

**M.Sc. Data Science with Logistic and Supply Chain Management**  
(Academic Year 2023-24 onwards)

**Curriculum**  
(effective from the academic year 2023-24)

**Semester I**

Course code	Course	L T P	Credit	ES
23DLS501	Linear Algebra	3 0 2	4	A
23DLS502	Probability and Statistics	3 0 2	4	B
23DLS503	Logistic	3 0 2	4	C
23DLS504	Optimization Techniques	3 1 0	4	D
23DLS505	Introduction to Data Analytics with R Programming	3 0 2	4	E
23DLS506	Python Programming	3 0 2	4	F
22ADM501	Glimpses of Indian Culture	2 0 0	P/F	G
	<b>Total</b>		<b>24</b>	

**Semester II**

Course code	Course	L T P	Credit	ES
23DLS511	Supply Chain Management	3 0 2	4	A
23DLS512	Multivariate Statistics and Regression Analysis	3 0 2	4	B
23DLS513	Machine Learning	3 0 2	4	C
23DLS514	Inventory Control	3 0 2	4	D
23DLS515	Procurement, Storage and Warehouse Management	3 1 0	4	E
23DLS516	Demand and Revenue Management	3 0 2	4	F
	Amrita Value Programme	1 0 0	1	G
22AVP103	Mastery Over Mind	1 0 2	2	
	<b>Total</b>		<b>27</b>	

**Semester III**

Course code	Course	L T P	Credit	ES
23DLS601	Multimodal Transportation	3 1 0	4	A
23DLS602	Deep Learning	3 0 2	4	B
	Elective I	3 0 0	3	D
	Elective II	3 0 0	3	E
	Elective III	3 0 0	3	F
23DLS690@	Live-in-Lab.@/ Open Elective *	2 0 0	2	J
	<b>Total</b>		<b>19</b>	

**Semester IV**

Course code	Course	L T P	Credit	ES
23DLS699	Dissertation		10	P
	<b>Total</b>		<b>10</b>	

**Total credits for the programme: 80**

### ELECTIVES (any three)

Course code	Course	L T P	Credit	ES
23DLS631	Taugchi Techniques	3 0 0	3	D/E
23DLS632	Pattern Recognition	3 0 0	3	D/E
23DLS633	Stochastic Process	3 0 0	3	D/E
23DLS634	Queuing Theory	3 0 0	3	D/E
23DLS635	Market Analytics	3 0 0	3	D/E
23DLS636	Survival Analysis	3 0 0	3	D/E
23DLS637	Demography and Actuarial Statistics	3 0 0	3	D/E
23DLS638	Official Statistics	3 0 0	3	D/E
23DLS639	Healthcare Analytics	3 0 0	3	D/E
23DLS640	Reinforcement Learning	3 0 0	3	D/E
23DLS641	Social Network Analytics	3 0 0	3	D/E
23DLS642	Mining of Massive Datasets	3 0 0	3	D/E
23DLS643	Thinking with Data	3 0 0	3	D/E
23DLS644	Business Analytics	3 0 0	3	D/E
23DLS645	Categorical Data Analysis	3 0 0	3	D/E

**\*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.

Table 2 New names for Amrita Value Programmes for PG programmes			
Course Code	Title	L-T-P	Credits
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 ArtsForms	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	1-0-0	1

OPEN ELECTIVES PG

Course Code	Course Title	L – T – P	Cr.	ES
21OEL631	Advanced Statistical Analysis for Research	2 0 0	2	D/E
21OEL632	Basics of PC Software	2 0 0	2	D/E
21OEL633	Computer Hardware and Networking	1 0 1	2	D/E
21OEL634	Consumer Protection Act	2 0 0	2	D/E
21OEL635	Corporate Communication	2 0 0	2	D/E
21OEL636	Design Studies	2 0 0	2	D/E
21OEL637	Disaster Management	2 0 0	2	D/E
21OEL638	Essentials of Cultural Studies	2 0 0	2	D/E
21OEL639	Foundations of Mathematics	2 0 0	2	D/E
21OEL640	Foundations of Quantum Mechanics	2 0 0	2	D/E
21OEL641	Glimpses of Life through Literature	2 0 0	2	D/E
21OEL642	Information Technology in Banking	2 0 0	2	D/E
21OEL643	Knowledge Management	2 0 0	2	D/E
21OEL644	Marketing Research	2 0 0	2	D/E
21OEL645	Media for Social Change	2 0 0	2	D/E
21OEL646	Media Management	2 0 0	2	D/E
21OEL647	Object-Oriented Programming	2 0 0	2	D/E
21OEL648	Painting and Sculpture	1 0 1	2	D/E
21OEL649	Personal Finance	2 0 0	2	D/E
21OEL650	Principles of Advertising	2 0 0	2	D/E
21OEL651	Principles of Packaging	2 0 0	2	D/E
21OEL652	Scripting for Rural Broadcasting	1 0 1	2	D/E
21OEL653	Social Media Website Awareness	1 0 1	2	D/E
21OEL654	Theatre Studies	1 0 1	2	D/E
21OEL655	Writing for Technical Purposes	2 0 0	2	D/E
21OEL656	Yoga and Personal Development	1 0 1	2	D/E
21OEL657	Fundamentals of Legal Awareness	2 0 0	2	D/E

# Syllabus

**23DLS501**

**Linear Algebra**

**3 0 2 4**

**Unit-I:** Vector Spaces: Vector spaces - Sub spaces - Linear independence - Basis – Dimension.

**Inner Product Spaces:** Inner products - Orthogonality - Orthogonal basis - Gram Schmidt Process - Change of basis - Orthogonal complements - Projection on subspace - Least Square Principle.

**Unit-II:** 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-III:** 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. Decompositions : LU,QR and SVD

## Text Books

Howard Anton and Chris Rorres, “Elementary Linear Algebra”, Tenth Edition, John Wiley & Sons, 2010.

## Reference Books:

1. Nabil Nassif, Jocelyne Erhel, Bernard Philippe, Introduction to Computational Linear Algebra, CRC press, 2015.
2. Gilbert Strang, “Linear Algebra and Its Applications”, Fourth Edition, Cengage, 2006.
3. Kenneth Hoffmann and Ray Kunze, Linear Algebra, Second Edition, Prentice Hall, 1971.
4. I. N. Herstein, ‘Topics in Algebra’, Second Edition, John Wiley and Sons, 2000.

**23DLS502**

**Probability and Statistics**

**3 0 2 4**

**Unit I:** Sample Space and Events, Interpretations and Axioms of Probability, Addition rules, Conditional Probability, Multiplication and Total Probability rules, Independence, Bayes theorem. Random variables, Probability Distributions and Probability mass functions, Cumulative Distribution functions, mathematical expectation, variance, moments and moment generating function.

**Unit II:** Standard discrete distributions - Binomial, Poisson, Uniform, Geometric distributions, Negative binomial and Hypergeometric Distributions -Standard continuous distributions - Uniform, Exponential, Gamma, Beta and Normal distributions. Chebyshev’s theorem.

Two dimensional random variables-Joint, marginal and conditional probability distributions for discrete and continuous cases, independence, expectation of two dimensional random variables - conditional mean, conditional variance, covariance and correlation.

**Unit III:** Tests of Hypotheses: Tests of Statistical Hypotheses, One-Sided and Two-Sided Hypotheses, *P*-Values in Hypothesis Tests, General Procedure for Hypothesis Tests, Tests on the Mean and Variance. F, t and Chi-square tests.

**Textbooks:**

1. Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, John Wiley and Sons Inc., 2005
2. Amir D Azcel, Jayavel Sounderpandian, Palanisamy Saravanan and Rohit Joshi, Complete Business Statistics, 7<sup>th</sup> edition McGrawHill education 2012.
3. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, Probability and Statistics for Engineers and Scientists, 8<sup>th</sup> Edition, Pearson Education Asia, 2007.

**Reference books:**

- a. Ross S.M., *Introduction to Probability and Statistics for Engineers and Scientists*, 3rd edition, Elsevier Academic Press.
- b. Ravichandran, J. Probability and Statistics for engineers, First Reprint Edition, Wiley India, 2012.

**23DLS503**

**Logistic**

**3 0 2 4**

**Unit I:** Logistics Information-Meaning & Need Forms: LIS-Definition-Information functionality - Activities involved in transaction system-Principles of designing or evaluating LIS applications. LIS Architecture: Components: Two forms of activities; Planning & co-ordination flows & operating flows - Flow and use of integrated logistics information.

**Unit II:** Information forecasting: Definition-Process- components-characteristics. Information Approaches-forecast techniques-Forecast error.

Information Technology & Logistics: Electronic Data Interchange-Personal Computers-Artificial Intelligence-Expert System- Bar coding & scanning. Electronic Data Interchange standards of Communication, Information, Future directions.

**Unit III:** Information Technology for supply chain management: Bull whip effect-IT in supply chain-Business. Process Reengineering-ERP and EDI problem; Impact of Internet on SCM.;

Text Book

1. Martin Christopher, Logistics and Supply Chain Management, Prentice-Hall.

**REFERENCE Books:**

1. David J. Bloomberg, Stephen LeMay& : Logistics, Prentice-Hall of India PvtLtd.,Joe B. Hanna New Delhi, 2003.
2. Donald J. Bowersox & David J. Closs : Logistical Management, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 2004.
3. Satish C. Ailawadi& Rakesh Singh : Logistics Management, Prentice-Hall of India Pvt Ltd., New Delhi, 2005.
4. Donald Waters : Logistics. Palgrave Macmillan, New York, 2004

Unit I: Introduction to optimization: classical optimization, Optimality criteria – Necessary and sufficient conditions for existence of extreme point.

Direct search methods: unidirectional search, evolutionary search method, simplex search method, Introduction, Conditions for local minimization. One dimensional Search methods: Golden search method, Fibonacci method, Newton's Method, Secant Method, Remarks on Line Search Sections. Hook-Jeeves pattern search method.

Unit II: Gradient-based methods- introduction, the method of steepest descent, analysis of Gradient Methods, Convergence, Convergence Rate. Analysis of Newton's Method, Levenberg-Marquardt Modification, Newton's Method for Nonlinear Least-Squares.

Conjugate direction method, Introduction The Conjugate Direction Algorithm, The Conjugate Gradient Algorithm for Non-Quadratic Quasi Newton method.

Unit III: Nonlinear Equality Constrained Optimization- Introduction, Problems with equality constraints Problem Formulation, Tangent and Normal Spaces, Lagrange Condition.

Nonlinear Inequality Constrained Optimization -Introduction – Problems with inequality constraints: Kuhn-Tucker conditions.

Text Book

1. Edwin K.P. Chong, Stanislaw H. Zak, "An Introduction to Optimization", 2<sup>nd</sup> edition, Wiley, 2013.

Reference Books

1. Mokhtar S. Bazarra, Hamit D Sherali, C.M. Shetty, "Nonlinear programming Theory and applications", 2<sup>nd</sup> edition, Wiley , 2004.
2. Mohan C. Joshi and Kannan M. Moudgalya, Optimization: Theory and Practice, Narosa Publishing House, New Delhi, 2004 (Reference)
3. Kalyanmoy Deb, "Optimization for Engineering Design Algorithms and Examples", Prentice Hall of India, New Delhi, 2004.
4. S.S. Rao, "Optimization Theory and Applications", Second Edition, New Age International (P) Limited Publishers, 1995.
5. Bertsimas, Dimitris, and John Tsitsiklis. *Introduction to Linear Optimization*. Belmont, MA: Athena Scientific, 1997.

## 23DLS505 Introduction to Data Analytics with R Programming

3 0 2 4

Unit I: Introduction, Causality and Experiments, Data Preprocessing: Data cleaning, Data reduction, Data transformation, Data discretization. Visualization and Graphing: Visualizing Categorical Distributions, Visualizing Numerical Distributions, Overlaid Graphs, plots, and summary statistics of exploratory data analysis, Randomness, Probability, Introduction to Statistics, Sampling, Sample Means and Sample Sizes.

Unit II: Descriptive statistics – Central tendency, dispersion, variance, covariance, kurtosis, five point summary, Distributions, Bayes Theorem, Error Probabilities; Permutation Testing,

Statistical Inference; Hypothesis Testing, Assessing Models, Decisions and Uncertainty, Comparing Samples, A/B Testing, P-Values, Causality.

Unit III: Estimation, Prediction, Confidence Intervals, Inference for Regression, Classification , Graphical Models, Updating Predictions.

### **TEXT BOOKS**

1. Adi Adhikari and John DeNero, “Computational and Inferential Thinking: The Foundations of Data Science”, e-book.

### **REFERENCES:**

1. Data Mining for Business Analytics: Concepts, Techniques and Applications in R, by Galit Shmueli, Peter C. Bruce, Inbal Yahav, Nitin R. Patel, Kenneth C. Lichtendahl Jr., Wiley India, 2018.
2. Rachel Schutt & Cathy O’Neil, “Doing Data Science” O’ Reilly, First Edition, 2013.

**23DLS506**

**Python Programming**

**3 0 2 4**

**Unit I :** 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.

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

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 III:**

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.

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:**

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. CreateSpace.

### **Reference Books**

1. <https://www.w3schools.com/python>
2. Learning Python, Mark Lutz, Orielly
3. Python Programming: A Modern Approach, Vamsi Kurama, Pearson
4. VanderPlas, J. (2016). Python data science handbook: Essential tools for working with data. "O'Reilly Media, Inc."

**23DLS511**

**Supply Chain Management**

**3 0 2 4**

**Unit I:** Logistics management and Supply Chain management - Definition, Evolution, Importance. The concepts of logistics and Supply Chain Management, Key Drivers of Supply Chain Management and Logistics relationships.

Basics of Transportation, Transportation Functionality and Principles; Multimodal Transport: Modal Characteristics; Modal Comparisons; International Air Cargo Transport; Coastal and Ocean transportation, Characteristics of shipping transport- Types of Ships.

**Unit II:** Containerization: Genesis, Concept, Classification, Benefits and Constraints; Inland Container Depot (ICD): Roles and Functions, CFS, Export Clearance at ICD; CONCOR; ICDs under CONCOR.

Packing and Packaging: Meaning, Functions and Essentials of Packing and Packaging, Packing for Storage- Overseas Shipment-Inland-Transportation- Product content Protection, Packaging Types: Primary, Secondary and Tertiary- Requirements of Consumer Packaging, Channel Member Packaging and Transport Packaging - Shrink packaging –Identification codes, bar codes, and electronic data interchange (EDI)- Universal Product Code- GS1 Standards- package labels- Symbols used on packages and labels.

**Unit III:** Special Aspects of Export logistics: Picking, Packing, Vessel Booking [Less-than Container Load(LCL) / Full Container Load (FCL)], Customs, Documentation, Shipment, Delivery to distribution centers, distributors and lastly the retail outlets- Import Logistics: Documents Collection- Valuing- Bonded Warehousing- Customs Formalities- Clearing, Distribution to Units.

Text / Reference Books:

1. Bowersox, Closs, Cooper, Supply Chain Logistics Management, McGraw Hill.
2. Burt, Dobbler, Starling, World Class Supply Management, TMH.



3. Donald J Bowersox, David J Closs, Logistical Management, TMH
4. Pierre David, “International Logistics”, Biztantra.
5. Sunil Chopra, Peter Meindl, Supply Chain Management ,Pearson Education, India.

**23DLS512**

### **Multivariate Statistics and Regression Analysis**

**3 0 2 4**

**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. Sampling distributions of  $\bar{X}$  and  $S$ , Large sample behaviour of  $\bar{X}$  and  $S$ .

**Unit-II:** Classification for two populations, classification with two multivariate normal populations, Fisher’s discriminant functions for discriminating several population.

Principal components analysis, Dimensionality reduction, Factor Analysis- factor loadings using principal component analysis, Cluster Analysis- Cluster Analysis: Hierarchical Clustering and divisive clustering methods.

**Unit-III:** Simple Linear Regression- Properties, Least Squares Estimation of parameters, Hypothesis Tests in Simple Linear Regression, Interval estimation in simple linear regression, Coefficient of determination.

Multiple Linear Regression: Estimation of model parameters. Nonlinear Regression models, Examples of nonlinear regression models.

#### **Text books/ Reference books:**

1. Anderson, T. W. (1983): An Introduction to Multivariate Statistical Analysis. 3rdEd. Wiley.
2. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye. Probability and Statistics for Engineers and Scientists, Eighth Edition, Pearson Education Asia, 2007.
3. Douglas C. Montgomery and Elizabeth A. Peck and G. Geoffrey Vining. Introduction to Linear Regression Analysis”, Third Edition, John Wiley & Sons, Inc
4. Amir D. Aczel and Jayavel Sounderpandian. Complete Business Statistics, Sixth Edition, Tata McGraw-Hill Publishing Company, New Delhi. 2006.

**23DLS513**

### **Machine Learning**

**3 0 2 4**

**Unit-I:** Introduction: Well-Posed Learning Problems, Designing a Learning System. The Inductive Learning Hypothesis and Concept Learning as Search (definitions). Machine Learning Basics: Learning Algorithms, Capacity, Over fitting and Under fitting, Hyper parameters and Validation Sets, No Free Lunch theorem, Estimators, Bias and Variance, Bayesian statistics, Supervised Learning Algorithms, Unsupervised Learning Algorithms, Stochastic Gradient Descent, Building a Machine Learning Algorithm and Issues in Machine Learning.

Decision Tree learning: Introduction, Decision tree representation, Appropriate problems for decision tree learning, The basic decision tree learning algorithm, Hypothesis space search in decision tree learning, Inductive bias in decision tree learning, Issues in decision tree learning. Implementation aspects of the Decision Tree and Classification Example.

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

Support Vector Machines: Optimal Separation: The Margin and Support Vectors, a Constrained Optimization Problem, Slack Variables for Non-Linearly Separable Problems. KERNELS: Choosing Kernels. The Support Vector Machine Algorithm and Multi-Class Classification. Case Study.

**Unit-III:** Genetic Algorithms: Motivation, Genetic Algorithms, Elitism, Tournaments, and Niching, Using Genetic Algorithms and An illustrative Example. Hypothesis Space Search, Genetic Programming, Models of Evolution and Learning, Parallelizing Genetic Algorithms.

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
2. Machine Learning: An Algorithmic Perspective, Stephen Marsland, Taylor & Francis (CRC)
3. Haroon, D. (2017). Python Machine Learning Case Studies: Five Case Studies for the Data Scientist Apress.

### **Reference Books:**

1. Harrington, P. (2012). Machine learning in action. Manning Publications Co..
2. Richard o. Duda, Peter E. Hart and David G. Stork, pattern classification, John Wiley & Sons
3. Machine Learning by Peter Flach , Cambridge.

**23DLS514**

**Inventory Control**

**3 0 2 4**

**Unit I:** The Basic Concepts. Inventory management. Independent and dependent demands. Deterministic and stochastic demands. Different inventory systems. Inventory costs Service level and safety stock Inventory policy, order quantity and reorder point.

**Unit II:** Inventory Models: Deterministic demand model, Stochastic demand model, Newsvendor model, Optimal solution and approximations, Multi-Item Inventory Models, Independent and dependent demands, ABC Analysis.

**Unit III:** Joint replenishment inventory problem, Series, assembly, tree and general production network systems, Optimal solution, heuristics and approximation, Bill of material and material requirements planning (MRP), Supply chain management, Material management organization Centralized and decentralized management.

Text / Reference Books:

1. Toomey, J. W., Inventory Management: Principles, Concepts and Techniques. Kluwer Academic Publishers, 2000.
2. Zipkin, Paul H., Foundations of Inventory Management. The McGraw-Hill Company, 2000.
3. Silver, E. A., Pyke, D. F. and Peterson, R., Inventory Management and Production Planning and Scheduling. 3 rd Edition, Wiley, 1999.

**23DLS515**

**Procurement, Storage and Warehouse Management**

**3 1 0 4**

**Unit I:** Objectives of Procurement System, Principles of Procurement, History of procurement function: from administrative to strategic, value added role, Procurement Cycle, Procurement

Planning, Purchasing Mix: Six Rights, Selecting the right supplier, Source of information and process, Supplier appraisal/vendor capability, Bidding process.

Introduction to Warehousing Concepts -Role of warehouse-types of warehouse- warehouse location- Need for warehousing- Supply chain trends affecting warehouse –Warehouse functions- Role of warehouse manager-Warehouse process: e-commerce warehouse- Receiving and put away- Warehouse process – pick up preparation-Receiving - Pre-receipt - In- handling - Preparation - offloading - Checking - Cross-docking - Quality control - Put-away - Pick preparation - Pick area layout – Picking strategies and equipment -order picking methods - Warehouse processes-Replenishment to dispatch- Value adding services - Indirect activities - Stock management - Stock or Inventory counting - Perpetual inventory counts - Security - Returns processing – Dispatch.

**Unit II:** Storage Management system – Storage Inventory Management – Functions of storage & Inventory - Classification of Inventory- Methods of Controlling Stock Levels- Always Better Control (ABC) Inventory system- Warehouse Management Systems (WMS) - choosing a WMS- the process implementation-cloud computing- Warehouse layout-Data collection-space calculation-aisle width- finding additional space.

Storage and Warehousing Information system -Storage Equipment: storage option - shuttle technology - very high bay warehouse - warehouse handling equipment - vertical and horizontal movement - Automated Storage/ Retrieval System (AS/RS)-specialised equipment- Technical advancements- Resourcing a warehouse- warehouse costs-Types of cost - Return on Investment (ROI) - Charging for shared-user warehouse service - Logistics charging methods Warehousing

**Unit III:** Information System (WIS)- Performance management- outsourcing decisions. Material Handling and Warehouse safety Material handling- Product movement- concept- costs-product load activity—dispatch activity- unload activity-control device-impact of the computer technology- automatic identification-issues and trends in product transport--Packaging - Pallet - Stretch wraps - Cartons – Labeling- Health and safety- Risk assessment - Layout and design - Fire safety- Slips and trips – Manual handling - Working at height - Vehicles - Forklift trucks – Warehouse equipment legislation. Warehouse safety check list- Warehouse Environment- Energy production - - Product waste - waste disposal - Hazardous waste- Sustainable warehouse Management.

Text / Reference Books:

1. GWYNNE RICHARDS (2014) Warehouse Management: A Complete Guide to Improve Efficiency and Minimizing Cost in the Modern Warehouse. The Chartered Institute of Logistics and Transport, Kegan page limited.
2. DAVID E. MULCHY & JOACHIM SIDON (2008) A Supply Chain Logistics Program for Warehouse Management. Auerbachian Publications
3. Bowersox, D.J., Closs, D.J., Cooper, M.B., & Bowersox, J.C. (2013). Supply Chain Logistics Management. (4 th ed.), McGraw Hill/Irwin.
4. Arnold, J.R., Chapman, S.N. (2012). The Introduction to Materials Management. (7<sup>th</sup> ed.), Prentice-Hall.
5. Coyle, J.J., Jr. Langley, C.J., Novack, R.A., & Gibson, B.J. (2013). Managing Supply Chains: A Logistics Approach. (9 th ed.), McGrawHill.
6. Edward, F. World-Class Warehousing and Material Handling. (International ed.), McGraw-Hill.
7. Muller, M. (2011). Essentials of Inventory Management. (2 nd ed.), American Management Association.

**Unit I:** Introduction to pricing and revenue optimization. Demand functions and price optimization: Price-response function; Competition. Price-response estimation. Price differentiation: Volume discounts; Arbitrage and cannibalization; Consumer welfare. Constrained supply: Opportunity cost; Segmentation; Variable pricing.

**Unit II:** Introduction to Revenue Management. Capacity Allocation. Network Management. Overbooking.

**Unit III:** Markdown Pricing. Customized Pricing: List prices vs. customized prices; Responses to competitor bids.

Case studies.

Revenue Management Solution Developers: Sabre Inc. [www.sabre.com](http://www.sabre.com). JDA Software Group

[www.jda.com](http://www.jda.com). PROS Revenue Management [www.prospricing.com](http://www.prospricing.com). Veritec Solutions

[www.veritecsolutions.com](http://www.veritecsolutions.com). KSS revenue management solutions [www.kssg.com](http://www.kssg.com).

Text / Reference Books:

1. Pricing and Revenue Optimization. By Robert L. Phillips. First edition published by Stanford University Press, 2005.
2. Data Analysis for Managers by Christian Albright, Wayne Winston and Christopher J. Zappe. Second edition by Duxbury, 2004.
3. The Theory and Practice of Revenue Management by Kalyan T. Talluri and Garrett J. van Ryzin. First edition published by Kluwer Academic Publishers, 2004.
4. Revenue Management and Pricing: Case Studies and Applications by I. Yeoman and U. McMohan-Beattie.

## 23DLS601

## Multimodal Transportation

3 1 0 4

**Unit I:** Introduction to Multimodal Transport. Introduction to multimodal transportation- Definitions, MTO, MTD, MTC, concepts, benefits, current scenario, challenges faced and reforms. Overview Of Multimodal Transportation: Definition of multimodal transportation, Multimodal transport in India.

**Unit II:** Containerization: Evolution of containerization, Contribution of Malcolm Mclean in containerization, Types of containers, Benefits of containerization, Growth prospects of trade with containerization.

Road Transport in India, Rail Transport in India, Container corporation of India(CONCOR), Freight Corridors(DFCC), Commercial terms of rail-road transport in India, Sea Transport in India, Coastal /Inland shipping, Introduction to Air Transport, Combination of different modes of transport, Incoterms. Role of seaports, airports, ICDs/CFS, terminals, in multimodal transportation.

**Unit III:** Overview Of Intermodal Transportation: Types of Ships, Definition of Intermodal Transport, Various aspects of Intermodal transport in India, Custom clearance process, Role of CHAs, Role of NVOCCS, Trade Financing Options, Letter of Credits, Role of intermediaries like Freight forwarders, ship brokers, ship agents, Port authorities.

National Law On Transport, Multimodal Transportation Goods (Amendment) Act, 2000:

Multimodal transportation of Goods Act, 1993- its objectives and benefits, Multimodal transportation of Goods Act, 2000, International Conventions on Intermodal transport, Dangerous good classification, Regulations concerning dangerous goods regulations, Motor Vehicles Act, Warsaw Convention.

Text Book

1. Container and Multimodal Transport Management – Hariharan K.V. – Shroffs Publishers & Distributors

Reference Books

1. International Trade Logistics-Ram Singh- Oxford Publication.

**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.

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

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

Convolution neural networks, backpropagation convolutions and pooling – optimization algorithms: mini-batch gradient descent, - convolutional nets case studies using Keras / TensorFlow.

**Unit-III:** Neural network architectures – recurrent neural networks, adversarial neural networks Spectral CNN, self-organizing maps, restricted boltzmann machines, long short-term memory networks, deep meta learning - deep reinforcement learning.

### **Text Books / Reference Books**

1. Ian Goodfellow, YoshuaBengio and Aeron Courville, Deep Learning, MIT Press,First Edition, 2016.
2. Gibson and Josh Patterson, Deep Learning A practitioner's approach, Adam O'Reilly, First Edition, 2017.
3. Francois Chollet, Deep Learning with Python, Manning Publications Co, First Edition, 2018.
4. Bishop C.M.Neural Networks for Pattern Recognition, Oxford University Press,1995.

## ELECTIVES

**23DLS644**

**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
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

***Reference Book:***

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

**23DLS645**

**Categorical Data Analysis**

**3 0 0 3**

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.

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

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**

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.
- Santner, T.J. and Duffy, D., The Statistical Analysis of Discrete Data, Springer-Verlag, New York, 1989.

**23DLS637**

**Demography and Actuarial Statistics**

**3 0 0 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.

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.

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:**

1. Ramkumar. R : Technical Demography, Wiley eastern Ltd, New Delhi, 1986.
2. Rogers. A : Introduction to Mathematical Demography, John Wiley, 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

**23DLS639**

**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.

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.

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 / 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.

**23DLS635**

**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.

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 / References Books:**



1. Grigsby Gert H.N Laursen and Jesper Thorlund : *Business analytics for managers taking business intelligence beyond reporting*, 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.

**23DLS642**

**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.

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 / References Book**

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; 4 edition , 2015.

**23DLS638**

**Official Statistics**

**3 0 0 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.

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.

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.

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/>

**23DLS632**

**Pattern Recognition**

**3 0 0 3**

**Course outcomes**

CO 1 To understand Bayesian decision theory and its use
CO 2 To gain knowledge about Bayesian estimation methods
CO 3 To apply nonparametric techniques and linear discriminant functions
CO 4 To gain knowledge about nonmetric methods and algorithm independent machine learning
CO 5 To apply unsupervised learning and clustering

Pattern recognition systems – the design cycle – learning and adaptation – Bayesian decision theory – continuous features – Minimum error rate classification – discriminant functions and decision surfaces – the normal density based discriminant functions. Bayesian parameter estimation – Gaussian case and general theory – problems of dimensionality – components analysis and discriminants- Nonparametric techniques – density estimation – Parzen windows – nearest neighborhood estimation – rules and metrics - decision trees – CART methods – algorithm-independent machine learning – bias and variance for regression and classification – resampling or estimating statistics- Unsupervised learning and clustering – mixture densities and identifiability – maximum likelihood estimates – application to normal mixtures – unsupervised Bayesian learning – data description and clustering – criterion functions for clustering – hierarchical clustering – k-means clustering.

**Text Reference Book:**

1. Richard O. Duda, Peter E. Hart and David G. Stork, “*Pattern Classification*”, Second Edition, 2003, John wily & sons.
2. Earl Gose, Richard Johnsonbaugh and Steve Jost, “*Pattern Recognition and Image Analysis*”, 2002, Prentice Hall of India.

**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 models for various problems..

Queueing Models: Basic characteristics of a Queueing Model – Role of Poisson and Exponential distributions, Stochastic Processes, Markov chains, Poisson Processes, Poisson Queueing 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 Queueing 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**

1. Donald Gross & Carl M Harris (1998): Fundamentals of Queueing theory, John Wiley & Sons, Inc
2. Hamdy A. Taha (2006): Operations Research – An Introduction, 8/e, Prentice Hall of India Private Ltd., New Delhi

**Reference Books**

1. S.D. Sharma (2003) Operations Research, Kedar Nath Ram Nath & Co, Meerut, India
2. Kanthi Swarup, P.K. Gupta and Man Mohan (2004), Operations Research, Sultan Chand & Sons, New Delhi

**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.

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.

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.

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/ References Book:**

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.

**23DLS641**

**Social Network Analytics**

**3 0 0 3**

**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**

Application of Topic models, Information Diffusion, Opinions and Sentiments - Mining, Analysis and Summarization, Case Study: Sentiment Analysis on a set of Movie Reviews using Deep Learning techniques, Recommendation Systems, Language dynamics and influence in online communities, Community identification, link prediction and topical search in social networks, Case Study: The Interplay of Identity and Social Network: A Methodological and Empirical Study

**Text and Reference Literature**

1. Cioffi-Revilla, Claudio. *Introduction to Computational Social Science*, Springer, 2014.
2. Matthew A. Russell. *Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Google+, Github, and More*, 2nd Edition, O'Reilly Media, 2013.
3. Robert Hanneman and Mark Riddle. *Introduction to social network methods*. Online Text Book, 2005.
4. Jennifer Golbeck, *Analyzing the social web*, Morgan Kaufmann, 2013.
5. Claudio Castellano, Santo Fortunato, and Vittorio Loreto, *Statistical physics of social dynamics*, Rev. Mod. Phys. 81, 591, 11 May 2009.

6. S. Fortunato and C. Castellano, *Word of mouth and universal voting behaviour in proportional elections*, Phys. Rev. Lett. 99, (2007).
7. Douglas D. Heckathorn, *The Dynamics and Dilemmas of Collective Action*, American Sociological Review (1996).
8. Michael W. Macy and Robert Willer, *From factors to actors: Computational Sociology and Agent-Based Modeling*, Annual Review of Sociology Vol. 28: 143-166 (2002).
9. Nilanjan Dey Samarjeet Borah Rosalina Babo Amira Ashour, *Social Network Analytics - Computational Research Methods and Techniques, First Edition*, eBook ISBN: 9780128156414, Paperback ISBN: 9780128154588, Imprint: Academic Press, Published Date: 23rd November 2018

**23DLS633**

**Stochastic Process**

**3 0 0 3**

### Course outcomes

CO1 Understand the concepts of stochastic process, markov chains and classifical 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.

Random processes: General concepts and definitions - stationarity in random processes - strict sense and wide sense stationary processes - autocorrelation and properties- special processes – Poisson points, Poisson and Gaussian processes and properties , spectrum estimation , ergodicity, mean ergodicity, correlation ergodicity, Power spectrum density functions – properties, 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. Douglas C. Montgomery and George C. Runger, *Applied Statistics and Probability for Engineers*, (2005) John Wiley and Sons Inc.

### Reference Books:

1. A. Papoulis, and Unnikrishna Pillai, “*Probability, Random Variables and Stochastic Processes*”, Fourth Edition, McGraw Hill, 2002.
2. Scott L. Miller, Donald G. Childers, “*Probability and Random Processes*”, Academic press, 2012.

**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.

Non-parametric methods: Actuarial and Kaplan-Meier methods for estimating survival function and variance of the Estimator.

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**

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.

**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
2. Taguchi G, (1991). Introduction to Quality Engineering: Designing Quality into Products and Processes. Asian Productivity Organization Second Edition,. Wiley

**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:**

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.

**Amrita Values Program****1 0 0 1**

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 Amritanandamayī Devi**

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.

#### **22AVP502                      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.

#### **22AVP503                      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.

#### **22AVP504                      Insights from the Upanishads**

Introduction: Sruti versus Smriti, 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**

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**

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.

#### **22AVP507                      Great Spiritual Teachers of India**

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

#### **22AVP508                      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.



22AVP509

### Yoga and Meditation

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.

22AVP510

### 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.

22AVP512

### 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.

22ADM501

### Glimpses of Indian Culture

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
10. Cultivating self-Development, Self-effort, and Divine Grace - their roles – 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*
4. *Deepak Chopra - Book 1: Quantum Healing; Book 2: Alpha and Omega of God; Book 3: Seven Spiritual Rules for Success*
5. *Dr. A. P. J. Abdul Kalam - 1. Ignited Minds 2. Talks (CD)*
6. *Swami Ramakrishnanda Puri - Ultimate Success*
7. *Swami Jnanamritananda Puri - Upadesamritham (Trans: Malayalam)*
8. *Vedanta Kesari Publication - Values - Key to a meaningful life*
9. *Swami Ranganathananda - Eternal values for a changing society*
10. *David Megginson and Vivien Whitaker - Cultivating Self Development*
11. *Elizabeth B. Hurlock - Personality Development, Tata McGraw Hill*
12. *Swami Jagatatmananda - Learn to Live (Vol.1 and 2), RK Ashram, Mylapore*

**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)

Causes of Stress: The problem of not being relaxed. Need for meditation -basics of stress management at home and workplace. Traditions and Culture. Principles of meditation– promote a sense of control and autonomy in the Universal Human Value System. Different stages of Meditation. Various Meditation Models. Various practices of Meditation techniques in different schools of philosophy and Indian Knowledge System.

### 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:

- 1.Mata Amritanandamayi Devi, "Cultivating Strength and vitality," published by Mata Amritanandamayi Math, Dec 2019
- 2.Swami Amritaswarupananda Puri ,"The Color of Rainbow " published by MAM, Amritapuri.

### REFERENCES:

- 1.Craig Groeschel, "Winning the War in Your Mind: Change Your Thinking, Change Your Life" Zondervan Publishers, February 2019
- 2.R Nagarathna et al, "New Perspectives in Stress Management "Swami Vivekananda Yoga Prakashana publications, Jan 1986
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
5. Secret of Inner Peace- Swami Ramakrishnananda Puri, Amrita Books, Jan 2018.
6. Mata Amritanandamayi Devi "Compassion :The only way to Peace:Paris Speech", MA Center, April 2016.
7. Mata Amritanandamayi Devi "Understanding and collaboration between Religions", MA Center, April 2016.
8. Mata Amritanandamayi Devi "Awakening of Universal Motherhood: Geneva Speech" M A center, April 2016.

