M.Sc APPLIED STATISTICS AND DATA ANALYTICS
(Academic Year 2022-23 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.
## Curriculum
*(effective from the academic year 2022-23)*

### Semester I

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Total credits for the programme: **80**

*(α) Course code for Live in Lab*
## ELECTIVES (any three)

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## OPEN ELECTIVES PG

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*One Open Elective course is to be taken by each student, in the third semester, from the list of Open electives offered by the School.

* Students undertaking and registering for a Live-in-Lab project, can be exempted from registering for the Open Elective course in the third semester.
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 algorithms.

Unit I

Abstraction - Abstract data types; Data Representation; Elementary data types; Basic concepts of data Structures; Mathematical preliminaries - big-Oh notation; efficiency of algorithms; notion of time and space complexity; performance measures for data structures. ADT array - Computations on arrays - sorting and searching algorithms.

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.

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.

Unit-IV

Introduction to time complexity. Bio-O, worst case complexity, polynomial classifications. Satisfiability, NP Complete and NP Hard (Definitions only).

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.

**Text Books:**
1. Goodrich M T, Tamassia R and Michael H. Goldwasser, “Data Structures and

**Reference Books:**
   Wiley publication, 2010.

**CO-PO Mapping:**

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**22MAT522 Introduction to Data Analysis with R Programming** 3 0 2 4

**Course Outcomes**
CO1: Exploring and implementing exploratory data analytics
CO2: Understanding correlation and regression and visualising them using R
CO3: Understanding supervised learning through linear and logistic regressions
CO4: Understanding and implementing classifiers for unsupervised data
CO5: Exploring Massive data sets and implementing classification algorithms

Overview of R software, Data Frames, R Scripts, creating, importing/exporting and merging
of datasets, creating matrices and basic matrix operations in R, 2d/3d plotting, programming
in R (for, if else, do and while loops),.functions, creating report using R markdown.

Exploring data using R, Scatter plot, histogram, bar chart, pie chart, box plot, basic statistics
computation (mean, median, variance etc.)

Generating random samples from standard distributions (such as Bernoulli, Poisson, Normal,
Exponential etc.) and comparing theoretical pdfs/pmfs using histograms/frequency
distributions, quantiles of sampling distributions (t, chi and F distribution).

Maximization/minimization of functions in R (some algorithm), MLE estimation.
Polynomial fitting of scatter plot, introducing regression line, least squares estimates,
residual plots, testing normality of residuals (qqplot), goodness of fit measures and tests, testing of regression parameters, simulation of regression model, empirical distribution of least square estimator and its comparison with theoretical distribution.

Simulation of multivariate normal random vectors, estimation of mean and covariance matrix, eigen values and eigen vector of variance covariance matrix, spectral decomposition covariance matrix.

Generating dependent random variables with so

**Text Books /Reference books:**
4. Data Science and big data analytics: Discovering, analyzing, visualizing and presenting data ,EMC Education Services,John Wiley 2015

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**22MAT523**  **Linear Algebra**  **3 0 2 4**

**Course outcomes**

CO-1: To understand the axioms in the definition of a vector space through examples; to understand Subspaces / Quotient Space / mappings and identify them; To familiarize the concept of basis and its relevance.
CO-2: To understand inner products and compute the angle/length of a vector. To construct the orthonormal basis.
CO-3: To familiarize the types of matrices, understand their properties and apply them in the real quadratic forms
CO-4: To understand the construction of matrices for a linear transformation in the triangular form
CO 5 To understand the concepts of Eigen Values, Eigen Vectors & Diagonalization

Unit-I

Unit-II

Unit-III
Linear Transformations: Positive definite matrices - Matrix norm and condition number - QR-Decomposition - Linear transformation - Relation between matrices and linear transformations - Kernel and range of a linear transformation - Change of basis - Nilpotent transformations - Trace and Transpose, Determinants, Symmetric and Skew Symmetric Matrices, Adjoint and Hermitian Adjoint of a Matrix, Hermitian, Unitary and Normal Transformations, Self Adjoint and Normal Transformations, Real Quadratic Forms.

Unit-IV
Eigen values and Eigen vectors: Problems in Eigen Values and Eigen Vectors, Diagonalization, Orthogonal Diagonalization, Quadratic Forms, Diagonalizing Quadratic Forms, Conic Sections. Similarity of linear transformations - Diagonalisation and its applications - Jordan form and rational canonical form.

Unit-V
Quotient Space. Symmetric and Non-degenerate bilinear forms. Decompositions : LU,QR and SVD

Text Books


Reference Books:


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CO2. Learn gradient based Optimizations Techniques in single variables as well as multi-variables (non-linear).

CO3. Understand the Optimality criteria for functions in several variables and learn to apply OT methods like Unidirectional search and Direct search methods.

CO4. Learn constrained optimization techniques. Learn to verify Kuhn-Tucker conditions and Lagrangian Method.

CO5. Understand and solve the integer linear programming and dynamic programming.

Course outcomes


Introduction to Linear Programming: Lines and hyperplanes, Convex sets, Convex hull, Formulation of a Linear Programming Problem, Theorems dealing with vertices of feasible regions and optimality, Graphical solution. Simplex method (including Big M method and two-phase method), Dual problem, Duality theory, Dual simplex method, Revised simplex method.

Texts/References:


CO-PO Mapping:
22MAT525 Probability Theory and Estimation 3 0 2 4

Course outcomes

CO1: Understand the basics of probability, random variables and distribution functions.
CO2: Gain knowledge about standard statistical distributions and their properties
CO3: Know the importance of two dimensional random variables and correlation studies
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 -

Unit-II
Standard distributions - Binomial, Multinomial, Poisson, Uniform, exponential, Weibull, Gamma, Beta, Normal. Mean, variance and applications of these distributions- Chebyshev’s theorem and central limit theorem.

Unit-III
Joint, marginal and conditional probability distributions for discrete and continuous cases, stochastic independence, expectation of two dimensional random variables, conditional mean and variance, correlation and introduction to regression.

Unit-IV
Point estimation, properties, methods of estimating a point estimator, minimum risk estimators Sampling distributions of mean and variance, Central and Non-central distributions of t, F and Chi-Square distribution. Central limit theorem.

Unit-V
Interval estimation- Confidence interval for one mean, difference of two means, single proportion, difference of two proportions, single variance, ratio of two variances.

**TEXT BOOKS /REFERENCE BOOKS:**


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**22MAT526 Python Programming 3 0 2 4**

**Course outcomes**

| CO-1: Understand the basic data types and string operations. |
| CO-2: Understand and apply various function calls in Python. |
| CO-3: Familiarise and implement boolean expressions, logical operators and executive statements. |
| CO-4: Execute the Python programme for tree traversals and search problems. |
| CO-5: Understand and apply the concepts of dictionaries and lists in Python programme. |

**Unit I**


**Unit II**
Data Structures: Lists - Operations, Slicing, Methods; Tuples, Sets, Dictionaries, Sequences Comprehensions. Case Study: Nondirective Psychotherapy

Unit III

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

Unit IV

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, Reading Data from the HTML Format, and Reading Data from the XML 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.

Unit V

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.
Coding Simple GUI-Based Programs: Windows and Labels, Displaying Images, Command Buttons and Responding to Events, Viewing the Images of Playing Cards, Entry Fields for the Input and Output of Text, and Using Pop-up Dialog Boxes. Case Study: A GUI-Based ATM

Text Books:


Reference Books

1. https://www.w3schools.com/python
2. Learning Python, Mark Lutz, Orielly

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**SEMESTER-II**

**22MAT527**  | Big Data Analytics and Hadoop | 3 0 2 4

**Course Outcomes**

CO1: Understanding the concepts of Big Data
CO2: Understanding the aspects of managing, cleaning and sampling of Data
CO3: Understanding Hadoop architecture and implement Map Reduce concept
CO4: To understand the aspects of Data base management and Querying system
CO5: Understanding and executing HDFS using PIG and HIVE

**Unit I**

Introduction to Big Data: Types of Digital Data-Characteristics of Data – Evolution of Big Data - Definition of Big Data - Challenges with Big Data - 3Vs of Big Data - Non Definition traits of Big Data - Business Intelligence vs. Big Data - Data warehouse and Hadoop environment.

**Unit II**

Big Data Analytics: Classification of analytics - Data Science - Terminologies in Big Data Data science process – roles, stages in data science project – working with data from files — exploring data – managing data – cleaning and sampling for modeling and validation. working with relational databases - NoSQL: Types of Databases – Advantages – NewSQL - SQL vs. NOSQL vs NewSQL.

**Unit III**


**Unit IV**


Unit V
Hadoop Eco systems: Hive – Architecture - data type - File format – HQL – SerDe - 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 - Parameter substitution - Diagnostic operator.

Text Books / Reference Books:
3. Data Science and big data analytics : Discovering, analyzing , visualizing and presenting data ,EMC Education Services,John Wiley 2015

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22MAT528 Database Management 3 0 2 4

Course outcomes

CO1: Understand the basics database systems and rational models.
CO2: Gain knowledge about various design processes
CO3: To understand the intermediate SQL and advanced SQL.
CO4: To understand the normal forms.
CO5: To understand and apply the algorithms for decomposition using multi-values dependencies – PJNF and DKNF.

Unit I
Unit II

Unit III
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 – algorithm for decomposition -decomposition using multi-values dependencies – PJNF and DKNF. Over view of Transaction Management and Concurrency control

Text Book:

Reference Books

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22MAT529 Data Mining 3 1 0 4

Course Objectives:
CO1: Learn data mining basic concepts and understand association rules mining.
CO2: Capable of grouping data using clustering techniques.
CO3: Able to identify the outliers of the given dataset.
CO4: Capable of minimizing dimensionality of the data with minimum loss of information.
CO5: Able to prioritize the web links and advertisements

Unit - I
Introduction to Data Mining: Introduction, What is Data Mining, Definition, KDD, Challenges, Data Mining Tasks, Data Preprocessing, Data Cleaning, Missing data, Dimensionality Reduction, Feature Subset Selection, Discretization and Binaryzation, Data Transformation; Measures of Similarity and Dissimilarity- Basics.

Unit - II

Unit-III

Unit-IV
Outlier Detection: Outliers and Outlier Analysis -What Are Outliers?, Types of Outliers ,Challenges of Outlier Detection, Outlier Detection Methods, Statistical Approaches, Parametric Methods, Nonparametric Methods, Proximity-Based Approaches, Clustering-Based Approaches, Classification-Based Approaches, Mining Contextual and Collective Outliers.

Unit-V

Text Books:

Reference Books and websites:
1. https://nptel.ac.in/courses/106/105/106105174/

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Course Objectives:
CO1: To be able to formulate machine learning problems corresponding to different applications.
CO2: To understand a range of machine learning algorithms along with their strengths and weaknesses.
CO3: To understand the basic theory underlying machine learning.
CO4: To be able to apply machine learning algorithms to solve problems of moderate complexity.

Unit-I

Unit-II

Unit-III
Instance-Based Learning: Introduction, k-Nearest Neighbour Learning, Locally Weighted Regression, Radial Basis Functions, Case-Based Reasoning, Remarks on Lazy and Eager Learning.


Unit-IV

Unit-V
Reinforcement Learning: Introduction, the Learning Task, Q Learning, Non-Deterministic, Rewards and Actions, Temporal Difference Learning, Generalizing from Examples, Relationship to Dynamic Programming. Case Study.

Text Books:
1. Machine Learning – Tom M. Mitchell, - MGH

Reference Books:
2. Richard o. Duda, Peter E. Hart and David G. Stork, pattern classification, John Wiley & Sons

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22MAT531  Multivariate Statistics and Regression Analysis  3 0 2 4

Course Outcomes

CO1: To understand the basics of multivariate random variables and sampling distributions.

CO2: To apply multivariate techniques for classification of distributions

CO3: To understand the concept of PCA and its application in clustering analysis

CO4: To gain knowledge on simple linear regression, estimation and testing of model parameters

CO5: To gain knowledge on multiple linear and nonlinear regression and estimation of model parameters

Unit-I:

Multivariate Random variables and Distribution functions – Variance - covariance matrix – correlation - Bivariate normal distribution, Multivariate normal density and its properties - Definition of Wishart matrix and its properties, Mahalanobis Distance.

Unit-II:

Classification for two populations, classification with two multivariate normal populations, Fisher’s discriminant functions for discriminating several population.

Unit-III:

Principal components analysis, Dimensionality reduction, Factor Analysis- factor loadings using principal component analysis.

Unit-IV:

**Unit-V:**

Multiple Linear Regression: Estimation of model parameters. Nonlinear Regression models.

**Text books/ Reference books:**


**CO-PO Mapping:**

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**22MAT532 Statistical Inference and Design of Experiments 3 0 2 4**

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 know to apply goodness of fit tests and nonparametric tests

CO3: To understand statistical inference for two samples and apply to engineering, science and business problems.

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

**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- Inference on Two Population Proportions.

**Unit III**

**Unit IV**

**Unit V**
Design of Experiments with Several Factors-Introduction, Factorial Experiments, Two-Factor Factorial Experiments, General Factorial Experiments, $2^k$ Factorial Designs.

**Text Books /Reference Books**

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**SEMESTER-III**

22MAT621 SQC AND RELIABILITY THEORY 3 0 2 4

CO1 To understand the basic concepts of quality control and to construct variable and attribute control charts.
CO2 To understand and construct EWMA and CUSUM charts, analyse the process capability and Six Sigma quality metrics.
CO3 To gain knowledge about acceptance sampling methods and their properties
CO4 To gain knowledge about reliability and properties
CO5 To study reliability distributions and analyse reliability of systems and maintenance

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

Unit- II
OC and ARL curves 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 – C_p and C_pk, Six Sigma quality metrics

Unit- III
Acceptance sampling for attributes, single sampling, double sampling, measuring performance of the sampling plans- OC, AQL, LTPD, AOQ, ATI curves.

Unit -IV
Introduction to Reliability and its needs; Different Approaches to Reliability Analysis, Application Areas, State Variable, Time to Failure, Failure 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 families of some common life distributions –Exponential, Weibull and Gamma and its characterization-Reliability estimation of parameters in these models. Fault Tree Analysis, Reliability Block Diagrams, Systems of Independent Components -System Reliability, Nonrepairable Systems, Quantitative Fault Tree Analysis, Reliability of Maintained Systems - Types of Maintenance, Downtime and Downtime Distributions, System Availability Assessment

Text Books/References:

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3 1
Course outcomes

CO1: Understand the basics concepts of artificial neural networks.
CO2: Gain knowledge about activation functions and understand the multi layer neural network
CO3: Know the importance of regularization, bagging and ensemble methods
CO4: To gain knowledge convolution neural network and case studies
CO5: To gain knowledge about recurrent neural networks, adversarial neural networks, Spectral CNN and deep reinforcement learning

Unit-I

Biological neuron, idea of computational units, McCulloch – pitts unit and thresholding logic, linear perceptron, perceptron learning algorithm, convergence theorem for Perceptron learning algorithm, logistic regression, gradient descent.

Unit-II

Feed forward neural network, activation functions, non-linear activation functions. multi-layer neural network.

Unit-III

Practical aspects of deep Learning: training, testing, regularization –dataset augmentation, Noise robustness, multitask learning, bagging and other ensemble methods, dropout- generalization.

Unit-IV


Unit-V


Text Books / Reference Books
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:

Art of Living through Amma

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 very inner being of our personality. Life gets enriched by Amma’s guidance, and She teaches us the art of exemplary life skills where we become witness to all the happenings around us keeping the balance of the mind.

Insights from the Ramayana

The historical significance of Ramayana, the first Epic in the world, influence of Ramayana on Indian 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.

Insights from the Mahabharata

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.

Insights from the Upanishads

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.

Insights from Bhagavad Gita
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.

Swami Vivekananda and his Message
Brief sketch of Swami Vivekananda’s life, meeting with Guru, disciplining of Narendra, travel across India, inspiring life incidents, address at the parliament of religions, travel in the United States and Europe, return and reception in India, message to Indians about our duties to the nation.

Great Spiritual Teachers of India
Sri Rama, Sri Krishna, Sri Buddha, Adi Shankaracharya, Sri Ramanujacharya, Sri Madhavacharya, Sri Ramakrishna Paramahamsa, Swami Vivekananda, Sri Ramana Maharshi, Mata Amritanandamayi Devi

Indian Arts and Literature:
The aim of this course is to present the rich literature, culture of ancient India, and help students appreciate 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 ancient Indian Literature.

Importance of Yoga and Meditation in Life:
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 Ashtanga Yoga. The coverage also includes the effect of yoga on integrated personality development.

Appreciation of Kerala’s Mural Art Forms:
A mural is any piece of artwork painted or applied directly on a wall, ceiling, or another large permanent surface. In the contemporary scenario, Mural painting is not restricted to permanent structures and is being done even on canvas. A distinguishing characteristic of mural painting is 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 drawn on 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 paintings mostly 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 objective of this course.

Practicing Organic Farming
Life and nature are linked through the healthy practices of society for maintaining sustainability. When modern technological knowledge microorganisms are applied in farming using the traditional practice, we can avoid damage to the environment. The course will train the youth on modern practices of organic farming. Amma says “we have to return this land to the coming
generations without allowing even the slightest damage to happen to it.” Putting this philosophy to practice will bring about an awakening and enthusiasm in all to strive for good health and to restore the harmony in nature.”

**Ancient Indian Science and Technology**

Science and technology in ancient and medieval India covered all the major branches of human knowledge 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.

**21CUL501** Cultural Education 200 P/F

Objective: Love is the substratum of life and spirituality. If love is absent life becomes meaningless. In the present world, if love is used as the string to connect the beads of values, life becomes precious, rare, and beautiful like a fragrant blossom. Values are not to be learned alone. They must be imbibed into the inner spirit and put into practice. This should happen at the right time when you have vitality and strength when your hearts are open.

The present course in value education is a humble experience-based effort to lead and metamorphosis the students through the process of transformation of their inner self towards achieving the best. Amma’s nectarous words of wisdom and acts of love are our guiding principles. Amma’s philosophy provides an insight into the vision of our optimistic future.

1. Invocation, Satsang, and Question-Answers
2. Values - What are they? Definition, Guiding Principles with examples Sharing own experiences
3. Values - Key to a meaningful life. Values in different contexts
4. Personality - Mind, Soul, and Consciousness - Q and A. Body-Mind-Intellect and the Innerpsyche Experience sharing
5. Psychological Significance of samskara (with e.g. From Epics)
6. Indian Heritage and Contribution and Q and A; Indian Ethos and Culture
7. Self-Discipline (Evolution and Practice) – Q and A
8. Human Development and Spiritual Growth - Q and A
9. Purpose of Life plus Q and A
11. Vedanta and Creation - Understanding a spiritual Master
12. Dimensions of Spiritual Education; Need for change Lecture – 1; Need for Perfection Lecture – 2
13. How to help others who have achieved less - Man and Nature Q and A, Sharing of experiences

**REFERENCES**

1. *Swami Amritaswaroopananda Puri - Awaken Children (Volume VII and VIII)*
2. *Swami Amritaswaroopananda Puri - Amma’s Heart*
3. *Swami Ramakrishnanda Puri - Rising Along the Razor’s Edge*
22AVP103 Mastery Over Mind (MAOM) 1-0-2 2

1. Course Overview

Master Over the Mind (MAOM) is an Amrita initiative to implement schemes and organise university-wide programs to enhance health and wellbeing of all faculty, staff, and students (UN SDG -3). This program as part of our efforts for sustainable stress reduction gives an introduction to immediate and long-term benefits and equips every attendee to manage stressful emotions and anxiety facilitating inner peace and harmony.

With a meditation technique offered by Amrita Chancellor and world-renowned humanitarian and spiritual leader, Sri Mata Amritanandamayi Devi (Amma), this course has been planned to be offered to all students of all campuses of AMRITA, starting off with all first years, wherein one hour per week is completely dedicated for guided practical meditation session and one hour on the theory aspects of MAOM. The theory section comprises lecture hours within a structured syllabus and will include invited guest lecture series from eminent personalities from diverse fields of excellence. This course will enhance the understanding of experiential learning based on university’s mission: “Education for Life along with Education for Living”, and is aimed to allow learners to realize and rediscover the infinite potential of one’s true Being and the fulfilment of life’s goals.

2. Course Syllabus

Unit 1 (4 hours)


Unit 2 ( 4 hours )

Improving work and study performance. Meditation in daily life. Cultivating compassion and good mental health with an attitude of openness and acceptance. Research and Science of Meditation: Significance of practising meditation and perspectives from diverse fields like science, medicine, technology. philosophy, culture, arts, management, sports, economics,
healthcare, environment etc. The role of meditation for stress and anxiety reduction in one’s life with insights based on recent cutting-edge technology. The effect of practicing meditation for the wholesome wellbeing of an individual.

Unit 3 (4 hours)

Communications: principles of conscious communication. Relationships and empathy: meditative approach in managing and maintaining better relationships in life during the interactions in the world, role of MAOM in developing compassion, empathy and responsibility, instilling interest, and orientation to humanitarian projects as a key to harness intelligence and compassion in youth. Methodologies to evaluate effective awareness and relaxation gained from meditation. Evaluating the global transformation through meditation by instilling human values which leads to service learning and compassion driven research.

TEXT BOOKS:

REFERENCES:
3. Swami Amritaswarupananda Puri “Awaken Children Vol 1, 5 and 7 - Dialogues with Amma on Meditation”, August 2019
4. Swami Amritaswarupananda Puri “From Amma’s Heart - Amma’s answer to questions raised during world tours” March 2018

3. Evaluation and Grading

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<th>Internal Components</th>
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4. Course Outcomes (CO)

CO1: Relate to the causes of stress in one’s life.
CO2: Experiment with a range of relaxation techniques CO3:
Model a meditative approach to work, study, and life.
CO4: Develop appropriate practice of MA-OM technique that is effective in one’s life CO5:
Inculcate a higher level of awareness and focus.
CO6: Evaluate the impact of a meditation technique

*Programme Outcomes (PO) (As given by NBA and ABET)*

PO1: Engineering Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Engineer and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

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ELECTIVES

22MAT731 Business Analytics 3 0 0 3

Course Objectives:
1. Understanding the Role of Business Analyst and Data Science in business.
2. Understanding the basic concept of data management and data mining techniques
3. To understand the basic concept of machine learning
4. To understand the application of business analysis.

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

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.

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:
1. Essentials of Business Analytics: An Introduction to the methodology and its application, Bhimasankaram Pochiraju, SridharSeshadri, Springer
3. Introduction to Data Science, Laura Igual Santi Seguí, Springer

Reference Book:
1. Introduction to Data Mining, Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Pearson Education India

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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 basics of Generalized Linear Models

Categorical Data-nominal and ordinal random variables.


Generalized Linear Models (GLMs): components of a GLM.
Logistic 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.

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.

Texts / References

CO-PO Mapping:
## 22MAT733  Computational Biology  3003

### 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.

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.


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.

### References/ Textbooks


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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.

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.


Multivariate Statistical methods in QSAR - Principal Component Analysis (PCA) and Hierarchical Cluster Analysis (HCR). Regression analysis tools - Principal Component Regression (PCR), Partial Least Squares (PLS) - Case studies.

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

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.

References/ Textbooks


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.


Life Table: Basic definitions, probabilities, construction of life tables, life expectancy.

Life annuities: calculating annuity premium, interest and survivorship discount function, guaranteed payments, deferred annuities.

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.

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

Text Books:

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22MAT735 Demography and Actuarial Statistics 3003
**22MAT736  Healthcare Analytics  3 0 0 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.


**Text / References books :**


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**22MAT737  Market Analytics  3 0 0 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.

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.

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.


Text/References Books:


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22MAT738  Mining of Massive Datasets  3 0 0 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.

Text / References Book

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22MAT739 Official Statistics 3 0 0 3

Course outcomes

CO1: Understand the Indian statistical system.
CO2: Understand the CSO, NSSO and RGO.
CO4: To gain knowledge economic development.


Text Books:
2. Principles and Accommodation of National Population Census, UNEDCO
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22MAT740 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.

Introduction – parallelism and goals, parallel computing models – RAM, PRAM, CTA.


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


Text Reference Book:


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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.

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

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22MAT743 Reinforcement Learning 3 0 0 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.


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22MAT744  Sampling Techniques  3 0 0 3

Course outcomes

CO1: Understand the preliminary concepts like schedules and pilot survey.
CO2: Gain knowledge about Simple random sampling with and without replacements, random number generation.
CO3: To understand Probability proportional to size sampling, estimates of these standard errors.
CO4: To gain knowledge on cluster sampling.

Preliminary concepts – schedules and questionnaires, pilot survey, non-sampling errors, use of random numbers. Simple random sampling with and without replacements, random number generation – estimates of population mean and population proportion and their standard errors, Probability proportional to size sampling, estimates of these standard errors. Stratified random sampling – estimates of sample statistic and estimates of their standard errors. Allocation of sample size in stratified random sampling. Linear and circular systematic sampling. Cluster sampling: Two stage sampling (equal first stage units). Ideas of ratio and regression estimators – only estimates of sample mean.

References


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Course outcomes

Course Outcomes:

CO1: To understand the basics of social networks and its modelling.
CO2: To understand the fundamental of social data analytics.
CO3: Understand and apply the data mining concepts in social networks.
CO4: Carry out some case studies in social network analysis.

Unit 1: Online Social Networks (OSNs)

Introduction - Types of social networks (e.g., Twitter, Facebook), Measurement and Collection of Social Network Data. Techniques to study different aspects of OSNs -- Follower-followee dynamics, link farming, spam detection, hashtag popularity and prediction, linguistic styles of tweets. Case Study: An Analysis of Demographic and Behaviour Trends using Social Media: Facebook, Twitter and Instagram

Unit 2: Fundamentals of Social Data Analytics

Introduction - Working with Social Media Data, Topic Models, Modelling social interactions on the Web – Agent Based Simulations, Random Walks and variants, Case Study: Social Network Influence on Mode Choice and Carpooling during Special Events: The Case of Purdue Game Day

Unit 3: Applied Social Data Analytics


Text and Reference Literature


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**22MAT746**  
**Special Distribution Functions**  
**3 0 0 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.


**Text/Reference books**


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22MAT747 Stochastic Process 3003

Course outcomes

| CO1 | Understand the concepts of stochastic process, markov chains and classification of states and chains. |
| CO2 | Understand the markov process with discrete state space as poisson process and its properties with related theorems. |
| CO3 | Understand the markov process with continuous state space as wiener process and its properties. |
| CO4 | Understand the renewal process and related theorems. |
| CO5 | Understand the concepts of branching process and Bellman-Harris process. |


Text Books:

Reference Books:

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22MAT748 Survival Analysis 3 0 0 3

Course outcomes

CO1: Understand the basics of survival distributions and its applications.
CO2: Understand the censoring schemes and its applications.
CO3: Know the importance of non-parametric methods.
CO4: To gain knowledge competing risk theory.

Survival Analysis: Functions of survival times, survival distributions and their applications
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.
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.

References
2. Collet, D. Statistical analysis of life time data,1984

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Course outcomes

CO1: Understand the basics of Taguchi loss functions.
CO2: Gain knowledge about factorial experiments.
CO3: To understand the two and three level factors.
CO4: To gain knowledge about inner and out array experiments.

Taguchi loss functions –mean square error loss function, average loss function, higher the better and lower the better loss functions –two-way analysis of variance with interactions –factorial experiments with two and three-level factors – orthogonal array experiments with two and three-level factors – methods of interpretation of experimental results - parameter and tolerance design experiments – signal-to-noise ratios – inner and outer array experiments.

Text/Reference Books

1. Taguchi Techniques for Quality Engineering

CO-PO Mapping:
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.

References:
2. Max Shron, Thinking with Data, How to Turn Information Into Insights, O'Reilly Media, 2014.

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