.
CO5	To explore sequence modlling algorithms are BPTT, LSTM, GRU and application in NLP.

Unit – I: Foundations of Deep Learning

Introduction to Machine Learning vs Deep Learning; Biological Neuron vs Artificial Neuron; Perceptron and Multilayer Perceptron (MLP); Representation Learning; Width vs Depth of Neural Networks; Activation Functions: Sigmoid, Tanh, ReLU, Leaky ReLU, ELU, Softmax; Loss Functions: MSE, Cross-Entropy; Backpropagation Algorithm; Binary and Multiclass Classification; Weight Initialization Techniques; Overfitting and Underfitting; Regularization Techniques (L1, L2, Dropout). **(15Hrs)**

Unit – II: Convolutional Neural Networks

Motivation for CNN; Convolution Operation and Feature Maps; Filters, Stride, Padding; Pooling Layers; Parameter Sharing; Batch Normalization; Regularization in CNN; Optimization Techniques: Gradient Descent, Stochastic Gradient Descent, Mini-batch SGD, Momentum, Nesterov Accelerated Gradient, Adagrad, Adadelta, RMSProp, Adam and AdamW; Popular CNN Architectures: AlexNet, VGGNet, ResNet, DenseNet; Applications in Image Classification and Object Detection **(15Hrs)**

Unit – III: Transfer Learning and Advanced CNNs

Concept of Transfer Learning; Feature Extraction vs Fine-Tuning; Pre-trained Models; Large-scale Datasets (ImageNet); Advanced Architectures: Inception, MobileNet; Vision Transformers (ViT) – Basic Concepts; Applications in Medical Imaging, Face Recognition, and Industrial AI. **(10Hrs)**

Unit – IV: Generative Models

Autoencoders: Undercomplete, Sparse, Denoising, Contractive; Variational Autoencoder (VAE); Generative Adversarial Networks (GAN): Architecture, Minimax Optimization, DCGAN, Conditional GAN; Applications in Image Generation and Data Augmentation. **(10Hrs)**

Unit – V: Sequence Modelling and Transformers

Recurrent Neural Networks (RNN); Vanishing and Exploding Gradient Problem; Backpropagation Through Time (BPTT); Long Short-Term Memory (LSTM); Gated Recurrent Unit (GRU); Bidirectional RNN; Encoder–Decoder Architecture; Attention Mechanism; Introduction to Transformers; Applications in NLP, Time Series Forecasting, and Speech Recognition. **(10Hrs)**

Text Books:

1. Ian Goodfellow, YoshuaBengio and Aaron Courville, *Deep Learning,* MIT Press, 2017.
2. Josh Patterson, Adam Gibson, *Deep Learning: A Practitioner's Approach*, O'Reilly Media, 2017
3. Umberto Michelucci, *Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks,* Apress, 2018.
4. Kevin P. Murphy, *Machine Learning: A Probabilistic Perspective*, The MIT Press, 2012.

5. EthemAlpaydin, *Introduction to Machine Learning*, MIT Press, Prentice Hall of India, ThirdEdition 2014.
6. Giancarlo Zaccone, Md. RezaulKarim, Ahmed Menshawy *Deep Learning with TensorFlow:Explore neural networks with Python*, Packt Publisher, 2017.
7. Antonio Gulli, Sujit Pal, *Deep Learning with Keras*, Packt Publishers, 2017.
8. Francois Chollet, *Deep Learning with Python*, Manning Publications, 2017.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	2					3	1
CO2	3	2	2	2	2	2					3	1
CO3	3	2	2	2	2	3					3	1
CO4	3	2	1	2	2	2					3	1
CO5	3	2	2	2	2	2					3	1

ELECTIVES

(2026-2027)

26ASD631 **Business Analytics** **2 0 2 3**

Course Outcomes	
CO1	Understanding the Role of Business Analyst and Data Science in business.
CO2	Understanding the basic concept of data management and data mining techniques
CO3	To understand the basic concept of machine learning
CO4	To understand the application of business analysis.

Unit – I: Introduction: What is business analytics? Historical Overview of data analysis, Data Scientist vs. Data Engineer vs. Business Analyst, Career in Business Analytics, What is data science, Why Data Science, Applications for data science, Data Scientists Roles and Responsibility.

Unit – II: Data: Data Collection, Data Management, Big Data Management, Organization/sources of data, Importance of data quality, Dealing with missing or incomplete data, Data Visualization, Data Classification Data Science Project Life Cycle: Business Requirement, Data Acquisition, Data Preparation.

Unit – III: Introduction to Data Mining, The origins of Data Mining, Data Mining Tasks, OLAP and Multidimensional data analysis, Basic concept of Association Analysis and Cluster Analysis.

Application of Business Analysis: Retail Analytics, Marketing Analytics, Financial Analytics, Healthcare Analytics, Supply Chain Analytics.

Text Books / Reference Books:

1. Essentials of Business Analytics: An Introduction to the methodology and its application, Bhimasankaram Pochiraju, SridharSeshadri, Springer
2. Introduction to Machine Learning with Python: A Guide for Data Scientists 1st Edition, by Andreas C. Müller, Sarah Guido, O'Reilly
3. Introduction to Data Science, Laura Igual Santi Seguí, Springer

4. Introduction to Data Mining, Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Pearson Education India
5. An Introduction to Business Analytics, Ger Koole, Lulu.com, 2019.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	2	-	-	-	-	1	1	
CO2	3	3	2	2	2	2	-	-	-	-	1	1	
CO3	2	2	3	2	2	2	-	-	-	-	1	1	

26ASD632 **Categorical Data Analysis** **2 0 2 3**

Course Outcomes	
CO1	Understand the Categorical Data-nominal and ordinal random variables.
CO2	Understand the two-way contingency tables.
CO3	Understand the three-way contingency tables.
CO4	Understand the basic of Generalized Linear Models

Unit – I: Categorical Data-nominal and ordinal random variables.
Two-way contingency tables: Table structure for two dimensions. Ways of comparing proportions. Measures of associations-odds ratio. Sampling distributions. Goodness-of-fit tests, testing of independence. Exact and large sample inference.

Unit – II: Three-way contingency tables, Partial associations, Cochran-Mantel-Haenszel methods. Conditional association and related inference.

Unit – III: Generalized Linear Models (GLMs): components of a GLM. Logisitc regression models for binary data, inference for logistic regression models, multiple logistic regression with qualitative predictors, exact inference for logistic regression, sample size and power of test.

Unit – IV: Loglinear models for two-way and three-way contingency tables, inference for loglinear models, the connection between loglinear-logit regression models. Multicategory logit models for nominal responses, cumulative logit models for ordinal responses.

Text Books / Reference Books:

1. Agresti, A., Categorical Data Analysis, 3rd Edition, Wiley, New York, 2013.
2. Agresti, A., An Introduction to Categorical Data Analysis, 3rd Edition, Wiley, New York, 2019.
3. Andersen, E.B., The Statistical Analysis of Categorical Data, Springer-Verlag, Berlin, 1994.
4. Santner, T.J. and Duffy, D., The Statistical Analysis of Discrete Data, Springer-Verlag, New York, 1989.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	2	-	-	-	-	1	1	
CO2	3	3	2	2	2	2	-	-	-	-	1	1	
CO3	2	2	3	2	2	2	-	-	-	-	1	1	
CO4	3	3	3	2	2	2	-	-	-	-	1	1	

Course Outcomes	
CO1	Understand the fundamental concepts of cloud computing, including service models, deployment models, and cloud architecture.
CO2	Apply cloud infrastructure and service models (IaaS, PaaS, SaaS) to design and manage cloud-based solutions.
CO3	Design and implement containerized and microservices-based applications using Docker.
CO4	Deploy, manage, and scale applications using Kubernetes in cloud environments.

Unit – I: Introduction to Cloud Computing (6 Hrs)

Definition and evolution of cloud computing, Cloud service models: IaaS, PaaS, SaaS. Cloud deployment models: Public, Private, Hybrid, Community. Benefits and challenges of cloud computing.

Unit – II: Cloud Infrastructure and Architecture (6 Hrs)

Cloud computing architecture, Virtualization concepts, Storage solutions, Cloud networking, Cloud security.

Unit – III: Cloud Service Models in Detail (8 Hrs)

Infrastructure as a Service (IaaS): Concepts and components, Compute, storage, networking services, Security and identity services. Platform as a Service (PaaS): Application development platforms, Data management services, Middleware services, Integration and deployment. Software as a Service (SaaS): SaaS concepts and components, SaaS applications and delivery.

Unit – IV: Cloud-Native Applications and Containerization (10 Hrs)

Cloud management and monitoring, Cloud orchestration and automation, Cloud resource management, Microservices architecture, Monolithic vs Microservices architecture, Designing and implementing Microservices.

Containerization: Containers and benefits, Docker: images, registries, runtimes, containerizing applications and dependency management, Multi-container applications using Docker Compose.

Unit – V: Container Orchestration and Kubernetes (10 Hrs)

Overview of container orchestration platforms: Kubernetes-Architecture, Components and core concepts, Deploying and managing applications, Service discovery, Scaling and load balancing, Rolling updates and fault tolerance. Alternative orchestration platform: Docker Swarm.

LIST OF HANDS ON EXERCISES

1. Create an account in a cloud platform and launch a virtual machine; configure basic storage and networking services.
2. Install Docker and execute basic commands to run, stop, and manage containers.
3. Create Docker images using Dockerfile and push images to a container registry.
4. Develop and deploy a multi-container application using Docker Compose.
5. Design and implement a simple microservices-based application and containerize the services.
6. Install and set up a Kubernetes cluster using Minikube.
7. Create and manage Pods, Deployments, and Services in Kubernetes.
8. Perform scaling, load balancing, and service exposure (ClusterIP/NodePort) in Kubernetes.
9. Implement rolling updates, rollback mechanisms, and monitor logs in Docker and Kubernetes environments.
10. Mini Project: Design and deploy a multi-tier cloud-native application using Docker and Kubernetes.

TEXT BOOKS

1. Erl, T., Mahmood, Z., & Puttini, R. (2013). *Cloud computing: Concepts, technology & architecture*. Pearson.
2. Poulton, N. (2025). *Docker deep dive* (4th ed.). O'Reilly Media.
3. Burns, B., Beda, J., Hightower, K., & Evenson, L. (2022). *Kubernetes: Up and running: Dive into the future of infrastructure* (3rd ed.). O'Reilly Media.
4. Denniss, W. (2024). *Kubernetes for developers*. Manning Publications.

REFERENCES

1. Bartlett, J. (2022). *Cloud native applications with Docker and Kubernetes: Design and build cloud architecture and applications with microservices*. Apress.
2. Christudas, B. A. (2024). *Java microservices and containers in the cloud: With Spring Boot, Kafka, PostgreSQL, Kubernetes, Helm, Terraform and AWS EKS*. Apress.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	1	1	-	1	-	1	-	1
CO2	3	2	3	2	2	2	-	1	1	1	1	1
CO3	2	2	3	2	2	3	-	1	2	1	1	1
CO4	2	2	3	3	3	3	-	1	2	1	2	2

26ASD634 Computational Biology 2 0 2 3

Course Outcomes	
CO1	Understand the basics of bioinformatics.
CO2	Gain knowledge about primary and secondary databases for bioinformatics.
CO3	Understand the sequence alignment methods.
CO4	To gain knowledge on UPGMA and other algorithms for maximum parsimony.

Unit – 1: Introduction to Bioinformatics - applications of Bioinformatics - challenges and opportunities - introduction to NCBI data model- Various file formats for biological sequences.
Bioinformatics resources – Importance of databases - Biological databases- Primary & Secondary databases.

Unit – II: Sequence alignment methods: Sequence analysis of biological data-Significance of sequence alignment- pairwise sequence alignment methods- Use of scoring matrices and gap penalties in sequence alignments- PAM and BLOSUM Scoring Matrices. Introduction to Dynamic Programming, Global alignments: Needleman Wunsch Algorithm, Local Alignments: Smith Waterman Algorithm, Gap Penalties.
Unit – III: Multiple sequence alignment methods – Tools and application of multiple sequence alignment. Sequence alignment tools Phylogenetic analysis algorithms: Maximum Parsimony, UPGMA, Transformed Distance, Neighbors-Relation, Neighbor-Joining, jackknife.

Text Books/ References Books

1. Higgins,Des and Willie Taylor: B*ioinformatics: Sequence , Structure and databanks*, Oxford , University Press,2000.
2. Baxenvants, AD., Bioinformatics: *A practical guide to the analysis of genes and protein*s, Third edition, John wiley & Sons ,2005

3. Teresa Attwood, *Introduction To Bioinformatics* ,Pearson Education Singapore Pte Ltd, 2007
4. S.C. Rastogi et al, *Bioinformatics: Methods and Applications*: (Genomics, Proteomics and Drug Discovery) Kindle Edi

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	1						2	1
CO2	2	2	2	2	2	1						2	1
CO3	2	2	2	2	2	1						2	1
CO4	2	2	1	2	2	1						2	1

26ASD635 Computer Aided Drug Designing 2 0 2 3

Course Outcomes	
CO1	To understand the basics of molecular modelling.
CO2	To understand the quantitative structure and activity relationship.
CO3	Understand and apply PCA in molecular design.
CO4	To understand important drug databases, designing Lipinski's rule of five.

Unit – I: Introduction to Molecular Modeling: Molecular Modeling and Pharmacoinformatics in Drug Design, Phases of Drug Discovery, Target identification and validation
Protein Structure Prediction and Analysis: Protein Structure prediction methods: Secondary Structure Prediction, Tools for Structure prediction; Protein structural visualization; Structure validation tools; Ramachandran Plot.

Unit – II: QSAR : Quantitative Structure and Activity Relationship - Historical Development of QSAR, Tools and Techniques of QSAR, Molecular Structure Descriptors.
Multivariate Statistical methods in QSAR -Principal Component Analysis (PCA) and Hierarchical Cluster Analysis(HCR). Regression analysis tools - Pincipal Component Regression (PCR), Partial Least Squares (PLS) - Case studies.

Unit – III: High Throughput / Virtual screening- Introduction, Basic Steps, Important Drug Databases, Designing Lipinski's Rule of Five, ADMET screening

Unit – IV: Docking Studies- Target Selection, Active site analysis, Ligand preparation and conformational analysis, Rigid and flexible docking.
Molecular visualization tools: RasMol and Swiss-Pdb Viewer
Molecular docking tools: AutoDock and ArgusLab.

Text Books/ References Books:

1. Leach Andrew R., Valerie J. Gillet, An introduction to Chemoinformatics. Publisher: Kluwer academic , 2003. ISBN: 1402013477.
2. Gasteiger Johann, Handbook of Chemoinformatics: From Data to Knowledge (4 Volumes), 2003. Publisher: Wiley-VCH. ISBN:3527306803.
3. Opera Tudor I,Ed. , Chemoinformatics in drug discovery, Wiley-VCH Verlag,2005.
4. Bunin Barry A. Siesel Brian,Morales Guillermo,Bajorath Jürgen. Chemoinformatics: Theory, Practice, & Products Publisher:New York, Springer. 2006. ISBN: 1402050003.
5. Gasteiger Johann, Engel Thomas. Chemoinformatics: A Textbook. Publisher: WileyVCH; 1st edition. 2003. ISBN: 3527306811.

6. Kenneth M Merz, Jr, Dagmar Ringe, Charles H. Reynolds , Drug design: Structure and ligand based approaches (2010) publisher : Cmabridge University press

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	2	-	-	-	-	1	1
CO2	3	3	2	2	2	2	-	-	-	-	1	1
CO3	2	2	3	2	2	2	-	-	-	-	1	1
CO4	3	3	3	2	2	2	-	-	-	-	1	1

26ASD636 Demography and Actuarial Statistics 2 0 2 3

Course Outcomes	
CO1	Understand the basics of content errors and fertility levels.
CO2	Gain knowledge about life table and life annuities.
CO3	Know the importance of life insurance.
CO4	To gain knowledge about contingent functions.

Unit – 1: Demographic data – Sources, Coverage and Content errors in demographic data. Measures of fertility period and cohort measures. Use of birth order Statistics and child - Woman ratio. Brass technique to estimate current-fertility levels Estimation of TFR age pattern of fertility. Measures of mortality - standard death rates, neo-natal, perinatal death rates, maternal and infant mortality rates standardization of mortality rates.

Unit – II: Life table: Basic definitions, probabilities, construction of life tables, life expectancy, Life annuities: calculating annuity premium, interest and survivorship discount unction, guaranteed payments, deferred annuities.

Unit – III: Life insurance: Introduction, calculation of life insurance premiums, types of life insurance, combined benefits, insurances viewed as annuities, Insurance and annuity reserves: General pattern reserves, recursion, detailed analysis of an insurance.

Unit – IV: Contingent Functions: Contingent probabilities, assurances. Decrement tables. Pension funds: Capital sums on retirement and death, widow's pensions, benefits dependent on marriage.

Text Books:

1. Ramkumar. R : Technical Demography, Wiley eastern Ltd, New Delhi,1986.
2. Rogers.A : Introduction to Mathematical Demography, Johnwiley,New york,1975
3. Biswas.S. : Stochastic processes in Demography and applications,Wiley eastern limited,1988
4. Atkinson, M.E. and Dickson, D.C.M.: An Introduction to Actuarial Studies, Elgar Publishing,2000
5. Philip, M. et. al : Modern Actuarial Theory and Practice, Chapman and Hall,1999.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	1						2	1
CO2	2	2	2	2	2	1						2	1
CO3	2	2	2	2	2	1						2	1
CO4	2	2	1	2	2	1						2	1

26ASD637 **Healthcare Analytics** **2 0 2 3**

Course Outcomes	
CO1	Understand the basics of healthcare data analytics.
CO2	Gain knowledge about phenotyping algorithms.
CO3	Know the importance of clinical trials and prediction models.
CO4	To gain knowledge pervasive health analysis.

Unit – I : Introduction to Healthcare Data Analytics- Electronic Health Records–Components of EHR-Coding Systems- Benefits of EHR- Barrier to Adopting HER Challenges- Phenotyping Algorithms. Challenges in Healthcare Data Analysis, Acquisition Challenges, Pre-processing, Transformation, Social Media Analytics for Healthcare.

Unit – II: Advanced Data Analytics for Healthcare: Review of clinical trials, Prediction Models. Statistical Prediction Models, Alternative Clinical Prediction Models, Survival Models, Predictive Models for Integrating Clinical and Genomic Data, Data Analytics for Pervasive Health, Fraud Detection in Healthcare, Pharmaceutical Discoveries and Clinical Decision Support Systems.

Text Books/ References Books:

1. Chandan K. Reddy and Charu C Aggarwal, "*Healthcare data analytics*", Taylor & Francis, 2015
2. Hui Yang and Eva K. Lee, "*Healthcare Analytics: From Data to Knowledge to Healthcare Improvement*, Wiley, 2016.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	1						2	1
CO2	2	2	2	2	2	1						2	1
CO3	2	2	2	2	2	1						2	1
CO4	2	2	1	2	2	1						2	1

26ASD638 **Market Analytics** **2 0 2 3**

Course Outcomes	
CO1	Understand the basics of business analytics.
CO2	Gain knowledge about auto-correlations and time series analysis.
CO3	To understand the linear time series models.
CO4	To gain knowledge about sYule Walker estimation for AR processes.

Unit – I: Business Analytics Basics: Definition of analytics, Evolution of analytics, Need of Analytics, Business analytics vs business analysis, Business intelligence vs Data Science, Data Analyst Vs Business Analyst, Business Analytics at the Strategic Level, Functional Level, Analytical Level, Data Warehouse Level. Market Segmentation Variables, Market Segmentation Types, Marketing Data Landscape, Analyzing the trend of data in Marketing– case studies.

Unit – II: Time series as a discrete parameter stochastic process, Auto - covariance, Auto-correlation functions and their properties. Exploratory time series analysis, Test for trend and seasonality, Exponential and moving average smoothing, forecasting based on smoothing.

Unit – III: Linear time series models: Autoregressive, Moving Average, autoregressive Moving Average models, Autoregressive Integrated Moving Average models. Estimation of ARMA models: Yule-Walker estimation for AR Processes, Maximum likelihood and least squares estimation for ARMA Processes.

Text Books / References Books:

1. GrigsbyGert H.N Laursen and Jesper Thorlund : *Business analytics for managers taking business intelligence beyond reportin*g, second edition 2016.
2. Wayne L. Winston:*Marketing Analytics: Data-Driven Techniques with Microsoft Excel*, Wiley,2014.
3. Mike Grigsby : *Marketing Analytics: A Practical Guide to Improving Consumer Insights Using Data Techniques*, Kogan Page; 2 edition ,2018
4. Mike Anderson, T.W *: The Statistical Analysis of Time Series*, John Wiley, New York, 1971.
5. Kendall, Sir Maurice and Ord, J.K. : *Time Series*, Edward Arnold, London, 1990.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	1						2	1
CO2	3	2	2	2	2	1						2	1
CO3	3	2	2	2	2	1						2	1
CO4	3	2	1	2	2	1						2	1

26ASD639 Mining of Massive Datasets 2 0 2 3

Course Outcomes	
CO1	Understand the basics of data mining and its limitations.
CO2	Gain knowledge about data mining streams.
CO3	Understand the clustering techniques for data mining.
CO4	Apply the dimensionality reduction algorithm for social network analysis.

Unit – I: Basics of Data Mining - computational approaches - statistical limits on data mining - MapReduce - Distributed File Systems . MapReduce. Algorithms using MapReduce. Extensions to MapReduce. Mining Data Streams: The Stream Data Model - Sampling Data in a Stream - Filtering Streams. Link analysis, Frequent itemsets, Clustering, Advertising on web, Recommendation system, Mining Social-Network Graphs, Dimensionality Reduction, Large-Scale Machine Learning.

Text Books / References Books

1. Jure Leskovec , Anand Rajaraman, Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 2014.
2. Tom White, Hadoop: The Definitive Guide: Storage and Analysis at Internet Scale O'Reilly Media; 4th edition, 2015.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	2	-	-	-	-	1	1	
CO2	3	3	2	2	2	2	-	-	-	-	1	1	
CO3	2	2	3	2	2	2	-	-	-	-	1	1	
CO4	3	3	3	2	2	2	-	-	-	-	1	1	

26ASD640 **Official Statistics** **2 0 2 3**

Course Outcomes	
CO1	Understand the Indian statistical system.
CO2	Understand the CSO, NSSO and RGO.
CO3	Understand evaluation of performance of family welfare programmes and Statistics related to Industries.
CO4	To gain knowledge economic development.

Unit – I: Introduction to Indian Statistical systems- Role, function and activities of Central Statistical organization and State Agencies. Role of National Sample Survey Organization. General and special data dissemination systems. Scope and Contents of population census of India. statistics, their reliability and limitations. Role of Ministry of Statistics & Program Implementation (MoSPI), Central Statistical Office (CSO), National Sample Survey Office (NSSO), Registered General Office and National Statistical Commission.

Unit – II: Population growth in developed and developing countries, Evaluation of performance of family welfare programmes. Statistics related to Industries, foreign trade, balance of payment, cost of living, inflation, educational and other social statistics.

Unit – III: Economic development: Growth in per capita income and distributive justice indices of development, human development index. National income estimation- Product approach,income approach and expenditure approach. Measuring inequality in income: Gini Coefficient, Theil's measure; Poverty measurements: Different issues, measures of incidence and intensity; Combined Measures: Indices due to Kakwani, Sen etc.

Text Books:

1. Guide to Official Statistics (CSO) 1999.
2. Principles and Accommodation of National Population Census, UNEDCO
3. CSO (1989)a: National Accounts Statistics- Sources and Methods.
4. Guide to current Indian Official Statistics, Central Statistical Office, GOI, and New Delhi.http://mospi.nic.in/

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	1						2	1
CO2	2	2	2	2	2	1						2	1
CO3	2	2	2	2	2	1						2	1
CO4	2	2	1	2	2	1						2	1

26ASD641 Parallel and Distributed Systems 3 0 0 3

Course Outcomes	
CO1	Understand the basics of parallel computing models.
CO2	Gain knowledge about task and data parallelism.
CO3	Understand the concepts of inter process communication and internet protocols.
CO4	To gain knowledge the system models.

Unit – I: Introduction – parallelism and goals, parallel computing models – RAM, PRAM , CTA. Reasoning about Performance – Introduction -Basic Concepts - Performance Loss - Parallel Structure - Measuring Performance. Shared memory architecture.

Unit – II: Parallel Programming: Task and Data Parallelism with examples –Comparison Programming with Threads - POSIX Threads- Thread Creation and Destruction. Mutual Exclusion- Synchronization - Safety and Performance Issues – Reduction – threads Inter process communication – internet protocols – multicast communication – MPI. Remote invocation: Remote procedure call – remote method invocation -

Unit – III: System models : physical models, architecture models, operating system support. Distributed file systems – introduction- time and global states – synchronization of physical clocks – coordination and agreements: Mutual exclusion, election, consensus.

Text Books/ References Books:

1. George Coulouris , Jean Dollimore , Tim Kindberg , Gordon Blair: *Distributed Aystems : Concepts and Design* , Fifth Edition , Addison Wiley, 2012.
2. Calvin Lin ,Larry Snyder : *Principles of Parallel Programming*, Pearson, 2009
3. Bertil Schmidt, Jorge Gonzalez-Dominguez, Christian Hundt , Moritz Schlarb, *Parallel Programming: Concepts and Practice* First Edition, Morgan Kaufmann, 2017.
4. Ajay D. Kshemkalyani, Mukesh Singhal , *Distributed Computing: Principles, Algorithms, and Systems*, Cambridge University Press, First edition, 2008.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	2	-	-	-	-	1	1	
CO2	3	3	2	2	2	2	-	-	-	-	1	1	
CO3	2	2	3	2	2	2	-	-	-	-	1	1	
CO4	3	3	3	2	2	2	-	-	-	-	1	1	

26ASD642 **Pattern Recognition** **3 0 0 3**

Course Outcomes	
CO1	To understand Bayesian decision theory and its use
CO2	To gain knowledge about Bayesian estimation methods
CO3	To apply nonparametric techniques and linear discriminant functions
CO4	To gain knowledge about nonmetric methods and algorithm independent machine learning
CO5	To apply unsupervised learning and clustering

Unit – I: Introduction to Pattern Recognition, Introduction – Pattern recognition systems – the design cycle – learning and adaptation – Applications of Pattern recognition – statistical decision theory – Examples on pattern recognition, and image processing and analysis. **(7Hrs)**

Unit – II: Parametric methods of Classification, Introduction – Bayes theorem and Bayesian decision making – classifications based on single and multiple features – conditionally independent features – discrete and continuous features - Gaussian case and general theory - discriminant functions, decision boundaries and decision regions — problems of dimensionality – components analysis and discriminants – Minimum error rate classification – Receiver Operating characteristic curves – Estimation of the composition of populations based on machine learning classification. **(15Hrs)**

Unit – III: Nonparametric methods Classification, Introduction - histograms – density estimation – mixture densities - kernel and window estimators – nearest neighbor classification techniques – rules and distance metrics - single and k-nearest neighbor techniques –adaptive decision boundaries and discriminant functions – minimum squared error discriminant functions. **(8Hrs)**

Unit – IV: Nonmetric methods of classification, Introduction to Nonmetric methods – decision trees and decision regions– CART methods – algorithm-independent machine learning – lack of inherent superiority of any classifier – bias and variance for regression and classification – resampling or estimating statistics – jackknife and bootstrap resampling methods. **(7Hrs)**

Unit – V: Methods of Clustering, Introduction to unsupervised learning and clustering – data description and clustering – criterion functions for clustering – hierarchical clustering – single linkage algorithm, complete linkage algorithm, average linkage algorithm and Ward's algorithm – partitional clustering – Forgy's algorithm - and k-means algorithm. **(8Hrs)**

TEXT BOOKS

1. Earl Gose, Richard Johnsonbaugh and Steve Jost, *Pattern Recognition and Image Analysis,* 2002, Prentice Hall of India.

REFERENCES

1. Richard O. Duda, Peter E. Hart and David G. Stork, *Pattern Classification,* Second Edition, 2003, John Wily & Sons.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	2						2	2
CO2		3	3	3	2						2	2
CO3		3	3	3	2						2	2
CO4		3	3	3	2						2	2
CO5		3	3	3	2						2	2

26ASD643 **Queuing Theory** **2 0 2 3**

Course outcomes	
CO1	Understand basic characteristics of Queueing models.
CO2	Learn basic concepts of Poisson models with single server.
CO3	Understand and apply the queueing modals for various problems.

Unit – I: Queuing Models: Basic characteristics of a Queueing Model – Role of Poisson and Exponential distributions, Stochastic Processes, Markov chains, Poisson Processes, Poisson Queuing Models with single server: Descriptions of the model, Assumptions, Probability distributions for number of Units (steady state), waiting time distribution, simple numerical problems on (M/M/1): (/FIFO) and (M/M/1): (N/FIFO) Models.

Unit – II: Poisson Queuing Models with multiple server: Descriptions of the model, Assumptions, Probability distributions for number of Units (steady state), waiting time distribution, simple numerical problems on (M/M/C): (/FIFO), (M/M/C): (N/FIFO) and (M/M/C): (C/FIFO) Models, M/M/G Models.

Text Books / Reference Books

1. Donald Gross&Carl M Harris(1998):Fundamentals of Queuing theory,John Wiley & Sons, Inc
2. Hamdy A.Taha(2006): Operations Research – An Introduction, 8/e , Prentice Hall of India Private Ltd., New Delhi
3. S.D.Sharma (2003)Operations Research , Kedar Nath Ram Nath & Co, Meerut, India
4. Kanthi Swarup, P.K.Gupta and Man Mohan (2004), Operations Research, Sultan Chand & Sons, New Delhi.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	1							1	
CO2	2	2	2	2	1							1	
CO3	1	2	1	2	1							1	

26ASD644 **Reinforcement Learning** **2 0 2 3**

Course Outcomes	
CO1	Understand the basics of reinforcement learning. Its elements and limitations.
CO2	Understand the finite Markov decision process.
CO3	Understand the temporal difference learning and its advantages.
CO4	Understand the Sarsa maximization bias and double learning.

Unit – I: Introduction: Reinforcement Learning, Elements of Reinforcement Learning, Limitations and Scope, An Extended Example- Tic-Tac-Toe. Multi-armed Bandits: A k-armed Bandit Problem, Action-value Methods, The 10-armed Testbed, Incremental Implementation, Tracking a Nonstationary Problem, Optimistic Initial Values, Upper-Confidence-Bound Action Selection, Gradient Bandit Algorithms.

Unit – II: Finite Markov Decision Processes: The Agent–Environment Interface, Goals and Rewards, Returns and Episodes, Unified Notation for Episodic and Continuing Tasks, Policies and Value Functions, Optimal Policies and Optimal Value Functions, Optimality and Approximation. Review of Markov process and Dynamic Programming.

Unit – III: Temporal-Difference Learning: TD Prediction, Advantages of TD Prediction Methods, Optimality of TD, Sarsa: On-policy TD Control, Q-learning: Policy TD Control. Expected Sarsa. Maximization Bias and Double Learning.

Text Books / References Books:

1. Richard S. Sutton and Andrew G. Barto, *Reinforcement Learning:An Introduction*, MIT Press, 2018.
2. Sudharsan Ravichandiran, *Hand-on Reinforcement Learning with Python*, Packt Publications, 2018.
3. Sayon Dutta, *Reinforcement Learning with Tensor Flow: A beginner's guide*, Packt Publications, 2018.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	2	-	-	-	-	1	1	
CO2	3	3	2	2	2	2	-	-	-	-	1	1	
CO3	2	2	3	2	2	2	-	-	-	-	1	1	
CO4	3	3	3	2	2	2	-	-	-	-	1	1	

26ASD645 **Social Network Analytics** **2 0 2 3**

Course Outcome:	
CO1:	Understand the levels of SNA and network measures
CO2:	Familiarize with network growth models
CO3:	Gain knowledge about different community structures and link prediction models
CO4:	Understand cascade behavior in networks
CO5:	Predict and recommend in online social networks

Unit – I: Introduction: Applications, Preliminaries, Three Levels of SNA, Graph Visualization Tools.
Network Measures: Network Basics, Node Centrality, Assortativity, Transitive and Reciprocity, Similarity.
Network Growth Models: Properties of real-world networks, Random network model. Preferential Attachment model, Price's model – Local-world network growth model.

Unit – II: Link Analysis: Applications, Strong and weak ties – Link analysis and algorithms, Page Rank.
Community Structure in Networks: Applications, Types of Community detection methods, Disjoint community detection, overlapping community detection, local community detection.

Unit – III: Cascade Behavior and Network Effects: Cascade model – probabilistic cascade – Cascade prediction.
Anomaly Detection in Static Networks: Outlier vs Network-based anomalies, challenges in anomaly detection.
Graph Representation Learning: Machine Learning pipelines, Intuition behind representational learning – benefits – representational learning methods.

Case Study: Analysis of social network datasets, Modeling the spread of COVID 19, Recommendation System.

Text Books/ Reference Books:

1. Social Network Analysis, Tanmoy Chakraborty, Wiley, 2021.
2. Network Science, Albert-Lazzlo Barabasi.
3. Social Network Analysis: Methods and Applications, Stanley Wasserman, Katherine Faus.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	2	-	-	-	-	1	1
CO2	3	3	2	2	2	2	-	-	-	-	1	1
CO3	2	2	3	2	2	2	-	-	-	-	1	1
CO4	3	3	3	2	2	2	-	-	-	-	1	1

26ASD646 Software Engineering and Testing 3 0 2 4

Course Outcomes	
CO1	Identify relevant software process models for software development.
CO2	Use appropriate principles of software modeling to create a data design.
CO3	Apply project management techniques in software development.
CO4	Apply different software testing types to ensure the quality of the software product.
CO5	Identify defects to improve the overall quality of the software using automated testing tools.

Unit – I: Basics of Software Engineering

Software, software engineering as layered approach, characteristics of software, types of software - Software development framework: Software generic process framework activities and umbrella activities - Software engineering core principles, communication practices, planning practices, modelling practices, construction practices, software deployment practices - Prescriptive process models: Waterfall model, incremental model, RAD model, prototyping model, spiral model - Agile software development: Agile process, and its importance, extreme programming, scrum - Selection criteria for software process model. **(12Hrs)**

Unit – II: Software Requirement, Modeling and Design

Requirement engineering: Requirement engineering task, types of requirement, developing use-case - SRS (Software Requirements Specifications): Need of SRS, format and it's characteristics - Translating requirement model into design model - Design modelling: Fundamental design concepts - abstraction, information hiding, patterns, modularity, concurrency, verification, aesthetics - Design notations: Data flow diagram (DFD), structured flowcharts.

Unit – III: Software Project Management (12Hrs)

The management spectrum- 4P's - Metrics for size estimation: Line of code (LoC), function points(FP) - Project cost estimation using COCOMO (Constructive Cost Model), COCOMO II - Define risk, types of risk, RMMM strategy - Project scheduling: Basic principle, scheduling techniques - CPM, PERT - Project tracking: Timeline charts, Gantt charts. **(12Hrs)**

Unit – IV: Basics of Software Testing

Software testing, objective of testing, software testing life cycle (STLC) - Failure, fault, error, defect, bug terminology - Test case, when to start and stop testing - Quality assurance, quality control and verification - validation, Quality evaluation standards: Six sigma, CMMI levels - Static and dynamic testing - The box approaches: Compare white box testing, black box testing - Levels of testing: Unit testing, integration testing, system testing, acceptance testing. **(12Hrs)**

Unit - V Test and Defect Management

Test planning: Preparing a test plan - Test management: Test infrastructure management - Test reporting: Executing test cases, preparing test summary report - Definition and types of defect, defect life cycle, defect template - Comparison of manual testing and automation testing - Metrics and measurement: Types of metrics - product metrics and process metrics. **(12Hrs)**

TEXT BOOKS

1. Roger S. Pressman & Bruce R. Maxim, *Software Engineering: A practitioner's approach,* McGraw-Hill Higher Education, New Delhi, (Ninth Edition) ISBN 93-5532-504-5
2. Srinivasan Desikan, Gopalaswamy Ramesh, *Software Testing: Principles and Practices,* Pearson Publisher: Pearson India 2007, ISBN: 978-81-7758-121-8,

REFERENCES

1. Richard Fairly, *Software Engineering Concepts*, McGraw-Hill Education, New Delhi -2001, ISBN-13: 9780074631218
2. Deepak Jain, *Software Engineering: Principles and Practices*, Oxford University Press, New Delhi, ISBN 9780195694840
3. Ron Patton, *Software Testing,* Sams Publishing; 2nd edition, 2005 ISBN: 0672327988
4. M. G. Limaye, *Software Testing: Principles, Techniques and Tools*, Tata McGraw-Hill Education, New Delhi., 2009. ISBN 13: 9780070139909
5. Naresh Chauhan, *Software Testing: Principles and Practices*, Oxford University Press, Noida. ISBN: 9780198061847
6. Yogesh Singh, *Software Testing,* Cambridge University Press, Cambridge, 2021, ISBN: 9781107012967

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	1					1	2
CO2	3	3	2	2	2	2					2	2
CO3	3	3	2	2	2	2					2	2
CO4	3	3	3	1	3	2					2	1
CO5	3	3	2	2	2	1					1	2

26ASD647 Special Distribution Functions 2 0 2 3

Course Outcomes	
CO1	To understand the basics of different beta distributions.
CO2	To understand the distribution like Empirical and Erlang.
CO3	Know the importance of inverse Gama distribution and generalized exponential distribution.
CO4	To understand the inverse Gaussian distribution and Lognormal distribution.

Unit – I: Inverted Beta Distribution, Noncentral Beta Distribution, Beta Binomial Distribution, Cauchy Distribution, Noncentral Chi-Squared Distribution, Dirichlet Distribution, Empirical Distribution Function, Erlang Distribution, Error Distribution, Generalized Exponential Distributions, Noncentral F-distribution, Inverted Gamma Distribution, Normal Gamma Distribution, Generalized Gamma Distribution, Inverse Gaussian (Wald) Distribution, Lognormal Distribution, Pareto Distribution, Power Function Distribution, Power Series (Discrete) Distribution, Wishart (Central) Distribution.

Text Books /Reference Books

1. Catherine Forbes, Merran Evens, Nicholas Hastings and Brian Peacock. (2010). S*tatistical Distributions*, Fourth Edition, Wiley & Sons Publication, USA.
2. Karl Bury (1999) : Statistical distributions in Engineering , Cambridge University Press.
3. Thomopoulos, Nick T (2017): Statistical Distributions: Applications and Parameter Estimates, Springer.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	2	2						2	1
CO2	2	2	2	2	2	2						2	1
CO3	2	2	2	2	2	3						2	1
CO4	2	2	1	2	2	2						2	1

26ASD648 Survival Analysis 2 0 2 3

Course Outcomes	
CO1	Understand the basics of survival distributions and its applications
CO2	Know the importance of various censoring schemes and its estimations
CO3	Gain knowledge about nonparametric approaches for estimating survival function
CO4	To gain knowledge about indices for measurement of probability of death under competing risks and its estimation

Unit – I: Survival Analysis: Functions of survival times, survival distributions and their applications. **(10Hrs)**

Unit – II: Censoring Schemes: Type I, Type II and progressive or random censoring with biological examples. Estimation of mean survival time and variance of the estimator for Type I and Type II censored data with numerical examples. **(10Hrs)**

Unit – III: Non-parametric methods: Actuarial and Kaplan-Meier methods for estimating survival function and variance of the Estimator. **(10Hrs)**

Unit – IV: Competing Risk Theory: Indices for measurement of probability of death under competing risks and their inter-relations. Estimation of probabilities of death using maximum likelihood principle and modified minimum Chi-square methods. **(15Hrs)**

Text Book:

1. Kleinbaum D.G. and Klein, M. (2012). *Survival Analysis: A Self Learning Text*. Third Edition, Springer Science, New York, USA.

References:

1. Miller,R.G. *Survival analysis*, John Wiley ,1981
2. Collet, D., *Statistical analysis of life time data*,1984
3. Cox, D.R. and Oakes, D.: *Analysis of survival data*, Chapman & Hall, New York,1984

4. Gross, A.J. and Clark, V.A.: *Survival distribution: Reliability applications in the Biomedical sciences*, John Wiley and Sons,1975
5. Elandt-Johnson,R.E. Johnson, N.L.: *Survival models and data analysis*, John Wiley & sons.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	2						2	2
CO2		3	3	3	2						2	2
CO3		3	3	3	2						2	2
CO4		3	3	3	2						2	2
CO5		3	3	3	2						2	2

26ASDXXX **Stochastic Process** **3 0 0 3**

Course Outcomes	
CO1	To Understand the basic concepts of Stochastic Process and Stationarity and Autocorrelation
CO2	To Understand the concepts of Special Processes
CO3	To Understand the concepts of Ergodicity and Power Spectral Density
CO4	To understand the concepts of Markov Chain and related results

Unit – I: Random processes: General concepts and Definitions - Stationarity in Random Processes – Strict Sense and Wide Sense Stationary Processes - Autocorrelation and Properties.

Unit – II: Special Processes –Poisson points, Poisson and Gaussian Processes and Properties

Unit – III: Spectrum Estimation, Ergodicity, Mean Ergodicity, Correlation Ergodicity, Power Spectrum Density functions –Properties

Unit – IV: Markov Process and Markov Chain, Transition Probabilities, Chapman Kolmogrov Theorem, Limiting Distributions. Classification of States.

Text Books:

1. J. Ravichandran, *Probability and Random Processes for Engineers*, First Edition, IK International, 2015.
2. Roy D. Yates and David J. Goodman, *Probability and Stochastic Processes A Friendly Introduction for Electrical and Computer Engineers*. Second Edition. John Wiley & Sons. Inc.,

References:

1. A. Papoulis, and Unnikrishna Pillai, *Probability, Random Variables and Stochastic Processes*, Fourth Edition, McGraw Hill, 2002.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2						2	2
CO2	3	2	2	2	2						2	2
CO3	3	2	2	2	2						2	2
CO4	3	2	3	2	2						2	2

26ASD649 **Thinking with Data** **2 0 2 3**

Course Outcomes	
CO1	Understand the Data Classifications and qualifications. Scientific thinking.
CO2	Understand Data quality issues and data quality metrics.
CO3	Understand and apply the Ethics of data science.

Data Classifications and qualifications. Scientific thinking. Creative and Logical thinking. Complexities in data. Data quality issues and data quality metrics.
Ethics in data science.

Text Books/ References Books:

1. Longbing Cao, Data Science Thinking, The Next Scientific, Technological and Economic Revolution, Springer, 2018.
2. Max Shron, Thinking with Data, How to Turn Information Into Insights, O'Reilly Media, 2014.
3. Robert Stackowiak, Tracey Kelly, Design Thinking in Software and AI Projects, Apress, 2020.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	2	-	-	-	-	1	1	
CO2	3	3	2	2	2	2	-	-	-	-	1	1	
CO3	2	2	3	2	2	2	-	-	-	-	1	1	

26ASD650 **Time Series** **2 0 2 3**

Course Outcomes	
CO1	Understand the concept of time series and its components
CO2	Understand the bases of different models of time series analysis including decomposition
CO3	To learn proper model identification and its estimation.
CO4	To learn several ways of identifying the forecasting methods with the least forecasting error.

Unit – I: Simple Descriptive Techniques: time series plots, trend, seasonal effect. Tests for trend and seasonality: estimation and elimination of trend and seasonal components. Exponential and moving average smoothing. Time Series as discrete parameter stochastic process. Stationarity, autocovariance and autocorrelation function and their properties. Partial autocorrelation function.

Unit – II: Probability Models: White noise model, random walk, linear processes, Moving Average (MA), Autoregressive (AR), ARMA and ARIMA, seasonal ARIMA models. Invertibility. ACF and PACF of these processes. Sample ACF and PACF. Model identification.

Unit – III: Model Building: Estimation of mean, autocovariance function and autocorrelation function. Estimation of AR models – Yule-Walker equations, estimation of MA model and ARMA models. Order selection in AR and MA models.

Unit – IV: Forecasting: Forecast mean square error (FMSE), Least squares prediction. BLUP. Box-Jenkins forecasting. Forecasting through exponential smoothing and Holt-Winters smoothing. Residual analysis and diagnostic checking. Nonstationary time series models and their identification.

Text Books/References Books:

1. Box, G.E.P. and Jenkins, G.M. (1976): Time series analysis—Forecasting and Control, Holden-day, San Francisco.
2. Anderson, T.W. (1971): The Statistical Analysis of Time Series, Wiley, N.Y.
3. Montgemory, D.C. and Johnson, L.A. (1977): Forecasting and Time Series Analysis, .
4. Kendall, Sir Maurice and Ord, J.K. (1990): Time Series (Third Edition), Edward Arnold.
5. Brockwell, P.J. and Davis, R.A.: Time Series: Theory and Methods (Second Edition), Springer Verlag.
6. Fuller, W.A. (1976): Introduction to Statistical Time Series, John Wiley, N.Y.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	1					3	2
CO2	3	3	3	2	2	1					3	2
CO3	3	3	3	2	2	1					3	2
CO4	3	2	3	2	2	1					3	2

26ASD651 Natural Language Processing and Large Language Models 3 0 0 3

Course Outcomes	
CO1	Understand the fundamentals of Natural Language Processing, including its applications, linguistic levels, and essential text preprocessing techniques such as tokenization, normalization, regular expressions, and finite state methods.
CO2	Apply statistical NLP techniques such as N-gram language models, smoothing methods, and sequence modeling using Hidden Markov Models and Conditional Random Fields for tasks like part-of-speech tagging and named entity recognition.
CO3	Analyze syntactic and semantic structures of language using formal grammars, parsing algorithms (CKY, dependency parsing), and semantic techniques including word sense disambiguation, semantic role labelling, and information extraction.
CO4	Explain and implement modern NLP architectures based on the Transformer architecture, including attention mechanisms, positional embeddings, and pre-trained models like BERT and its variants.
CO5	Evaluate and utilize Large Language Models (LLMs) by understanding their architecture, training strategies, prompting techniques, retrieval-augmented generation, and challenges such as bias, evaluation, and multimodal extensions.

Unit – I: Introduction to NLP: Overview of NLP - Applications - Linguistic Levels (Morphology, Syntax, Semantics, Pragmatics) - Text Preprocessing: Tokenization, Normalization - Regular Expressions - Finite State Transducers. **(5Hrs)**

Unit – II: Statistical NLP: N-gram Language Models - Smoothing Techniques- **Sequence Modeling:** Hidden Markov Models –Conditional Random Fields- Part-of-Speech Tagging – Named Entity Recognition. **(8Hrs)**

Unit – III: SYNTAX: Formal Grammars of English - Syntactic Parsing Ambiguity CockeKasami Younger (CKY) algorithm - PCFG - Dependency Grammar Transition based parsing-MST based Dependency parsing. **SEMANTICS:** Vector Semantics - Semantics with Dense Vectors Word

Senses: WSD and WordNet - Lexicons for Sentiment and Affect Extraction - Representation of Sentence Meaning - Computational Semantics - Information Extraction Named Entity Recognition - Semantic Role Labeling - Coreference Resolution and Entity Linking. **(12Hrs)**

Unit – IV: Transformer and Modern NLP: Transformer Architecture - Self-Attention Mechanism - Attention Approximation - Multi- Head Attention (MHA) - Multi-Query Attention (MQA) - Grouped Query Attention (GQA) - Positional Embeddings (Sinusoidal and Learned) - Transformer-based Architectures - BERT and its Derivatives, **(8Hrs)**

Unit – V: Large Language Models: Definition and Architecture of LLMs - Pretraining Objectives - Context Length - Temperature - Sampling Strategies (Greedy, Top-k, Top-p) - Prompting - In-context Learning - Chain-of-Thought Reasoning - Self-consistency, LLM Training and Optimization, **Agentic LLMs :** Retrieval-augmented generation - Advanced RAG techniques - **LLM evaluation :** LLM-as-a-judge overview - Best practices and benefits Biases and pitfalls. Beyond Transformer-based LLMs - Diffusion LLMs - Adapting Transformer architecture for image - Vision Transformer – multimodal LLMs. **(12 Hrs)**

Text Books:

1. Daniel Jurafsky and James H. Martin, "Speech and Language Processing ", Prentice – hall, Inc., 2017.
2. Afshine Amidi and Shervine Amidi, "Super Study Guide: Transformers & Large Language Models" First edition, United States, 2024.
3. Tanmoy Chakraborty, Introduction to Large Language Models, Wiley India, 1st Edition, 2025.

References:

1. Christopher D. Manning, Hinrich Schutze, "Foundations of Statistical Natural Language Processing", The MIT Press, 2018.
2. Denis Rothman, "Transformers for Natural Language Processing and Computer", Packt Publishing, Birmingham, 2024.
3. ZhihanLyu, "Applications of Generative AI", Springer, Switzerland, 2024.
4. Yoav Goldberg, "Neural Network Methods for Natural Language Processing", Synthesis Lectures on Human Language Technologies, April 2017.
5. Steven Bird, Ewan Klein, and Edward Loper, "Natural Language Processing with Python - Analyzing Text with the Natural Language Toolkit", O,Reilly. 2019

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	1	0		0	1		1	1
CO2	2	3	2	2	3	0		1	1		1	2
CO3	2	3	3	3	3	2		1	1		1	2
CO4	2	2	3	3	2	3		1	1		1	2
CO5	2	2	3	3	2	3		1	1		1	2

26CUL500	**INTEGRATED AMRITA MEDITATION TECHNIQUE**	**L-T-P-C 0-0-2-1**
A. Nature of Course: Lab/Practical		
B. Course Description:		

The course introduces students to the Integrated Amrita Meditation Technique (IAM 20), a structured practice that combines yogic stretches, regulated breathing (pranayama), and guided meditation. The course integrates both theoretical understanding and experiential practice to enhance emotional balance, stress resilience, concentration, and overall holistic development.

Aligned with United Nations Sustainable Development Goal 3 (SDG 3): Good Health and Well-Being, the course promotes preventive mental health care, emotional well-being, and sustainable lifestyle practices among students. By fostering inner stability, self-awareness, and self-regulation, the programme supports academic excellence and contributes to the development of healthy individuals and communities.

The course is expected to improve student well-being, enhance academic focus and cognitive clarity, reduce stress-related indicators, and promote compassionate and emotionally supportive culture.

C. Course Objectives:

- To promote overall health and well-being of students.
- To train students in the structured practice of IAM 20.
- To develop emotional regulation and stress management skills.
- To encourage reflective awareness and compassionate living.

D. Course Outcomes:

After successful completion of the course, students will be able to:

CO	Course Outcomes	Knowledge Level (Bloom's Taxonomy)
CO1	Explain principles and components of IAM 20	Understand (L2)
CO2	Demonstrate and correct meditation practice independently	Apply (L3)
CO3	Analyze personal stress patterns using meditation insights	Analyse (L4)
CO4	Evaluate personal growth through daily practice	Evaluate (L5)

E. CO-PO Mapping: [affinity: 3 – high; 2- moderate; 1- slightly]

CO's	Program Outcomes (PO's)											Program Specific Outcomes (PSF's)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	1	-	2	-	-	1	-	-	-
CO2	-	-	-	-	-	2	2	1	1	-	1	-	-	-
CO3	-	-	-	-	-	1	1	2	-	-	1	-	-	-
CO4	-	-	-	-	-	1	1	1	1	-	1	-	-	-

F. Syllabus

Unit 1: Foundations of Meditation (CO1)

- Meaning and purpose of meditation
- Demonstration and supervised training
- Overview of structure of IAM
- Guidance for safe and effective practice
- Importance of mental health

Unit 2: Theoretical Foundations (CO2)

- Structure and components of IAM: yogic stretches, regulated breathing, and guided meditation
- Breath–mind connection
- Integration of IAM practice into daily routine and academic life
- Application of IAM for stress management, concentration, and holistic student development

Unit 3: IAM Practical Training (CO3)

- Preparatory stretches
- Pranayama components
- Guided meditation sequence
- Corrections and common challenges

Unit 4: Integration and Transformation (CO4)

- Building daily discipline
- Research evidence in higher education
- Compassion and mindful communication

G. Evaluation Pattern:

Assessment	**Internal (60)**	**External (40)**
Attendance	20 Marks	
Class Participation	20 Marks	
Activity	20 Marks	
Practical Demonstration		30 Marks
Viva		10 Marks

Amrita University's Amrita Values Program (AVP) is a new initiative to give exposure to students to the richness and beauty of the Indian way of life. India is a country where history, culture, art, aesthetics, cuisine, and nature exhibit more diversity than anywhere else in the world. Amrita Values Programs emphasize making students familiar with the rich tapestry of Indian life, culture, arts, science, and heritage which has historically drawn people from all over the world. Post-graduate students shall have to register for any one of the following courses, in the second semester, which may be offered by the respective school.
Courses offered under the framework of the Amrita Values Program:

22AVP501 Message of Śrī Mātā Amritanandamayi Devi 1 0 0 1

Amma's messages can be put into action in our life through pragmatism and attuning of our thought process in a positive and creative manner. Every single word Amma speaks, and the guidance received in matters which we consider trivial are rich in content and touches the veryinner being of our personality. Life gets enriched by Amma's guidance, and She teaches us theart of exemplary life skills where we become witness to all the happenings around us keepingthe balance of the mind.

22AVP502 Insights from the Ramayana 1 0 0 1

The historical significance of Ramayana, the first Epic in the world, influence of Ramayana onIndian values and culture, storyline of Ramayana, study of leading characters in Ramayana, influence of Ramayana outside India, misinterpretation of Ramayana by colonial powers and its impact on Indian life, relevance of Ramayana for modern times.

22AVP503 Insights from the Mahabharata 1 0 0 1

The historical significance of Mahabharata, the largest Epic in the world, influence of Mahabharata on Indian values and culture, storyline of Mahabharata, study of leading characters in Mahabharata, Kurukshetra War and its significance, importance of Dharma in society, message of the Bhagavad Gita, relevance of Mahabharata for modern times.

22AVP504 Insights from the Upanishads 1 0 0 1

Introduction: Sruti versus Smrti, overview of the four Vedas and the ten Principal Upanishads,the central problems of the Upanishads, ultimate reality, the nature of Atman, the different modes of consciousness, Sanatana Dharma and its uniqueness, The Upanishads and Indian Culture, relevance of Upanishads for modern times, a few Upanishad Personalities: Nachiketas,Satyakama Jabala, Aruni, Shvetaketu.

22AVP505 Insights from Bhagavad Gita 1 0 0 1

Introduction to Bhagavad Gita, brief storyline of Mahabharata, context of Kurukshetra War, the anguish of Arjuna, counsel by Sri. Krishna, key teachings of the Bhagavad Gita, Karma Yoga, Jnana Yoga, and Bhakti Yoga, theory of Karma and Reincarnation, concept of Dharma,idea of the self and realization of the self, qualities of a realized person, concept of Avatar, relevance of Mahabharata for modern times.

22AVP506 Message of Swami Vivekananda 1 0 0 1

Brief sketch of Swami Vivekananda's life, meeting with Guru, disciplining of Narendra, travelacross India, inspiring life incidents, address at the parliament of religions, travel in the UnitedStates and Europe, return and reception India, message to Indians about our duties to the nation.

22AVP507 Great Spiritual Teachers of India 1 0 0 1

Sri Rama, Sri Krishna, Sri Buddha, Adi Shankaracharya, Sri Ramanujacharya, Sri Madhvacharya, Sri Ramakrishna Paramahamsa, Swami Vivekananda, Sri Ramana Maharshi, Mata Amritanandamayi Devi

22AVP508 Indian Arts and Literature 1 0 0 1

The aim of this course is to present the rich literature, culture of ancient India, and help studentsappreciate their deep influence on Indian life, Vedic culture, the primary source of Indian culture, brief introduction, and appreciation of a few of the art forms of India, arts, music, dance, theatre, paintings, sculpture and architecture, the wonder language, Sanskrit, and ancientIndian Literature.

22AVP509 Yoga and Meditation 1 0 0 1

The objective of the course is to provide practical training in YOGA ASANAS with a sound theoretical base and theory classes on selected verses of Patanjali's Yoga Sutra and AshtangaYoga. The coverage also includes the effect of yoga on integrated personality development.

22AVP510 Appreciation of Kerala's Mural Art Forms 1 0 0 1

A mural is any piece of artwork painted or applied directly on a wall, ceiling, or another largepermanent surface. In the contemporary scenario, Mural painting is not restricted to permanentstructures and is being done even on canvas. A distinguishing characteristic of mural paintingis that the architectural elements of the given space are harmoniously incorporated into the picture. Kerala mural paintings are frescos depicting mythology and legends, which are drawnon the walls of temples and churches in South India, principally in Kerala. Ancient temples, churches, and places in Kerala, South India, display an abounding tradition of mural paintingsmostly dating back to the 9th to 12th centuries CE when this form of art enjoyed Royal patronage. Learning Mural painting through the theory and practice workshop is the objectiveof this course.

22AVP512 Ancient Indian Science and Technology 1 0 0 1

Science and technology in ancient and medieval India covered all the major branches of humanknowledge and activities, including mathematics, astronomy, physics, chemistry, medical science and surgery, fine arts, mechanical, civil engineering, architecture, shipbuilding, and navigation. Ancient India was a land of sages, saints, and seers as well as a land of scholars and scientists. The course gives awareness of India's contribution to science and technology.