



M Sc.-Data Science with Logistic and Supply Chain Management – (2 Years)

CURRICULUM AND SYLLABUS

(From 2024 Admission Onwards)

Program Outcomes

PO1 Knowledge in Basic Data Science, Logistic and Supply Chain Management: Understand the basic concepts, fundamental principles and the scientific theories related to Data Science, Logistic and Supply Chain Management.

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 logistics problems.

PO5 Applications in Industries: Understand the role of data analytics and apply the same to solve the real time industrial problems in logistic and supply chain industries.

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

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

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

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

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

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

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

**M.Sc. Data Science with Logistic and Supply Chain Management
(Academic Year 2024 onwards)**

Curriculum

Semester -I

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

Semester -II

Course code	Course	L T P	Credit	ES
24DLS511	Supply Chain Management	3 0 2	4	A
24DLS512	Advanced Data Mining	3 0 2	4	B
24DLS513	Machine Learning	3 0 2	4	C
24DLS514	Information System Management	3 1 0	4	D
24DLS515	Pricing and Revenue Management	3 1 0	4	E
24DLS516	Warehouse and Production Management	3 1 0	4	F
	Amrita Value Programme	1 0 0	1	G
22AVP103	Mastery Over Mind	1 0 2	2	
Total			27	

Semester III

Course code	Course	L T P	Credit	ES
24DLS601	Inventory and Marketing Management	3 1 0	4	A
24DLS602	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
Total			17	

Semester IV

Course code	Course	L T P	Credit	ES
24DLS699	Dissertation		10	P
Total			10	

Total credits for

the programme: 78

ELECTIVES (any three)

Course code	Course	L T P	Credit	ES
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24DLS631	Pattern Recognition	3 0 0	3	D/E
24DLS632	Stochastic Process	3 0 0	3	D/E
24DLS633	Queuing Theory	3 0 0	3	D/E
24DLS634	Survival Analysis	3 0 0	3	D/E
24DLS635	Sampling Techniques	3 0 0	3	D/E
24DLS636	Demography and Actuarial Statistics	3 0 0	3	D/E
24DLS637	Official Statistics	3 0 0	3	D/E
24DLS638	Reinforcement Learning	3 0 0	3	D/E
24DLS639	Social Network Analytics	3 0 0	3	D/E
24DLS640	Mining of Massive Datasets	3 0 0	3	D/E
24DLS641	Parallel and Distributed Systems	3 0 0	3	D/E
24DLS642	Taguchi Techniques	3 0 0	3	D/E
24DLS643	Special Distribution Functions	3 0 0	3	D/E

**Amrita Value Programme

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

Evaluation Pattern:

S.No	Course Type	Theory / Lab	Mid Term marks	CA marks	End Semester marks
1	3- 1- 0- 4 / 4- 0- 0 – 4 / 3- 0 – 3 - 3	Theory	30	20	50
2	3- 0- 2- 4 / 2- 0 2 – 3/ 1- 0- 2 -2	Theory & Lab	30	40	30
3	0- 0- 2- 1	Lab	-	60	40

Syllabus

Course Outcomes:

CO-1: To understand the axioms in the definition of a vector space through examples; to understand Subspaces, basis and its relevance.

CO-2: To understand inner products and compute the angle/length of a vector and the orthonormal basis.

CO-3: To understand the concepts of Linear Transformations and Matrices for Linear Transformation

CO -4: To understand the concepts of Eigen Values, Eigen Vectors & Diagonalization form.

CO -5: Decompositions : LU,QR and SVD

Unit-I

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

Unit-II

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

Unit-III

Linear Transformations: Positive definite matrices - Matrix norm and condition number - - Linear transformation - Relation between matrices and linear transformations - Kernel and range of a linear transformation - Trace and Transpose, Determinants, Symmetric and Skew Symmetric Matrices.

Unit-IV

Eigen values and Eigen vectors: Problems in Eigen Values and Eigen Vectors, Diagonalization, Orthogonal Diagonalization, Quadratic Forms, Diagonalizing Quadratic Forms.

Unit V

Decomposition of matrices: LU, QR and SVD

Text Books

1. Howard Anton and Chris Rorres, “Elementary Linear Algebra”, Tenth Edition, John Wiley & Sons, 2010.
2. Linear Algebra, Arnold J. Insel, Lawrence E. Spence, and Stephen H. Friedberg, Fifth Edition, Pearson Education, 2014

Reference Books:

1. Nabil Nassif, Jocelyne Erhel, Bernard Philippe, Introduction to Computational Linear Algebra, CRC press, 2015.
2. Sheldon Axler, Linear Algebra Done Right, Springer, 2014.
3. Gilbert Strang, “Linear Algebra for Learning Data”, Cambridge press, 2019.
4. Kenneth Hoffmann and Ray Kunze, Linear Algebra, Second Edition, Prentice Hall, 1971.
5. Mike Cohen, Practical Linear Algebra for Data Science, Oreilly Publisher, 2022.
6. I. N. Herstein, ‘Topics in Algebra’, Second Edition, John Wiley and Sons, 2000.

CO-PO Mapping:

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

Course outcomes

CO1: Understand the basics of probability and random variables.

CO2: Gain knowledge about standard statistical distributions and their properties

CO3: Apply and analyse problems based on hypothesis testing

CO4: Understand the concept of ANOVA and analyse them using real time data set

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.

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, Correlation and Regression

Unit III:

Tests of Hypotheses: General Procedure for Hypothesis Tests, Problems based on large sample tests and small sample tests - Z, t, and F test. Analysis of variance- One way classification, Two way classification, Latin square design.

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, 7th edition McGrawHill education 2012.
3. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, Probability and Statistics for Engineers and Scientists, 8th Edition, Pearson Education Asia, 2007.

Reference books:

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

CO-PO Mapping

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

CO4	3	3	2	2	3	3	3					2	2
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24DLS503

Logistics

3 0 2 4

Course Outcomes	
CO01	Understand various concepts and critical elements in the logistics framework
CO02	Apply the logistics framework to enable enterprises improve business performance, provide customer value and achieve competitive advantage
CO03	Apply the logistics network to optimize the supply chain and transform them to ICT enabled, green and circular value chains using relevant technology tools and software
CO04	Analyse the logistics distribution systems to reduce the transportation, warehousing and supply chain costs as also address inefficiencies

Unit I:

Logistics: Logistics, SCM & competitive strategy, Competitive advantage, Value chain, Logistics & customer value: Marketing & logistics interface, customer service, out-of-stock, customer retention, customer-service priorities, service standards, market-driven supply chains, Logistics cost: Costing, Cost analysis, Logistics & bottom line, Shareholder value, Profitability analysis, Cost drivers, ABC

Unit II:

Matching Supply & Demand: Lead-time gap, Demand forecasting & management, CPFR, Supply Chain fulcrum, Responsive Supply Chain: Push & pull, Agility, Responsiveness, Strategic lead-time management: Lead-time concepts, pipeline management, Risk Management: Developing a risk profile, Managing risk, Achieving supply chain resilience, 3PL to 4PL, Supply Chain Integration: Developing the logistics organization, Logistics as the vehicle of change, Logistics core card

Unit III:

Synchronous Supply Chain: Extended enterprise, Virtual supply chain, Bull whip effect, QR logistics, Logistics system dynamics, AI, ML, Data science & block chain for logistics, Globalization: Visibility in the global pipeline, sourcing. Sustainable supply chains: Triple bottom line, Green supply chains and reducing carbon footprint

Text Book

1. Martin Christopher, Logistics and Supply Chain Management, Prentice-Hall, 2011.

Reference Books

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. Sunil Chopra, Peter Meindl, 'Supply Chain Management', Pearson Education, 2016

CO-PO Mapping

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

CO2	3	3	2	2	3	3	3					2	1
CO3	3	3	2	2	3	3	3					2	2
CO4	3	3	2	2	3	3	3					2	2

24DLS504

Optimization Techniques

3 1 0 4

CO1 To learn Linear Programming Problems.

CO2 To learn single variable optimization techniques

CO3 To understand the basics of unconstrained optimization problems and direct search, unidirection search methods for multivariable problems.

CO4 To learn the various unconstrained optimization techniques for multivariable.

CO5 To understand and solve the nonlinear optimization problem with equality and inequality constrained problems and to learn theory of few significant genetic evolutionary algorithms.

Unit I: Introduction to LPP: Lines and hyperplanes, Convex sets, Convex hull, Formulation of a Linear Programming Problem, Linear Programming Problem; Graphical Method; Simplex method; Dual problem, Duality theory, Dual simplex method, Revised simplex method.

Unit II: Introduction to optimization: classical optimization, Optimality criteria – Necessary and sufficient conditions for existence of optimum point. Fundamental Region Elimination Rules to eliminate a region. One dimensional Search methods: Golden search method, Fibonacci method, Newton’s Method, Secant Method, Remarks on line Search Sections.

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

Unit IV: Gradient-based methods- introduction, the method of steepest descent, analysis of Gradient Methods, Convergence, Convergence Rate. Analysis of Newton’s Method, Newton’s Method for Nonlinear Least-Squares. Introduction -The Conjugate Direction Algorithm, The Conjugate Gradient Algorithm for unconstrained optimization problems.

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

Text Book

1. Edwin K.P. Chong, Stanislaw H. Zak, “An Introduction to Optimization”, 2nd edition, Wiley, 2013.

Reference Books

1. Mokhtar S. Bazarrar, Hamit D Sherali, C.M. Shetty, “Nonlinear programming Theory and applications”, 2nd edition, Wiley , 2004.
2. Mohan C. Joshi and Kannan M. Moudgalya, Optimization: Theory and Practice, Narosa Publishing House, New Delhi, 2004 (Reference)
3. 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.

CO-PO Mapping

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

24DLS505 Foundation of Data Science with R Programming

3 0 2 4

Course Outcomes

CO1: Understanding the basic concepts in R programming

CO2: Understanding the concepts of classification, tabulation, diagrammatic and graphical representation of data

CO3: Applying probability distributions and testing of hypothesis to the real time data and analysing the results using R.

CO4: Gaining knowledge and apply the problems related to correlation, regression, times series and forecasting to real time data sets

Unit I

Overview of R software, Introduction to R Studio: R command Prompt, R script file, comments – Handling Packages in R: Installing a R Package, Basic commands to get started and Special Values functions, Data Types: Vectors, Lists, Matrices, Arrays, Factors, Data Frame – R -Strings - Vectors, Loading and handling Data in R, Writing into a CSV File, Reading the Excel file.

Unit II

Classification and Tabulation of Data, Diagrammatic and Graphic presentation of data, Measure of central tendency or averages, Measure of dispersion, Skewness and Kurtosis.

Unit III

Correlation and regression, Time series and forecasting: Weighted moving average, Exponential smoothing. Index numbers-Base period, Types of index numbers- price, value, quantity and special purpose index number.

Unit -IV

Case studies related logistic and supply chain management.

Text books / Reference Books

1. Norman Matloff: The Art of R Programming, Norman Matloff, Cengage Learning: Efficient R Programming: A tool of statistical software design, First edition, No Starch Press, 2011.
2. Jared P. Lander, : R for Everyone: Advanced Analytics and Graphics, Second Edition, Pearson Education
3. Hadley Wickham and Garrett Gorlemund : R for Data Science, First edition, O'Reilly

4. Winston Chang : R Graphics Cookbook: Practical Recipes for Visualizing Data, Second Edition , Shroff/O'Reilly
5. Nina Zumel and John Mount : Practical Data Science with R, Dream tech Press/Manning Publications.

CO-PO Mapping:

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

24DLS506

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 : 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.”.

CO-PO Mapping:

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

22ADM501

Glimpses of Indian Culture

2 0 1 P/F

Introduction: 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 have to be imbibed into the inner sprit 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 meaningful life. Values in different contexts
4. Personality - Mind, Soul and Consciousness - Q and A. Body-Mind-Intellect and the Inner psyche 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
11. Self effort and Divine Grace - their roles – Q and A; - Vedanta and Creation –Understanding a spiritual Master
12. Dimensions of Spiritual Education; Need for change Lecture – 1; Need for PerfectionLecture - 2
13. How to help others who have achieved less - Man and Nature Q and A, Sharing ofexperiences

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 RamakrishnandaPuri - Ultimate Success
7. Swami JnanamritanandaPuri - 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 & 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

Semester - II

24DLS511

Supply Chain Management

3 0 2 4

CO	Course Outcomes
CO01	Understand various concepts, drivers and key metrics in the supply chain management framework
CO02	Evaluate single and multiple facility location problems, vehicle routing and scheduling models
CO03	Develop the appropriate supply chain through distribution requirement planning and strategic alliances
CO04	Evaluate packing, packaging, and transportation models and modes so as to reduce transportation, warehousing and supply chain costs as also address inefficiencies
CO05	Identify the issues in global supply chain management, procurement and outsourcing strategies

Unit I:

Introduction: Introduction to Supply Chain Management (SCM), Complexity and key issues in SCM, Location strategy, Facility location decisions, Single facility and multiple location models Supply Chain Integration: Supply chain integration, Distributed strategies, Push versus pull systems. Distribution Requirements Planning (DRP) and demand forecasting, DRP and master production scheduling, DRP techniques – time-phased order point, managing variations in DRP, Strategic alliances, Third party logistics, Distribution integration.

Unit II:

Basics of Transportation, Transportation Functionality and Principles, Multimodal Transport, Modal Characteristics, Modal Comparisons, Vehicle routing and scheduling models, Traveling salesman problems, Exact and heuristic methods, International Air Cargo Transport; Coastal and Ocean transportation, Characteristics of shipping transport, Types of Ships, Containerization
Basics of Packing and Packaging: Packing for Storage, Product content Protection, Packaging Types: Primary, Secondary and Tertiary- Requirements of Consumer Packaging, Channel Member Packaging and Transport Packaging - Shrink packaging –Identification codes, Universal Product Code- GS1 Standards- package labels- Symbols used on packages and labels.

Unit III:

Issues in SCM: Procurement and outsourcing strategies, Framework of e-procurement, International issues in SCM, Regional differences in logistics, coordinated product and supply chain design, Customer value and SCM, Omni-channel supply chains

Text Book

1. Simchi-Levi,D., Kaminsky,P., Simchi-Levi, E., Shankar, R., ‘Designing and Managing the Supply Chain: Concepts, Strategies, and Cases’, Tata McGraw Hill, 2008.

Reference Books

2. Sunil Chopra, Peter Meindl, 'Supply Chain Management', Pearson Education, 2016
3. Martin Christopher, Logistics and Supply Chain Management, Prentice-Hall, 2011.
4. Donald J. Bowersox & David J. Closs: Logistical Management, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 2004.

CO-PO Mapping

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

24DLS512

Advanced Data Mining

3 0 2 4

CO1: Understand the basic concepts of data mining and apply association rule mining to the real life problems.

CO2: Gain and apply the knowledge to classify the data and apply them to datasets

CO3 : Group the data using various clustering techniques and analyse the outliers of the given dataset.

CO4: Gain knowledge about link analysis , spatial mining and temporal mining

Unit-I

Data Mining : Steps in Data mining process, Data Mining Functionalities, Architecture of a Typical Data Mining Systems, Classification of Data Mining Systems, Data Preprocessing, Data Cleaning, Data Transformation, Data Compression and Dimension Reduction, Binning Methods. Association Rule Mining, Classification and Prediction: Efficient and Scalable Frequent Itemset Mining Methods, Mining, Various Kinds of Association Rules, Market Basket Analysis, Apriori Algorithm, Case studies related to logistics and supply chain management

Unit-II

Classification: Classification and Prediction – Basic concepts–Decision tree induction–Bayesian classification, Rule-based classification, Lazy learner.

Clustering–Types of Data in Cluster Analysis–Categorization of Major Clustering Methods– Partitioning Methods, Hierarchical Methods– Density–Based Methods, Grid–Based Methods, Modelling based, clustering high dimensional data, Outlier Analysis. Case studies related to logistics and supply chain management

Unit-III

Link Analysis: Page Rank, Efficient Computation of Page Rank, Topic Sensitive Page Rank, Link Spam, Hubs and Authorities. Recommendation Systems: A Model for Recommendation Systems, Content-Based Recommendations. Mining data streams and time series data . Introduction to spatial mining – Construction of spatial data cubes , spatial classification and clustering, Temporal Data Mining , Temporal Association Rules .

Text /References books

1. ByRichard J. Roiger "Data Mining A Tutorial-Based Primer", Second Edition, 2017 Hall/CRC.
2. Jiawei Han, Micheline Kamber and Jian Pei“Data Mining Concepts and Techniques”, Third Edition, Elsevier, 2011.
3. Alex Berson and Stephen J. Smith “Data Warehousing, Data Mining & OLAP”, Tata McGraw – Hill Edition, Tenth Reprint 2007.
4. G. K. Gupta “Introduction to Data Mining with Case Studies”, Easter Economy Edition, Prentice Hall of India, 2006.
5. Ponniah, Paulraj. *Data warehousing fundamentals: a comprehensive guide for IT professionals*. John Wiley & Sons, 2004.
6. Trevor Hastie, Robert Tibshirani, Jerome Friedman, *The Elements of Statistical Learning-Data Mining, Inference, and Prediction*, Second Edition, Springer Verlag, 2009
7. Dunham,Sridhar , *Data Mining a: Introductory and Advanced topics*, Pearson Education , India , 2002

CO-PO Mapping

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

24DLS513

Machine Learning

3 0 2 4

Course Outcomes:

CO1: Understand the basic concepts of machine learning

CO2 : Apply classification techniques to the real time data sets

CO3 : Understand and apply the concepts of advanced supervised learning and ensemble algorithms

CO4: Understand and apply the concepts of genetic algorithms and reinforcement learning

Unit-I:

Introduction: Well-Posed Learning Problems, Over fitting and Under fitting, Bias and Variance, Training and testing sets, Learning a Class from training, Linear, Non-linear, Multi-class and Multi-label classification, Classification techniques : Linear Regression, Multiple Linear Regression, Logistic Regression, Decision Trees: ID3, Classification and Regression Trees (CART), K-Nearest Neighbours, Naïve Bayes classifier. Case studies related to logistic and supply chain management

Unit-II

Support vector machines: Linear and Non-Linear Kernel Functions, Artificial Neural Networks – Introduction, neural network representation, appropriate problems for neural network learning, perceptions, multilayer networks and the back-propagation algorithm with examples , Bayesian belief networks. Ensemble Learning Model Combination Schemes, Maximum Voting, Averaging, Weighted Averaging, Bagging: Random Forest Trees, Boosting: Adaboost, Stacking. Case studies related to logistic and supply chain management

Unit-IV:

Genetic Algorithms: Fundamentals of genetic algorithms, Genetic algorithms history, Basic concepts, Creation of offsprings, Working principle, Encoding, Fitness function, Reproduction

Genetic Modelling: Inheritance operators, Cross over, Inversion and deletion, Mutation operator, Bit-wise operators, Bit-wise operators used in genetic algorithms, Generational cycle, Convergence of genetic algorithm. Case studies related to logistic and supply chain management

Reinforcement Learning – Introduction, the learning task, Q -learning, non-deterministic, rewards and actions, temporal difference learning, generalizing from examples, relationship to dynamic Programming.

Text / Reference Books

1. Tom Mitchell, “Machine Learning”, McGraw Hill, 3rd Edition,1997.
2. Jiawei Han and MichelineKambers and Jian Pei, “Data Mining – Concepts and Techniques”, 3rd Edition,Morgan Kaufman Publications, 2012.
3. Charu C. Aggarwal, “Data Classification Algorithms and Applications”, CRC Press, 2014.
4. Stephen Marsland, “Machine Learning – An Algorithmic Perspective”, 2nd Edition, CRC Press, 2015.
5. Kevin P. Murphy "Machine Learning: A Probabilistic Perspective", The MIT Press, 2012.

CO-PO Mapping

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

24DLS514

Information System Management

3 1 0 4

CO1 : Understand the basic concepts involved in information systems and enterprise business system.

CO2 : Gain knowledge about e-commerce and decision support system.

CO3 : Understand about the types of telecommunications networks and it applications

CO4: Gain knowledge about the role of security and ethical issues challenges of information system

Information Management System : Fundamental role of IS in business, Types of Information system, Information system Managing Hardware, Software, and Data resources .

Enterprise business system

Customer relationship management(CRM), Three phases of CRM, Trends , challenges and Failure of CRM, Enterprise Resource Planning (ERP), basic features, selection and implantation challenges and Failure of ERP, Supply Chain Management (SCM), challenges and Failure of SCM

E-Commerce System and Decision support system

Essential e- commerce processes, Electronic payment process, Business to Consumer- e-commerce, Business to Business e- commerce, Decision support system (DSS) components and trends. Online Analytical Processing, Data mining for decision support. Domain of Artificial Intelligence, Components of expert system, Developing expert systems, Other Intelligence techniques: Neural networks, Fuzzy logic, Genetic algorithm .Virtual Reality and Intelligent agents.

Telecommunication and Networks

Basic components in a telecommunication networks, Types of telecommunication networks – Wide area networks, Metropolitan area networks, local area networks, virtual private networks client/server networks, peer to peer networks, digital and analog signals, wired technologies, wireless technologies, cellular and PCS systems, Telecommunication Processors.

Security and ethical challenges

Computer crime, Hacking and cracking- Examples , Cyber theft, Cyber terrorism, Software privacy, Computer viruses and worms Adware and Spyware, Privacy on the internet, Privacy laws and cyber law. Cryptography – keys, encryption, fire walls ,Denial of service attacks, virus defences, other security measures.

LEARNING RESOURCES

1. Kenneth C. Laudon, Jane P. Laudon, Jane P. Laudon (2020) – “*Management Information Systems: Managing the Digital Firm*” – 16th Edition – Pearson
2. James O'Brien and George Marakas (2019) – “*Management Information Systems*” – 11th Edition – MH Education
3. Efraim Turban, Carol Pollard, Gregory Wood (2018) - “*Information Technology for Management: On-Demand Strategies for Performance, Growth and Sustainability*” - 11th Edition - Wiley
4. Waman S Jawadekar (2017) – “*Management Information Systems : A Global Digital Enterprise Perspective*” – 5th Edition – Tata Mcgraw Hill Publishing Co Ltd
5. EwaZiemba (2017) – “*Information Technology for Management: New Ideas and Real Solutions*” – 1st Edition – Springer
6. A. R. Prathap Reddy (2017) – “*Information Technology for Managers*” – 1st Edition – Notion Express

CO-PO Mapping

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

24DLS515

Pricing and Revenue Optimization

3 1 0 4

CO1 To understand the concepts of price response functions .

CO2 To gain knowledge about price optimization and price differentiation with regard to supply constrain.

CO3 To gain knowledge about Revenue management, capacity allocation and network management.

Unit I: Introduction to pricing and revenue optimization: The Challenges of Pricing, Traditional Approaches to Pricing, The Scope of Pricing and Revenue Optimization, The Pricing and Revenue Optimization Process, Models of Demand function: The Price-Response Function, Measures of Price Sensitivity, Common Price-Response Functions; Estimation of price response and price optimization: Data Sources for Price-Response Estimation, Price-Response Estimation Using Historical Data, The Estimation Process, Challenges in Estimation;

Unit II: Optimization: Elements of Contribution, The Basic Price Optimization Problem, Existence and Uniqueness of Optimal Prices, Optimization with Multiple Prices, A Data-Driven Approach to Price Optimization, Competitive Response and Optimization, Optimization with Multiple Objective Functions Price differentiation: The Economics of Price Differentiation, Limits to Price Differentiation, Tactics for Price Differentiation, Calculating Differentiated Prices, Price Differentiation and Consumer Welfare, Nonlinear Pricing; Pricing with Constrained supply: The Nature of Supply Constraints, Optimal Pricing with a Supply Constraint, Opportunity Cost, Market Segmentation and Supply Constraints.

Unit III: Revenue Management: History, Levels of Revenue Management, Revenue Management Strategy, The System Context, Booking Control, Tactical Revenue Management, Revenue Management Metrics, Capacity Allocation: The Two-Class Problems, Capacity Allocation with Multiple Fare Classes; Network Management. When Is Network Management Applicable? A Linear Programming Approach. Overbooking: Background, Approaches to Overbooking.

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.

CO-PO Mapping

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

24DLS516 Warehouse and Production Management 3 1 0 4

CO1 : Understand the role , need and functions of warehouse and procurement management

CO2 : Understand the basic concepts of productions and operation management and

apply the forecasting and scheduling to real life problems

CO3 : Understand the concept of inventory techniques . Also construct and analyse various control charts to real life problems

Unit I:

Warehouse Management : Introduction to Warehousing Concepts -Role of warehouse types of warehouse-warehouse location- Need for warehousing- Supply chain trends affecting warehouse –Warehouse functions. Warehouse process – e-commerce warehouse - Value and non value added, Cross-docking .

Procurement Management : Objectives of Procurement System, Principles of procurement, History of procurement function, Procurement Cycle. Principles of Right purchasing, Centralised V/S. Decentralised purchasing, Purchase Procedures.

Unit- II

Production and Operation Management – Introduction P/OM mission, performance of P/OM systems, P/OM policy, Material requirement planning : - MRP process, Lot Sizing in MRP Systems, Facility capacity , assembly line balancing, aggregate planning. Demand forecasting : Moving average, method of least square , seasonal variation, smoothing method in time series .

Project Management : Project life cycle – Project selection – Types of project selection models Project planning.– Work breakdown structure. Scheduling – Network techniques: PERT and CPM –Gantt charts .

Unit-III

Material Management Scope and Importance of Materials Management. Functions of Materials Management ,Need for Inventory, Different Types of Inventory, Inventory Classification, ABC analysis , XYZ analysis, VED analysis.

Quality Management - Definition of Quality, Dimensions of Quality, Contribution of Deming , Shewhart, Juran, Taguchi and Ishikawa to quality management. Variations and Causes of Variations . Statistical process control – construction of control charts for attributes and variables -X bar , R chart, np chart , p chart and U chart . Process capability indices- Cp and Cpk, Quality Control Tools.

Text books / References

1. William J Stevenson, Operations Management, Twelfth Edition, McGraw Hill Education (India) Pvt. Ltd., 2017
2. Terry Hill, Operations Strategy: Design, Implementation and Delivery, Macmillan Education, 2018.
3. Adam E.E., Jr and Ebert R.J. 1997, Production and Operations Management: Concepts, Models and Behaviour, 5th Ed. Prentice Hall of India.
4. Panneerselvam, R, Operations Research , Prentice-Hall of India, New Delhi, 2002.
5. Chary S.N., Production and Operations Management, Tata McGraw Hill Publishing Co., Ltd., New Delhi.

CO-PO Mapping

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

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

Courses offered under the framework of the Amrita Values Program:

22AVP501 Message of Śrī Mātā Amritanandamayi Devi

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 Smṛti, 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, Sanātana 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.

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

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 /References 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.
3. Craig Groeschel, "Winning the War in Your Mind: Change Your Thinking, Change Your Life" Zondervan Publishers, February 2019
4. R Nagarathna et al, "New Perspectives in Stress Management" Swami Vivekananda Yoga Prakashana publications, Jan 1986
5. Swami Amritaswarupananda Puri "Awaken Children Vol 1, 5 and 7 - Dialogues with Amma on Meditation", August 2019
6. Swami Amritaswarupananda Puri "From Amma's Heart - Amma's answer to questions raised during world tours" March 2018
7. Secret of Inner Peace- Swami Ramakrishnananda Puri, Amrita Books, Jan 2018.

8. Mata Amritanandamayi Devi “Compassion :The only way to Peace:Paris Speech”, MA Center, April 2016.
9. Mata Amritanandamayi Devi “Understanding and collaboration between Religions”, MA Center, April 2016.
10. Mata Amritanandamayi Devi “Awakening of Universal Motherhood: Geneva Speech” M A center, April 2016.

CO – PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	3	3	2			2	3		3		3	
CO2	3	3	3	2	2		2	3	3	3		3	
CO3	3	3	2	2	2	2	2	3	3	3		3	
CO4	3	3	3	2		2	3	3	3	3		3	
CO5	3	2	2	2		2		3	2	2		2	
	3	2	2	2	3	2		3	2	2		2	

24DLS601

Inventory and Marketing Management

3 1 0 4

Course Outcome

CO	Course Outcomes
CO1	Understanding inventory management, dependent demand, independent demands models and its costs
CO2	Exploring different types of deterministic and stochastic inventory models.
CO3	Understanding joint replenishment inventory problem, BoM, MRP and Supply chain management
CO4	To gain knowledge on sales strategies and management

Unit I: The Basic Concepts of inventory management. Independent and dependent 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, EOQ with price break, Multi-Item Inventory Models, ABC Analysis, Stochastic demand model, Newsvendor model, S-S Policy, Optimal solution and approximations. Joint replenishment inventory problem, Supply chain management: Series, Assembly, Tree and general production network systems, Optimal solution, heuristics and approximation,

Unit III: Understanding Marketing Management, Marketing environmental analysis, Strategic marketing planning, Marketing strategy, Product life cycle Strategy, Branding and Packing, Integrated marketing communication, Advertising and sales promotion and sales management. Case studies related to supply chain 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. 3rd Edition, Wiley, 1999.
4. Philip Kotler, Marketing Management – Analysis, Planning and Control , 12th edition , Prentice Hall of India, New Delhi,2007.
5. Gert H.N Laursen and Jesper Thorlund :Business analytics for managers taking business intelligence beyond reporting, second edition 2016.
6. Schiffman, Kanuk, Kumar, Consumer Behaviour, Pearson, Tenth Edition,2010
7. Still, R., Richard, Sales Management, Pearson Prentice Hall, Delhi,2017

CO-PO Mapping

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

24DLS602

Deep Learning

3 0 2 4

Course outcomes

- CO1: Understand the basics concepts of machine learning and deep learning architectures
 CO2: Gain knowledge convolution neural networks and transfer learning
 CO3: Gain knowledge about sequence modelling and auto encoders

Unit-I: Machine learning basic and Deep learning architectures

Learning algorithms, Maximum likelihood estimation, Building machine learning algorithm, Neural Networks Multilayer Perceptron, Back-propagation algorithm and its variants Stochastic gradient decent, Curse of Dimensionality .Machine Learning and Deep Learning, Representation Learning, Width and Depth of Neural Networks, Activation Functions: RELU, LRELU, ERELU, Unsupervised Training of Neural Networks, Restricted Boltzmann Machines, Auto Encoders, Deep Learning Applications

Unit-II Convolution Neural Networks and Transfer Learning

Architectural Overview, Motivation, Layers, Filters, Parameter sharing, Regularization, Popular CNN Architectures: ResNet, AlexNet - Applications Transfer learning Techniques, Variants of CNN: DenseNet, PixelNet

Unit -III Sequence Modelling (RNN) and Auto encoders

Recurrent Neural Networks, Bidirectional RNNs, Encoder-decoder sequence to sequence architectures - BPTT for training RNN, Long Short Term Memory Networks , Auto encoder, Regularized Auto encoder, stochastic Encoders and Decoders, Contractive Encoders

Text / Reference books

1. Ian Goodfellow, YoshuaBengio and Aaron Courville, “ Deep Learning”, MIT Press, 2017.

2. Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017
3. Umberto Michelucci "Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks" Apress, 2018.
4. Kevin P. Murphy "Machine Learning: A Probabilistic Perspective", The MIT Press, 2012. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, Prentice Hall of India, Third Edition 2014.

CO-PO Mapping

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

Elective Courses

24DLS631

Pattern Recognition

3 0 0 3

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.

24DLS632

Stochastic Process

3 0 0 3

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.

24DLS633

Queuing Theory

3 0 0 3

Queuing Models: Basic characteristics of a Queuing 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

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

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

24DLS634

Survival Analysis

3 0 0 3

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.

24DLS635

Sampling Techniques

3 0 0 3

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

1. Cochran, W.G. :*Sampling Techniques* ,3rd Ed., Wiley Eastern. 1984
2. Murthy, M.N. :*Sampling Theory & Statistical Methods*, Statistical Pub. Society,Calcutta,1977
3. Des Raj and Chandhok P. :*Sample Survey Theory*, Narosa Publishing House,1988.

24DLS636

Demography and Actuarial Statistics

3 0 0 3

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 unction, 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*, Johnwiley,New york,1975
3. Biswas.S. : *Stochastic processes in Demography and applications*,Wiley eastern limited,1988
4. Atkinson, M.E. and Dickson, D.C.M.: *An Introduction to Actuarial Studies*, ElgarPublishing,2000
5. Philip, M. et. al : *Modern Actuarial Theory andPractice*, Chapman andHall,1999.

24DLS637

Official Statistics

3 0 0 3

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/>

24DLS638

Reinforcement Learning

3 0 0 3

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.

24DLS639

Social Network Analytics

3 0 0 3

An Introduction to social network data analytics: research Issues, statistical properties of social networks, random walks in social networks and their applications: survey, applications, community discovery in social networks, node classification in social networks, evolution in social networks - survey, survey of models and algorithms for social influence analysis, survey

of algorithms and systems for expert location in social networks, survey of link prediction in social networks, data mining in social media, text mining in social networks

Text and Reference

1. Charu C. Aggrawal : Social Network Data Analytics, Springer, 2011.
2. 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.

24DLS640

Mining of Massive Datasets

3 0 0 3

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.

24DLS641

Parallel and Distributed Systems

3 0 0 3

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

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

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

1. George Coulouris , Jean Dollimore , Tim Kindberg , Gordon Blair: *Distributed Aystems : Concepts and Design* , Fifth Edition , Addison Wiley, 2012.

2. Calvin Lin ,Larry Snyder : *Principles of Parallel Programming*, Pearson, 2009

References

1. Bertil Schmidt,Jorge Gonzalez-Dominguez, Christian Hundt , Moritz Schlarb, *Parallel Programming: Concepts and Practice* First Edition, Morgan Kaufmann, 2017.
2. Ajay D. Kshemkalyani,MukeshSinghal , *Distributed Computing: Principles, Algorithms, and Systems*, Cambridge University Press, First edition, 2008.

24DLS642

Taguchi Techniques

3 0 0 3

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

24DLS643

Special Distribution Functions

3 0 0 3

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

Text/Reference books

Catherine Forbes, Merran Evens, Nicholas Hastings and Brian Peacock. (2010). *Statistical Distributions*, Fourth Edition, Wiley & Sons Publication, USA.

Karl Bury (1999) :Statistical distributions in Engineering , Cambridge University Press.

Thomopoulos, Nick T(2017): Statistical Distributions:Applications and Parameter Estimates, Springer.

