RAJALAKSHMI ENGINEERING COLLEGE
CURRICULUM AND SYLLABUS

M.Tech (Data Science)

REGULATION 2019

Vision

- To be a Department of Excellence in Information Technology Education, Research and Development.

Mission

- To train the students to become highly knowledgeable in the field of Information Technology.
- To promote continuous learning and research in core and emerging areas.
- To develop globally competent students with strong foundations, who will be able to adapt to changing technologies.

PROGRAMME OUTCOMES (POs)

PO1: Graduates should be able to learn how to interpret data, extracts meaningful information, and assesses findings.

PO2: Graduates should capable of demonstrating and developing a design of mastery over the key technologies in data science and business analytics such as structured/unstructured data mining, machine learning, visualization techniques, predictive modeling and statistics.

PO3: Graduates should be capable of applying ethical principles and responsibilities during Professional practice.

PO4: Graduates should be able to function effectively as a team member and to write/ present a substantial technical report / document.

PO5: Graduates should independently carry out research / investigation and development work to solve industry and organization-specific problems and challenges using advanced analytics and computational methods.

PO6: Graduates should be able to engage in independent and life-long learning in the broadest context of technological change.

M.Tech (Data Science)
CHOICE BASED CREDIT SYSTEM

Now a day's industries, such as social media, healthcare, insurance, e-commerce, transport, government, banking, telecommunications, etc., that are producing massive amounts of data, the so-called "BIG DATA", at a remarkable scale. This has led to converting unprocessed data to useful information to make decisions. In response, the **Department of Information Technology at Rajalakshmi Engineering College** offers a Master's program on Data Science.

M.Tech. Data Science is a two year postgraduate course. The course is designed to meet the needs of the IT professionals to grasp the industrial requirements and create data scientists within short time. Data Science program is to create professional who can mine and interpret data and making sense for industrial applications.

Eligibility

- B.E./B.Tech. or equivalent degree with minimum 50% marks or equivalent CGPA in CSE,IT and ECE

Curriculum

SEMESTER I

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	MH19107	Mathematics for data Science	BS	4	3	1	0	4
2.	PG19101	Research Methodology and IPR	MC	3	3	0	0	3
3.	DS19101	Programming for Data Science	PC	3	3	0	0	3
4.	DS19102	Advanced Data Structures and Algorithmic methods	PC	3	3	0	0	3
5.	DS19103	Data Analysis and Visualization	PC	3	3	0	0	3
6.	DS19104	Scalable Systems for Data Science	PC	3	3	0	0	3
7.	AC19101	English for Research Paper Writing	HS	3	3	0	0	0
PRACTICALS								
7.	DS19111	Advanced Data Structures and Algorithms Laboratory	PC	4	0	0	4	2
8.	DS19112	Data Analysis using Python Laboratory	PC	4	0	0	4	2
Total				**30**	**21**	**1**	**8**	**23**

SEMESTER II

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	DS19201	Big Data Analytics and Tools	PC	3	3	0	0	3
2.	DS19202	Cloud Computing Technologies	PC	3	3	0	0	3
3.	DS19203	Machine Learning Techniques	PC	3	3	0	0	3
4.	DS19204	Computer Vision	PC	3	3	0	0	3
5.	DS19P2X	Professional Elective I	PE	3	3	0	0	3
6.	DS19P2X	Professional Elective II	PE	3	3	0	0	3
7.	AC19201	Constitution of India	MC	3	3	0	0	0
PRACTICALS								
7.	DS19211	Big Data Laboratory	PC	4	0	0	4	2
8.	DS19212	Cloud Computing Technologies Laboratory	PC	4	0	0	4	2
Total				**29**	**21**	**0**	**8**	**22**

SEMESTER III

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	DS19301	Security for Data Science	PC	3	3	0	0	3
2.	DS19P3X	Professional Elective III	PE	3	3	0	0	3
3.		Open Elective I	OE	3	3	0	0	3
PRACTICALS								
4.	DS19311	Project Work (Phase I)	EEC	12	0	0	12	6
Total				**21**	**9**	**0**	**12**	**15**

SEMESTER IV

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICALS								
1.	DS19411	Project Work (Phase II)	EEC	24	0	0	24	12
Total				24	0	0	24	12

Total Credits: 72

LIST OF ELECTIVES

SEMESTER II-ELECTIVE I

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	DS19P21	Advanced Database Technology	PE	3	3	0	0	3
2.	DS19P22	Video Analytics	PE	3	3	0	0	3
3.	DS19P23	Deep Learning	PE	3	3	0	0	3
4.	DS19P24	Finite Elements: Theory and Algorithms	PE	3	3	0	0	3

SEMESTER II-ELECTIVE II

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	DS19P25	Information Retrieval Techniques	PE	3	3	0	0	3
2.	DS19P26	Natural Language Processing	PE	3	3	0	0	3
3.	DS19P27	Social Network Analysis	PE	3	3	0	0	3
4.	DS19P28	Recommendation Systems	PE	3	3	0	0	3

SEMESTER III-ELECTIVE III

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	DS19P31	Health Care Analytics	PE	3	3	0	0	3
2.	DS19P32	Financial and Risk Analytics	PE	3	3	0	0	3
3.	DS19P33	Marketing and Retail Analytics	PE	3	3	0	0	3
4.	DS19P34	Supply Chain and Logistics Analytics	PE	3	3	0	0	3

OPEN ELECTIVE COURSES

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	CP19O31	Business Analytics	OE	3	3	0	0	3
2.	ED19032	Operation Research	OE	3	2	1	0	3
3.	PG19031	Cost Management of Engineering Projects	OE	3	3	0	0	3
4.	PG19032	Waste To Energy	OE	3	3	0	0	3
5.	ED19031	Industrial Safety	OE	3	3	0	0	3
6.	ED19033	Composite Materials	OE	3	3	0	0	3

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
MH19107	MATHEMATICS FOR DATA SCIENCE	BS	3	1	0	4

Objectives:	
●	To understand the concept of vector spaces and orthogonalityfor solving matrix decomposition problems.
●	To develop the concept of correlation and regression and apply in real life problems.
●	To develop the skills on decision making using the concepts in estimation theory.

UNIT-I	**VECTOR SPACE**	**12**
Vector spaces – Inner Products and Norms – Orthogonality – Eigen decomposition of Matrices: Similarity Transformation - Orthogonal Transformation of Symmetric matrices.		
UNIT-II	**MATRIX THEORY**	**12**
The Cholesky decomposition - generalized eigen vectors, canonical basis - QR factorization: Gram –Schmidt process - least squares method - singular value decomposition**.**		
UNIT-III	**TWO DIMENSIONAL RANDOM VARIABLES**	**12**
Joint distributions – marginal and conditional distributions – Transformation of two dimensional random variables – regression curve – correlation.		
UNIT-IV	**ESTIMATION THEORY**	**12**
Unbiased Estimators – method of moments – maximum likelihood estimation - curve fitting by principle of least squares – regression lines.		
UNIT-V	**MULTIVARIATE ANALYSIS**	**12**
Random vectors and matrices - mean vectors and covariance matrices –multivariatenormal density and its properties - population principal components- principle components from standardized variables.		
	Total Contact Hours : 60	

Course Outcomes: On completion of the course, students will be able to	
●	Use the concept of vector spaces and inner products.
●	Decompose matrices and obtain canonical bases.
●	Apply the concept of correlation and regression in real life situation.
●	Apply the concept of estimation theory and curve fitting for forecasting.
●	Identify and analyze the principle components of different processes.

Reference Books(s) / Web links:	
1	Richard Bronson, "Matrix Operation", Schaum's outline series, 2nd Edition, McGraw Hill, 2011.
2	Veerarajan T, Probability, statistics and random process with queueing theory and queueing networks, 4th edition, McGraw - Hill Publishing Company Limited
3	Richard A. Johnson and Dean W. Wichern, "Applied Multivariate Statistical Analysis",Pearson Education, Asia, Fifth Edition.
4	Gupta S.C. and Kapoor V.K."Fundamentals of Mathematical Statistics", Sultan and Sons.
5	Jay L. Devore, "Probability and Statistics for Engineering and the Sciences", Thomson andDuxbury.
6	Richard Johnson. "Miller & Freund's Probability and Statistics for Engineer", Prentice – Hall,Seventh Edition, 2007.
7	Dallas E Johnson, "Applied Multivariate Methods for Data Analysis", Thomson and Duxburypress.

CO-PO MAPPING

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6
C01	2	2	-	-	3	3
C02	1	2	-	-	3	2
C03	2	1	-	-	3	3
C04	2	2	-	-	3	3
C05	2	1	-	-	3	2
Average	1.8	1.6	0	0	3	2.6

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
PG19101	**Research Methodology And IPR**	MC	3	0	0	3

Objectives:

- To inculcate the importance of research methodology and Intellectual Property Rights. The main objective of the IPR is to make the students aware of their rights for the protection of their invention done in their project work.
- To get registration of patents in our country and foreign countries of invention, designs and thesis or theory written. To get knowledge of patents, copy right, trademarks and designs.

UNIT-I	Research Methodology: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.	9
UNIT-II	Review Of Literature And Technical Writing: Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.	9
UNIT-III	Intellectual Property Rights: Nature of Intellectual Property: Patents, Designs, Trade and Copyright, copyright registration in India Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under Patent Cooperation Treaty.	**9**
UNIT-IV	Patent Rights And Recent Developments In IPR: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.	9
UNIT-V	Industrial Designs And Geographical Indications : Industrial designs and IC Layout design, Registrations of designs, conditions and procedures of industrial designs- Cancellation of Registration, International convention of design- types and functions. Semiconductor Integrated circuits and layout design Act- Geographical indications-potential benefits of Geographical Indications.	9
	Total Contact Hours : 45	

Course Outcomes:

- Student can understand the research problem formulation and analyze research related information.
- Understanding that when IPR would take such important place in growth of individuals & nation.
- Understand the importance of copyright and industrial designs.
- Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.
- The students once they complete their academic projects, they get awareness of acquiring the patent and copyright for their innovative works.

Text Book (s):

1. Neeraj Pandey and Khushdeep Dharni, Intellectual Property Rights, First edition, PHI learning Pvt. Ltd., Delhi, 2014.
2. Uma Sekaran and Roger Bougie, Research methods for Business, 5th Edition, Wiley India, New Delhi, 2012.
3. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'" ,2nd edition, Juta Academic, 2001.
4. Ramakrishna B & Anilkumar H S, Fundamentals of Intellectual Property Rights, Ist edition, Notion Press, 2017.

Reference Books(s) / Web links:	
1	William G Zikmund, Barry J Babin, Jon C.Carr, Atanu Adhikari,Mitch Griffin, Business Research methods, A South Asian Perspective, 8th Edition, Cengage Learning, New Delhi, 2012.

CO-PO MAPPING

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6
C01	2	1	2	2	3	2
C02	2	2	2	2	2	2
C03	1	1	1	1	2	2
C04	1	2	2	2	3	2
C05	1	1	1	2	2	2
Average	2	1	2	2	2	2

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
DS19101	PROGRAMMING FOR DATA SCIENCE	PC	3	0	0	3

Objectives:	
●	To understand the basics of Data science.
●	To learn the basics of python programming.
●	To study the data structures provided by numpy library for arrays and Visualization using Python.
●	To learn the basics of R programming.
●	To learn and implement Data Science algorithms using R.

UNIT I	INTRODUCTION TO DATA SCIENCE	9
Data Science - Evolution of data – Best Practices for Big data Analytics – Big data characteristics – Validating – The Promotion of the Value of Big Data – Big Data Use Cases- Characteristics of Big Data Application-Statistics for Analytics – Data science life cycle – Analysis and reporting –Modern Data Analytics Tools		
UNIT II	**INTRODUCTION TO PYTHON PROGRAMMING**	**9**
Basics of Python-Starting with python interpreter-Control flow statements-Functions-List,tuple,Dictionary-Lambda with mapper,reduce and filter-List and dictionary comprehension- Files- Modules –Packages - Regular expressions - Working with classes and Objects		
UNIT III	**DATA SCIENCE USING PYTHON**	**9**
Data Science Packages-Numpy,scipy,pandas-Building models and evalution with Scikit-Data Loading,Storage and File format- Data Wrangling: Clean, Transform, Merge, Reshape-Plotting and Visualization – Data Aggregation and Group Operations – Time Series - The Jupyter and PyDev development environments-Neural Network Basics - Data Exploration in Python - Statistical Methods for Evaluation using R - Visualization using Python - Building models and evalution with Scikit		
UNIT IV	**INTRODUCTION TO R**	**9**
Overview- DataTypes, Variables, Operators, Decision Making, Loops, Functions, Strings, Vector, List, Matrices, Arrays, Factors, Data Frames, Packages-Data Visualization – Data Interfaces- Reading and writing of CSV files-Exploratory Data Analysis using R-Statistical Methods for Evaluation using R		
UNIT V	**DATA SCIENCE USING R**	**9**
Association –Classification – Clustering – Time series Analysis-Text Analysis-–Prediction Algorithm-Image Analytics – Video Analytics – Data base analytics		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
●	has experience in implementation/modification of methods involved in Data Science
●	Apply programming knowledge of python
●	manage data , analysis and problem solving
●	Gain knowledge in R Programming
●	Apply programming knowledge of R in Data Science

Reference Books(s) / Web links:	
1	Wes McKinney, "Python *for* Data Analysis", O'Reilly Media.2012
2	Sebastian Raschka, “Python Machine Learning”,Packpub.com,2015
3	https://www.datacamp.com/courses/statistical-thinking-in-python-part-1

CO-PO MAPPING

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6
C01	3	3	1	1	2	2
C02	3	3	1	1	3	1
C03	3	3	1	1	3	1
C04	3	3	1	1	3	2
C05	3	3	1	1	3	2
Average	3	3	1	1	2.8	1.6

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
DS19102	ADVANCED DATA STRUCTURES AND ALGORITHMIC METHODS	PC	3	0	0	3

Objectives:
● derstand the principles of iterative and recursive algorithms.
● rn the graph search algorithms.
● dy network flow and linear programming problems.
● rn the hill climbing and dynamic programming design techniques.
● velop recursive backtracking algorithms.

UNIT I	ITERATIVE AND RECURSIVE ALGORITHMS	9
Iterative Algorithms: Measures of Progress and Loop Invariants-Paradigm Shift: Sequence of Actions versus Sequence of Assertions- Steps to Develop an Iterative Algorithm-Different Types of Iterative Algorithms--Typical Errors-Recursion-Forward versus Backward- Towers of Hanoi Checklist for Recursive Algorithms-The Stack Frame-Proving Correctness with Strong Induction Examples of Recursive Algorithms-Sorting and Selecting Algorithms-Operations on Integers Ackermann's Function- Recursion on Trees-Tree Traversals- ExamplesGeneralizingtheProblem-HeapSortandPriorityQueues-RepresentingExpressions.		
UNIT II	**OPTIMISATION ALGORITHMS**	**9**
Optimization Problems-Graph Search Algorithms-Generic Search-Breadth-First Search Dijkstra's Shortest-Weighted-Path-Depth-First Search-Recursive Depth-First Search-Linear Ordering of a Partial Order- Network Flows and Linear Programming-Hill Climbing-Primal Dual Hill Climbing Steepest Ascent Hill Climbing-Linear Programming-Recursive Backtracking-Developing Recursive Backtracking Algorithm- Pruning Branches-Satisfiability.		
UNIT III	**DYNAMIC PROGRAMMING ALGORITHMS**	**9**
Developing a Dynamic Programming Algorithm-Subtle Points- Question for the Little Bird Sub instances and Sub solutions -Set of Substances-Decreasing Time and Space-Number of Solutions-Code. Reductions and NP - Completeness – Satisfiability - Proving NPCompleteness-3-Coloring- Bipartite Matching. Randomized Algorithms - Randomness to Hide Worst Cases Optimization Problems with a Random Structure		
UNIT IV	**SHARED OBJECTS AND CONCURRENT OBJECTS**	**9**
Shared Objects and Synchronization -Properties of Mutual Exclusion-The Mora l- The Producer–Consumer Problem -The Readers–Writers Problem-Realities of Parallelization Parallel Programming- Principles- Mutual Exclusion-Time- Critical Sections—Thread Solutions-The Filter Lock-Fairness-Lamport's Bakery Algorithm-Bounded Timestamps-Lower Bounds on the Number of Locations-Concurrent Objects- Concurrency and Correctness Sequential Objects-Quiescent Consistency- Sequential Consistency-Linearizability- Formal Definitions- Progress Conditions- The Java Memory Model.		
UNIT V	**CONCURRENT DATA STRUCTURES**	**9**
Practice-Linked Lists-The Role of Locking-List-Based Sets-Concurrent Reasoning- Coarse Grained Synchronization-Fine-Grained Synchronization-Optimistic Synchronization- Lazy Synchronization-Non-Blocking Synchronization-Concurrent Queues and the ABA Problem Queues-A Bounded Partial Queue-An Unbounded Total Queue-An Unbounded Lock-Free Queue Memory Reclamation and the ABA Problem- Dual Data Structures- Concurrent Stacks and Elimination- An Unbounded Lock-Free Stack- Elimination-The Elimination Backoff Stack.		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to
● Design and apply iterative and recursive algorithms.
● Design and implement optimization algorithms in specific applications.
● Design appropriate shared objects and concurrent objects for applications.
● Implement and apply concurrent linked lists, stacks, and queues.

Reference Books(s) / Web links:	
1	Jeff Edmonds, “How to Think about Algorithms”, Cambridge University Press, 2008.
2	M. Herlihy and N. Shavit, “The Art of Multiprocessor Programming”, MorganKaufmann, 2008.
3	Steven S. Skiena, “The Algorithm Design Manual”, Springer, 2008.
4	Peter Brass, “Advanced Data Structures”, Cambridge University Press, 2008.
5	S. Dasgupta, C. H. Papadimitriou and U. V. Vazirani, “Algorithms”,McGraw-Hill,2008.
6	J. Kleinberg and E. Tardos, "Algorithm Design“, Pearson Education, 2006.
7	T. H. Cormen, C. E. Leiserson, R. L. Rivest and C. Stein, “Introduction to Algorithms“,PHI Learning Private Limited, 2012.
8	RajeevMotwaniandPrabhakarRaghavan, “Randomized Algorithms”, CambridgeUniversity Press, 1995.
9	A. V. Aho, J. E. Hopcroft, and J. D. Ullman, “The Design and Analysis of ComputerAlgorithms”, Addison-Wesley, 1975.
10	A. V. Aho, J. E. Hopcroft, and J. D. Ullman,”Data Structures and Algorithms”,Pearson, 2006.

CO-PO MAPPING

PO CO	PO1	PO2	PO3	PO4	PO5	PO6
C01	3	3	1	2	3	2
C02	3	3	1	2	3	2
C03	3	3	1	2	3	2
C04	3	3	1	2	3	2
C05	3	3	1	2	3	2
Average	3	3	1	2	3	2

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : “-”

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
DS19103	DATA ANALYSIS AND VISUALIZATION	PC	3	0	0	3

Objectives:	
●	To parse a real-world data analysis problem into one or more computational components learned in this course,
●	To apply suitable machine learning and/or visualization techniques and analyse the results obtained to enable optimal decision making.
●	To understand regression and classification algorithms.
●	To learn data visualization techniques.

UNIT I	INTRODUCTION TO DATA ANALYTICS	9
Importance of analytics and visualization in the era of data abundance- -Review of probability, statistics and random processes-- Brief introduction to estimation theory		
UNIT II	**MACHINE LEARNING TECHNIQUES**	**9**
Introduction to machine learning, supervised and unsupervised learning, gradient descent, overfitting, regularization etc. – Clustering techniques: K-means, Gaussian mixture models and expectation-maximization, agglomerative clustering, evaluation of clustering - Rand index, mutual information based scores, Fowlkes-Mallows index etc.		
UNIT III	**REGRESSION AND CLASSIFICATION**	**9**
Regression: Linear models, ordinary least squares, ridge regression, LASSO, Gaussian Processes regression. - Supervised classification methods: K-nearest neighbor, naive Bayes, logistic regression, decision tree, support vector machine. - Sparse coding and dictionary learning, orthogonal matching pursuit.- Introduction to artificial neural networks (ANNs), deep NNs, convolutional neural network (CNN), and other recent topics.		
UNIT IV	**DATA VISUALIZATION**	**9**
Data visualization: Basic principles, categorical and continuous variables. - Exploratory graphical analysis. - Creating static graphs, animated visualizations - loops, GIFs and Videos.		
UNIT V	**DATA VISUALIZATION TOOLS**	**9**
Data visualization in Python and R, examples from Bokeh, Altair, ggPlot, ggplot2, gganimate, ImageMagick etc. - Introduction to Visualization Toolkit (VTK) for 3D computer graphics, image processing and visualization. - Visualization for deep learning.		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
●	Parse a real-world data analysis problem into one or more computational components learned in this course,
●	Apply suitable machine learning and/or visualization techniques and analyze the results obtained to enable optimal decision making.
●	Understand regression and classification algorithms.
●	Apply data visualization techniques.
●	Use Data visualization tools

Reference Books(s) / Web links:	
1	Jerome H. Friedman, Robert Tibshirani, and Trevor Hastie, The Elements of Statistical Learning, Springer, 2001.
2	Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
3	David G. Stork, Peter E. Hart, and Richard O. Duda, Pattern Classification (2nd edition), Wiley, 2000.
4	. Edward Tufte, The Visual Display of Quantitative Information (2nd edition), Graphics Press, 2001.
5	Colin Ware, Information Visualization: Perception for Design (2nd edition), Morgan Kaufmann, 2004.
6	Alberto Cairo, The Functional Art: An Introduction to Information Graphics and Visualization, New Riders, Pearson Education, 2013.
7	Nathan Yau, Data Points: Visualization That Means Something, Wiley, 2013.
8	Charles D. Hansen and Chris R. Johnson, Visualization Handbook, Academic Press, 2004.
9	Will Schroeder, Ken Martin, and Bill Lorensen, The Visualization Toolkit: An Object-Oriented Approach to 3D Graphics, Kitware Inc. Publishers, 2004.

CO-PO MAPPING

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6
C01	3	3	-	2	3	2
C02	3	3	-	2	3	2
C03	3	3	-	2	3	2
C04	3	3	-	2	3	2
C05	3	3	-	2	3	2
Average	3	3	-	2	3	2

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
DS19104	SCALABLE SYSTEMS FOR DATA SCIENCE	PC	3	0	0	3

Objectives:	
●	To understand the basics of data science.
●	To understand advanced analytical theory and methods.
●	To learn the advanced analytics technology and tools
●	To get exposed with the Hadoop distributed file system architecture
●	To understand the Map-Reduce concepts.

UNIT I	INTRODUCTION TO DATA SCIENCE	9
Introduction of Data Science, Basic Data Analytics using R, R Graphical User Interfaces- Data Import and Export, Attribute and Data Types, Descriptive Statistics, Exploratory Data Analysis, Visualization Before Analysis, Dirty Data, Visualizing a Single Variable, Examining Multiple Variables, Data Exploration Versus Presentation- Statistical Methods for Evaluation, Hypothesis Testing, Difference of Means, Wilcoxon Rank-Sum Test, ANOVA		
UNIT II	**ADVANCED ANALYTICAL THEORY AND METHODS**	**9**
Overview of Clustering, K-means, Use Cases, Overview of the Method, Perform a K-means Analysis using R-Classification, Decision Trees, Overview of a Decision Tree, Decision Tree Algorithms, Evaluating a Decision Tree-Decision Tree in R, Bayes' Theorem, Naïve Bayes Classifier, Smoothing, Naïve Bayes in R		
UNIT III	**ADVANCED ANALYTICS TECHNOLOGY AND TOOLS**	**9**
Analytics for Unstructured Data, Use Cases, MapReduce, Apache Hadoop, The Hadoop Ecosystem, Pig, Hive, Hbase, Mahouth, NoSQL, SQL Essentials- Joins, Set Operations, Grouping Extensions, In-Database Text Analysis, Advanced SQL, Window Functions, User-defined Functions and Aggregates, Ordered Aggregates, MADlib		
UNIT IV	**HADOOP DISTRIBUTED FILE SYSTEM ARCHITECTURE**	**9**
HDFS Architecture, HDFS Concepts, Blocks- NameNode, Secondary NameNode, DataNode, HDFS Federation, HDFS High Availability, Basic File System Operations- Data Flow, Anatomy of File Read, Anatomy of File Write, Anatomy of a MapReduce Job Run		
UNIT V	**PROCESSING DATA WITH MAPREDUCE**	**9**
Getting to know MapReduce, MapReduce Execution Pipeline, Runtime Coordination and Task Management-MapReduce Application, Hadoop Word Count Implementation- Installing and Running Pig, Hbase Versus RDBMS, Installing and Running ZooKeeper		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
●	Understand the basics of data science.
●	Apply theadvanced analytical theory and methods.
●	Understand and use the advanced analytics technology and tools.
●	Understand the Hadoop distributed file system architecture
●	Apply the Map-Reduce concepts.
Reference Books(s) / Web links:	
1	David Dietrich, Barry Heller and Beibei Yang, "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", EMC Education Services, Reprint 2015, Wiley, ISBN: 9788126556533.
2	Tom White, "Hadoop: The Definitive Guide", 4th Edition, 2015, O'Reilly, ISBN: 9789352130672.
3	BirisLublinsky, Kevin T. Smith and Alexey Yakubovich, "Professional Hadoop Solutions", Reprint 2014, Wiley, ISBN 13:9788126551071
4	Stephen Marsland, "Machine Learning – An Algorithmic Perspective", , Taylor& Francis Group, Second Edition, 2015, Chapman & Hall / CRC Press , ISBN:9781466583283.
5	Nathan Marz, James Warren, "Big Data-Principles and best practices of scalable real-time data systems", Edition 2015, DreamTech Press, ISBN: 9789351198062.

CO-PO MAPPING

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6
C01	3	3	1	2	3	2
C02	3	3	1	2	3	2
C03	3	3	1	2	3	2
C04	3	3	1	2	3	2
C05	3	3	1	2	3	2
Average	3	3	1	2	3	2

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name	Category	L	T	P	C
AC19101	English for Research Paper Writing Common to all branches of M.E. /M.Tech / MBA – I Semester	HS	3	0	0	0

Objectives:	
●	Express technical ideas in writing
●	Plan and organize the research paper
●	Understand the structure and familiarise the mechanics of organised writing
●	Improvise academic English and acquire research writing skills

UNIT-I	INTRODUCTION TO RESEARCH WRITING	9
Research – Types of Research - Selecting the Primary resources - Categorizing secondary sources - Discovering a researchable area and topic – Need Analysis - Research Question- Focussing on the Research Problem- Developing Research Design – Framing the Hypothesis – Identifying the Scope of the Research - Writing – General and Academic Writing.		
UNIT-II	**LANGUAGE OF WRITING**	**9**
Active reading – text mining – use of academic words – jargons – ambiguities – use of expression – use of tense - proper voices – third person narration – phraseology – use of foreign words – use of quotes – interpreting quotes.		
UNIT-III	**THE FORMAT OF WRITING**	**9**
Types of Journals - different formats and styles - IEEE format - Structure – Margins - Text Formatting - Heading and Title - Running Head with Page Numbers - Tables and illustrations - Paper and Printing - Paragraphs - Highlighting – Quotation – Footnotes		
UNIT-IV	**ORGANISING A RESEARCH PAPER**	**9**
Title- Abstract – Introduction – Literature review - Methodology - Results –Discussion –Conclusion - Appendices - Summarising - Citation and Bibliography.		
UNIT-V	**PUBLISHING PAPER**	**9**
Finding the Prospective publication or Journal - analysing the credits - Reviewing - Revising – Plagiarism Check - Proof reading - Preparing the Manuscript- Submitting - Resubmitting - Follow up – Publishing.		
	Total Contact Hours :	**45**

Course Outcomes: On completion of course students will be able to	
●	Understand the basic structure of research work
●	Apply proper use of language in writing paper
●	Comprehend different formats of journal paper
●	Learn the process of writing a research paper
●	Know the process of publishing journal paper

Reference Books / Web links:	
1	Adrian Wallwork: “English for Writing Research Papers”, Springer Science Business Media, Second Edition, LLC 2011
2	Stephen Howe and Kristina Henrikssion: “Phrasebook for Writing Papers and Research in English”, The Whole World Company Press, Cambridge, Fourth edition 2007
3	The Modern Language Association of America: “MLA Handbook for Writers of Research Papers” 8th Edition, The Modern Language Association of America, 2016
4	Rowena Murray: The Handbook of Academic Writing: A Fresh Approach, Sarah Moore Open University Press, 2006
5	Stephen Bailey: Academic Writing: A Practical Guide for Students Routledge Falmer: 2003
6	Joseph M. Moxley: Publish, Don't Perish: The Scholar's Guide to Academic Writing and Publishing, Praeger

	Publishers, 1992

CO-PO MAPPING

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6
C01	-	1	-	-	3	3
C02	-	-	-	-	3	1
C03	-	2	-	-	3	3
C04	-	1	-	-	2	3
C05	-	1	-	-	3	2
Average	0	1.25	0	0	2.8	2.4

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
DS19111	**ADVANCED DATA STRUCTURES AND ALGORITHMS LABORATORY**	PC	0	0	4	2

Objectives:	
●	To learn to implement iterative and recursive algorithms.
●	To learn to design and implement algorithms using hill climbing and dynamic programming techniques.
●	To learn to implement shared and concurrent objects.
●	To learn to implement concurrent data structures.

List of Experiments				
	Each student has to work individually on assigned lab exercises. It is recommended that all implementations are carried out in Java. If C or C++ has to be used, then the threads library will be required for concurrency. Exercises should be designed to cover the following topics			
1.	Implementation of graph search algorithms.			
2.	Implementation and application of network flow and linear programming problems.			
3.	Implementation of algorithms using the hill climbing and dynamic programming design techniques.			
4.	Implementation of recursive backtracking algorithms.			
5.	Implementation of randomized algorithms.			
6.	Implementation of various locking and synchronization mechanisms for concurrent linked lists, concurrent queues, and concurrent stacks.			
7.	Developing applications involving concurrency			
		Total Contact Hours	**:**	**60**

Course Outcomes:	
●	Design and apply iterative and recursive algorithms.
●	Design and implement algorithms using the hill climbing and dynamic programmingand recursive backtracking techniques.
●	Design and implement optimisation algorithms for specific applications.
●	Design and implement randomized algorithms.
●	Implement and apply concurrent linked lists, stacks, and queues.

CO-PO MAPPING:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6
C01	3	3	1	2	3	2
C02	3	3	1	2	3	2
C03	3	3	1	2	3	2
C04	3	3	1	2	3	2
C05	3	3	1	2	3	2
Average	3	3	1	2	3	2

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
DS19112	DATA ANALYSIS USING PYTHON LABORATORY	PC	0	0	4	2

Objectives:	
●	To Introduce Basic Tools In Python.
●	To Analyse the Data Using Statistical Methods
●	To develop the Skills in using Recent Machine Learning Tools for Solving practical problems
●	To develop the skills in applying appropriate supervised, semi-supervised or
List of Experiments	
1.	Analytics Tools And Techniques With Python Python: Data Manipulation, Data Exploration & Data Preparation, Modelling With Python
2.	Statistical Analysis
3.	Advanced Analytics And Machine Learning Linear Regression Logistic Regression Cluster Analysis Decision Trees And Resampling Techniques Ensemble Models, Boosting And Random Forest
4.	Complex Techniques In Statistics And ML Time Series PCA And SVM Text Mining And NLP
5.	Data Visualization Tools Python tools to visualize the result
6.	Deep Learning Techniques And Tools
7.	Real Time Case Studies Using ML in Python
	Total Contact Hours : 60

Course Outcomes:	
●	Use the python tools for analysis .
●	Apply statistical methods to understand the data
●	Perform data analysis with machine learning methods
●	Perform graphical data analysis
●	Build Analytical Models using Machine Learning and Deep learning methods.
	Software : Python Tools: NumPy, Pandas, Matplot Environment Framework: Anaconda-Jupyter Notebook DL frameworks: Keras , Tensor flow

CO-PO MAPPING

PO CO	PO1	PO2	PO3	PO4	PO5	PO6
C01	3	3	-	2	2	2
C02	3	3	-	2	2	2
C03	3	3	-	2	3	2
C04	3	3	-	2	3	2
C05	3	3	-	2	3	2
Average	3	3	0	2	3	2

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
DS19201	BIG DATA ANALYTICS AND TOOLS	PC	3	0	0	3

Objectives:	
●	Understand big data for business intelligence
●	Learn business case studies for big data analytics
●	Understand nosql big data management
●	Perform map-reduce analytics using Hadoop and related tools

UNIT I	UNDERSTANDING BIG DATA	9
What is big data – why big data – convergence of key trends – unstructured data – industry examples of big data – web analytics – big data and marketing – fraud and big data – risk and big data – credit risk management – big data and algorithmic trading – big data and healthcare – big data in medicine – advertising and big data – big data technologies – introduction to Hadoop – open source technologies – cloud and big data – mobile business intelligence – Crowd sourcing analytics – inter and trans firewall analytics		
UNIT II	**NOSQL DATA MANAGEMENT**	**9**
Introduction to NoSQL – aggregate data models – aggregates – key-value and document data models – relationships – graph databases – schemaless databases – materialized views – distribution models – sharding – master-slave replication – peer-peer replication – sharding and replication – consistency – relaxing consistency – version stamps – map reduce – partitioning and combining – composing map-reduce calculations		
UNIT III	**BASICS OF HADOOP**	**9**
Data format – analyzing data with Hadoop – scaling out – Hadoop streaming – Hadoop pipes –design of Hadoop distributed file system (HDFS) – HDFS concepts – Java interface – data flow –Hadoop I/O – data integrity – compression – serialization – Avro – file-based data structures		
UNIT IV	**MAPREDUCE APPLICATIONS**	**9**
MapReduce workflows – unit tests with MRUnit – test data and local tests – anatomy of Map Reduce job run – classic Map-reduce – YARN – failures in classic Map-reduce and YARN –job scheduling – shuffle and sort – task execution – MapReduce types – input formats – output formats		
UNIT V	**HADOOP RELATED TOOLS**	**9**
Hbase – data model and implementations – Hbase clients – Hbase examples – praxis.Cassandra– cassandra data model – cassandra examples – cassandra clients – Hadoop integration- Pig – Grunt – pig data model – Pig Latin – developing and testing Pig Latin scripts-Hive – data types and file formats – HiveQL data definition – HiveQL data manipulation – HiveQLqueries.		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
●	Describe big data and use cases from selected business domains
●	Explain NoSQL big data management
●	Install, configure, and run Hadoop and HDFS
●	Perform map-reduce analytics using Hadoop
●	Use Hadoop related tools such as HBase, Cassandra, Pig, and Hive for big dataanalytics
Reference Books(s) / Web links:	
1	Michael Minelli, Michelle Chambers, and AmbigaDhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013.
2	P. J. Sadalage and M. Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", Addison-Wesley Professional, 2012.
3	Tom White, "Hadoop: The Definitive Guide", Third Edition, O'Reilley, 2012.
4	Eric Sammer, "Hadoop Operations", O'Reilley, 2012.
5	E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilley, 2012
6	Lars George, "HBase: The Definitive Guide", O'Reilley, 2011.
7	Eben Hewitt, "Cassandra: The Definitive Guide", O'Reilley, 2010.
8	Alan Gates, "Programming Pig", O'Reilley, 2011.

CO-PO MAPPING

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6
C01	1	1	1	1	2	2
C02	2	2	0	0	2	2
C03	2	2	0	0	1	1
C04	3	3	1	1	2	2
C05	3	3	1	1	3	3
Average	2.2	2.2	0.6	0.6	2	2

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
DS19202	CLOUD COMPUTING TECHNOLOGIES	PC	3	0	0	3

Objectives:	
●	To introduce the broad perceptive of cloud architecture and model
●	To understand the concept of Virtualization
●	To be familiar with the lead players in cloud
●	To understand the features of cloud simulator
●	To apply different cloud programming model as per need

UNIT I	CLOUD ARCHITECTURE AND MODEL		9
Technologies for Network-Based System – System Models for Distributed and Cloud Computing – NIST Cloud Computing Reference Architecture. Cloud Models- Characteristics – Cloud Services – Cloud models (IaaS, PaaS, and SaaS) – Public vs Private Cloud –Cloud Solutions - Cloud ecosystem – Service management – Computing on demand.			
UNIT II	**VIRTUALIZATION**		**9**
Basics of Virtualization - Types of Virtualization - Implementation Levels of Virtualization -Virtualization Structures - Tools and Mechanisms - Virtualization of CPU, Memory, I/O Devices -Virtual Clusters and Resource management – Virtualization for Data-centre Automation.			
UNIT III	**CLOUD INFRASTRUCTURE**		**9**
Architectural Design of Compute and Storage Clouds – Layered Cloud Architecture Development– Design Challenges - Inter Cloud Resource Management – Resource Provisioning and Platform Deployment – Global Exchange of Cloud Resources			
UNIT IV	**PROGRAMMING MODEL**		**9**
Parallel and Distributed Programming Paradigms – Map Reduce , Twister and Iterative Map Reduce – Hadoop Library from Apache – Mapping Applications - Programming Support - Google App Engine, Amazon AWS - Cloud Software Environments -Eucalyptus, Open Nebula, Open Stack, Aneka, Cloud Sim.			
UNIT V	**SECURITY IN THE CLOUD**		**9**
Security Overview – Cloud Security Challenges and Risks – Software-as-a-Service Security –Security Governance – Risk Management – Security Monitoring – Security Architecture Design –Data Security – Application Security – Virtual Machine Security - Identity Management and Access Control – Autonomic Security.			
	Total Contact Hours	**:**	**45**

Course Outcomes: On completion of course students will be able to	
●	Compare the strengths and limitations of cloud computing
●	Identify the architecture, infrastructure and delivery models of cloud computing
●	Apply suitable virtualization concept.
●	Choose the appropriate cloud player
●	Choose the appropriate Programming Models and approach.

Reference Books(s) / Web links:	
1	Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and CloudComputing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
2	John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010.
3	Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", TMH, 2009.
4	Kumar Saurabh, "Cloud Computing – insights into New-Era Infrastructure", Wiley India, 2011.
5	George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud" O'Reilly
6	James E. Smith, Ravi Nair, "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.
7	Katarina Stanoevska-Slabeva, Thomas Wozniak, Santi Ristol, "Grid and Cloud Computing – A Business

	Perspective on Technology and Applications", Springer
8	Ronald L. Krutz, Russell Dean Vines, "Cloud Security – A comprehensive Guide to Secure Cloud Computing", Wiley – India, 2010.
9	RajkumarBuyya, Christian Vecchiola, S.TamaraiSelvi, 'Mastering Cloud Computing", TMGH, 2013.
10	Gautam Shroff, Enterprise Cloud Computing, Cambridge University Press, 2011
11	Michael Miller, Cloud Computing, Que Publishing,2008

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6
C01	1	1	0	0	1	1
C02	2	2	0	0	2	2
C03	3	3	0	0	3	3
C04	3	3	0	0	3	3
C05	3	3	0	0	3	3
Average	2.4	2.4	2.4	2.4	2.4	2.4

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
DS19203	MACHINE LEARNING TECHNIQUES	PC	3	0	0	3

Objectives:	
●	To understand the machine learning theory
●	To implement linear and non-linear learning models
●	To implement distance-based clustering techniques
●	To build tree and rule based models
●	To apply reinforcement learning techniques

UNIT I	FOUNDATIONS OF LEARNING	9
Components of learning – learning models – geometric models – probabilistic models – logic models – grouping and grading – learning versus design – types of learning – supervised – unsupervised – reinforcement – theory of learning – feasibility of learning – error and noise – training versus testing – theory of generalization – generalization bound – approximation generalization trade off – bias and variance – learning curve		
UNIT II	**LINEAR MODELS**	**9**
Linear classification – univariate linear regression – multivariate linear regression – regularized regression – Logistic regression – perceptrons – multilayer neural networks – learning neural networks structures – support vector machines – soft margin SVM – going beyond linearity – generalization and over fitting – regularization – validation		
UNIT III	**DISTANCE-BASED MODELS**	**9**
Nearest neighbor models – K-means – clustering around medoids – silhouttes – hierarchical clustering – k-d trees – locality sensitive hashing – non-parametric regression – ensemble learning– bagging and random forests – boosting – meta learning		
UNIT IV	**TREE AND RULE MODELS**	**9**
Decision trees – learning decision trees – ranking and probability estimation trees – regression trees – clustering trees – learning ordered rule lists – learning unordered rule lists – descriptive rule learning – association rule mining – first-order rule learning		
UNIT V	**REINFORCEMENT LEARNING**	**9**
Passive reinforcement learning – direct utility estimation – adaptive dynamic programming – temporal-difference learning – active reinforcement learning – exploration – learning an action utility function – Generalization in reinforcement learning – policy search – applications in game playing – applications in robot control		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
●	To explain theory underlying machine learning
●	To construct algorithms to learn linear and non-linear models
●	To implement data clustering algorithms
●	To construct algorithms to learn tree and rule-based models
●	To apply reinforcement learning techniques

Reference Books(s) / Web links:	
1	Y. S. Abu-Mostafa, M. Magdon-Ismail, and H.-T. Lin, “Learning from Data”,AMLBook Publishers, 2012.
2	P. Flach, “Machine Learning: The art and science of algorithms that make sense of data”, Cambridge University Press, 2012.
3	K. P. Murphy, “Machine Learning: A probabilistic perspective”, MIT Press, 2012.
4	C. M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2007
5	D. Barber, “Bayesian Reasoning and Machine Learning”, Cambridge University Press, 2012.
6	M. Mohri, A. Rostamizadeh, and A. Talwalkar, “Foundations of Machine Learning”, MIT Press, 2012.
7	T. M. Mitchell, “Machine Learning”, McGraw Hill, 1997.

8	S. Russel and P. Norvig, "Artificial Intelligence: A Modern Approach", Third Edition, Prentice Hall, 2009.

CO-PO MAPPING

PO CO	PO1	PO2	PO3	PO4	PO5	PO6
C01	3	2	-	2	-	1
C02	3	2	-	2	-	2
C03	2	2	1	2	-	1
C04	1	1	1	2	2	2
C05	1	1	-	2	2	1
Average	2	1.6	1	2	2	1.4

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
DS19204	COMPUTER VISION	PC	3	0	0	3

Objectives:	
●	To review image processing techniques for computer vision
●	To understand shape and region analysis
●	To understand Hough Transform and its applications to detect lines, circles, ellipses
●	To understand three-dimensional image analysis and motions.
●	To study some applications of computer vision algorithms.

UNIT I	IMAGE PROCESSING FOUNDATIONS	9
Introduction-Image Processing Operations– Basic Image filtering operations: Noise Suppression by Gaussian Smoothing- Median Filters- Mode Filters- Rank Order Filters- The Role of Filters in Industrial Applications of Vision-Thresholding- Adaptive Thresholding-Edgedetection techniques – corner and interest point detection – mathematical morphology – Some Basic Approaches to Texture Analysis.		
UNIT II	**SHAPES AND REGIONS**	**9**
Binary shape analysis – Connectedness – Object labeling and counting – Size filtering – Distance functions – Skeletons and thinning –Other Measures for Shape Recognition – Boundary tracking procedures – Boundary Pattern Analysis- Centroidal profiles – Problems- Plot- Handling occlusion- Accuracy of boundary length measures.		
UNIT III	**THE HOUGH TRANSFORM**	**9**
Line detection- Application of Hough Transform (HT) for line detection – The Foot-of-normal method – Longitudinal line localization – Final line fitting – Using RANSAC for straight line detection Circle and Ellipse Detection: HT for circular object detection – accurate center location – speed problem – ellipse detection – Case study- Human Iris location – hole detection- Generalized Hough Transform (GHT) – Spatial matched filtering – Use of the GHT for Ellipse Detection		
UNIT IV	**3D VISION AND MOTION**	**9**
3-D Vision - Methods for 3D vision – projection schemes – shape from shading – photometric stereo – Surface Smoothness– shape from texture – use of structured lighting- three dimensional object recognition schemes- Image Transformations and Camera Calibration- Motion: Optical Flow- Interpretation- Time-to-Adjacency Analysis-Difficulties- Stereo from Motion- The Kalman Filter.		
UNIT V	**APPLICATION**	**9**
Automated Visual Inspection: Process- Types- Application: Photo album – Face detection – Face recognition – Eigen faces – Active appearance and 3D shape models of faces Application- Surveillance-foreground-background separation – particle filtres – Chamfer matching- tracking- and occlusion – combining views from multiple cameras – human gait analysis Application- In-vehicle vision system: locating roadway – road markings – road signs – locating pedestrians.		
	Total Contact Hours :	**45**

Course Outcomes: On completion of course students will be able to	
●	Implement fundamental image processing techniques required for computer vision
●	Perform shape analysis and able to implement boundary tracking techniques
●	Apply Hough Transform for line, circle, and ellipse detections
●	Apply 3D vision techniques and to implement motion related techniques
●	Develop applications using computer vision techniques

Reference Books(s) / Web links:	
1	E. R. Davies, “Computer & Machine Vision”, Fourth Edition, Academic Press, 2012.
2	R. Szeliski, “Computer Vision: Algorithms and Applications”, Springer 2011.
3	Simon J. D. Prince, “Computer Vision: Models, Learning, and Inference”, Cambridge University Press, 2012.
4	Mark Nixon and Alberto S. Aquado, “Feature Extraction & Image Processing for Computer Vision”, Third Edition, Academic Press, 2012.
5	D. L. Baggio et al., “Mastering OpenCV with Practical Computer Vision Projects”, Packt Publishing, 2012.

6	Jan Erik Solem, "Programming Computer Vision with Python: Tools and algorithms for analyzing images", O'Reilly Media, 2012.

CO-PO MAPPING

PO CO	PO1	PO2	PO3	PO4	PO5	PO6
C01	2	2	0	0	1	1
C02	2	2	0	0	1	1
C03	1	1	0	0	0	0
C04	1	1	0	0	1	1
C05	2	2	0	0	2	1
Average	1.6	1.6	0	0	1	0.8

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name	Category	L	T	P	C
AC19201	CONSTITUTION OF INDIA	MC	3	0	0	0

Objectives:	
●	To inculcate the values enshrined in the Indian constitution.
●	To create a sense of responsible and active citizenship.
●	To know about Constitutional and Non- Constitutional bodies
●	To understand sacrifices made by the freedom fighters.

UNIT-I	INTRODUCTION	9
Historical Background - Constituent Assembly of India - Philosophical foundations of the Indian Constitution - Features - Basic Structure – Preamble.		
UNIT-II	**UNION GOVERNMENT**	**9**
Union and its territory - Citizenship - Fundamental Rights - Directive Principles of State Policy (DPSP) - Fundamental Duties. **Union Government: Executive, Legislature and Judiciary:** President - Vice President - Prime Minister - Central Council of Ministers - Cabinet Committees - Parliament: Committees, Forums and Groups - Supreme Court.		
UNIT-III	**STATE GOVERNMENT & UNION TERRITORIES**	**9**
State Government : Executive, Legislature and Judiciary- Governor - Chief Minister - State Council of Ministers - State Legislature - High Court - Subordinate Courts -Panchayati Raj – Municipalities-Union Territories - Scheduled and Tribal Areas.		
UNIT-IV	**RELATIONS BETWEEN UNION AND STATES**	**9**
Relations between Union and States - Services under Union and States. Cooperative Societies - Scheduled and Tribal Areas - Finance, Property, Contracts and Suits - Trade and Commerce within Indian Territory – Tribunals.		
UNIT-V	**CONSTITUTIONAL BODIES AND AMENDMENTS**	**9**
Introduction to Constitutional & Non-Constitutional Bodies-Elections - Special Provisions relating to certain classes - Languages - Emergency Provisions - Miscellaneous - Amendment of the Constitution - Temporary, Transitional and Special Provisions – Short title, date of commencement, Authoritative text in Hindi and Repeals. Schedules of the Constitution of India - Appendices in the Constitution of India.		
	Total Contact Hours : 45	

Course Outcomes: On completion of the course, students will be able to	
●	Appreciate the philosophical foundations of the Indian Constitution.
●	Understand the functions of the Indian government.
●	Understand and abide the rules of the Indian constitution.
●	Gain knowledge on functions of state Government and Local bodies.
●	Gain Knowledge on constitution functions and role of constitutional bodies and amendments of constitution.

Text Book(s):	
1	M Lakshmikanth “Indian Polity”, McGraw Hill Education, 5th edition 2017.
2	Durga Das Basu, “Introduction to the Constitution of India “, Lexis Nexis, New Delhi., 21st edition, 2013.
Reference Books(s) / Web links:	
1	Sharma, Brij Kishore, “Introduction to the Constitution of India”, Prentice Hall of India, New Delhi, 7th edition, 2015.
2	SubhashKashyap, “Our Constitution: An Introduction to India’s Constitution and Constitutional Law”, National

	Book Trust India, 1994.
3	Mahendra Prasad Singh and Himanshu Roy, "Indian Political System", Pearson India, 4th edition, 2017.

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
DS19211	BIG DATA LABORATORY	PC	0	0	4	2

Objectives:	
●	To optimize business decisions and create competitive advantage with Big Data analytics.
●	To impart the architectural concepts of Hadoop and introducing map reduce paradigm.
●	To introduce Java concepts required for developing map reduce programs.
●	To introduce programming tools PIG & HIVE in Hadoop echo system.
●	To develop Big Data applications for streaming data using Apache Spark

List of Experiments				
1.	(i).Perform setting up and Installing Hadoop in its two operating modes: · Pseudo distributed · Fully distributed. (ii).Use web based tools to monitor your Hadoop setup			
2.	Implement the following file management tasks in Hadoop: • Adding files and directories • Retrieving files • Deleting files			
3.	Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm. • Find the number of occurrence of each word appearing in the input file(s) • Performing a MapReduce Job for word search count (look for specific keywords in a file)			
4.	Stop word elimination problem: Input: A large textual file containing one sentence per line . A small file containing a set of stop words (One stop word per line) Output: A textual file containing the same sentences of the large input file without the words appearing in the small file			
5.	Write a Map Reduce program that mines weather data. Weather sensors collecting data every hour at many locations across the globe gather large volume of log data, which is a good candidate for analysis with MapReduce, since it is semi structured and record-oriented. • Find average, max and min temperature for each year in NCDC data set? • Filter the readings of a set based on value of the measurement, Output the line of input files associated with a temperature value greater than 30.0 and store it in a separate file.			
6.	Install and Run Pig then write Pig Latin scripts to sort, group, join, project, and filter your data			
7.	Developing applications involving concurrency			
8.	Write a Pig Latin scripts for finding TF-IDF value for book dataset			
9	Install and Run Hive then use Hive to create, alter, and drop databases, tables, views, functions, and indexes.			
10	Install, Deploy & configure Apache Spark Cluster. Run apache spark applications using Scala			
11.	Data analytics using Apache Spark on Amazon food dataset, find all the pairs of items frequently reviewed together. Write a single Spark application that: • Transposes the original Amazon food dataset, obtaining a PairRDD of the type • A Counts the frequencies of all the pairs of products reviewed together; • Writes on the output folder all the pairs of products that appear more than once and their frequencies. The pairs of products must be sorted by frequency.			
		Total Contact Hours	**:**	**60**

Course Outcomes:	
●	Optimize business decisions and create competitive advantage with Big Data analytics.
●	Imparting the architectural concepts of Hadoop and introducing map reduce paradigm.
●	Introducing Java concepts required for developing map reduce programs.
●	Introduce programming tools PIG & HIVE in Hadoop echo system.
●	Developing Big Data applications for streaming data using Apache Spark.

CO-PO MAPPING:

PO CO	PO1	PO2	PO3	PO4	PO5	PO6
C01	1	1	1	1	2	2
C02	2	2	0	0	2	2
C03	2	2	0	0	1	1
C04	3	3	1	1	2	2
C05	3	3	1	1	3	3
Average	2.2	2.2	0.6	0.6	2	2

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Laboratory Course)	Category	L	T	P	C
DS19212	CLOUD COMPUTING TECHNOLOGIES LABORATORY	PC	0	0	4	2

Objectives:	
●	Appreciate cloud architecture
●	Create and run virtual machines on open source OS
●	Implement Infrastructure, storage as a Service.
●	Install and appreciate security features for cloud

List of Experiments			
1	Study of Cloud Computing & Architecture		
2	Virtualization in Cloud		
3	Study and implementation of Infrastructure as a Service		
4	Study and installation of Storage as Service		
5	Implementation of identity management		
6	Write a program for web feed		
7	Study and implementation of Single-Sing-On		
8	Securing Servers in Cloud		
9	User Management in Cloud		
10	Case study on Amazon EC2		
11	Case study on Microsoft azure		
12	Mini project		
	Total Contact Hours	**:**	**60**

Course Outcomes:	
●	Appreciate cloud architecture.
●	Create and run virtual machines on open source OS.
●	Implement Infrastructure, storage as a Service.
●	Install and appreciate security features for cloud.
●	Design and develop cloud computing based applications.

CO-PO MAPPING

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6
C01	1	1	0	0	1	1
C02	2	2	0	0	2	2
C03	3	3	0	0	3	3
C04	3	3	0	0	3	3
C05	3	3	0	0	3	3
Average	2.4	2.4	2.4	2.4	2.4	2.4

Correlation levels 1, 2 or 3 are as defined below: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
DS19301	SECURITY FOR DATA SCIENCE	PC	3	0	0	3

Objectives:	
●	To understand and apply the models of Information Security.
●	To study the Information assurance tools and methods.
●	To study and analyze cryptographic and forensic methods.
●	To analyze and simulate the network and application security.
●	To explore the nature and logic behind the cyber security threats as an ethical hacker.

UNIT I	AUTHENTICATION APPLICATIONS	9
Authentication Applications : Kerberos – X.509 Authentication service – Public-key Infrastructure Electronic Mail Security : Pretty Good Privacy – S/MIME		
UNIT II	**NETWORK SECURITY**	**8**
IP Security : IP Security Overview- IP security Architecture – Authentication Header – Encapsulating Security Payload – Combining Security Associations – Key Management Web Security : Web security Considerations - Secure Socket Layer and Transport Layer Security- Secure Electronic Transactions.		
UNIT III	**IP AND WEB SECURITY**	**9**
Network security - Intrusion Prevention, detection and Management - Firewall – Ecommerce Security - Computer Forensics - Security for VPN and Next Generation Networks		
UNIT IV	**DATA PRIVACY AND ANONYMIZATION**	**10**
Understanding Privacy: Social Aspects of Privacy Legal Aspects of Privacy and Privacy Regulations Effect of Database and Data Mining technologies on privacy challenges raised by new emerging technologies such RFID, biometrics, etc., Privacy Models Introduction to Anonymization, Anonymization models: K-anonymity, l-diversity, t-closeness, differential privacy Database as a service		
UNIT V	**DATA PRIVACY FOR DATA SCIENCE**	**9**
Using technology for preserving privacy: Statistical Database security Inference Control Secure Multi-party computation and Cryptography Privacy-preserving Data mining Hippocratic databases Emerging Applications: Social Network Privacy, Location Privacy, Query Log Privacy, Biomedical Privacy		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
●	Identify the information security models and their characteristics.
●	Analyse the different types of cryptographic and forensic methods.
●	Study the network security issues.
●	Understand the privacy and anonymoization
●	Identify and solve different cyber security threats

Reference Books(s) / Web links:	
1	William Stallings, “Cryptography and Network Security: Principles and Practice”, 6 th Edition, PHI, 2014.
2	Michael E. Whitman and Herbert J Mattord, "Principles of Information Security", 6 thedition, Vikas Publishing House, 2017.
3	Bill Nelson, Amelia Phillips, F.Enfinger and Christopher Stuart, “Guide to Computer Forensics and Investigations, 4 th ed., Thomson Course Technology, 2010
4	Matt Bishop, “Computer Security: Art and Science”, 1 st edition, Addison-Wesley Professional, 2015.
5	Privacy-Preserving Data Mining- Models and Algorithms, Charu C Aggarwal, Yu Philips, S., Springer
6	Principles of Information Security, Information SecurityProfessional - Michael E. Whitman and Herbert J.

	Mattord,4th Edition, Thompson.

CO-PO MAPPING

PO CO	PO1	PO2	PO3	PO4	PO5	PO6
C01	-	-	3	2	2	2
C02	-	1	2	3	2	2
C03	-	-	2	2	-	2
C04	-	-	-	-	2	2
C05	-	-	-	2	2	2
Average	-	1	1.4	1.8	1.6	2

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
DS19P21	ADVANCED DATABASE TECHNOLOGY	PE	3	0	0	3

Objectives:	
●	To understand the design of databases
●	To acquire knowledge on parallel databases and its applications.
●	To acquire knowledge on distributed databases and its applications.
●	To understand the usage and applications of Object Oriented and Intelligent databases and emerging databases like Mobile, XML, Cloud and Big Data
●	To learn the special databases like Multimedia, text/document databases

UNIT I	PARALLEL AND DISTRIBUTED DATABASES	9
Database System Architectures: Centralized and Client-Server Architectures – Server System Architectures – Parallel Systems- Distributed Systems – Parallel Databases: I/O Parallelism – Inter and Intra Query Parallelism – Inter and Intra operation Parallelism – Design of Parallel Systems Distributed Database Concepts - Distributed Data Storage – Distributed Transactions – Commit Protocols – Concurrency Control – Distributed Query Processing – Case Studies		
UNIT II	**INTELLIGENT DATABASES**	**9**
Active Databases: Syntax and Semantics (Starburst, Oracle, DB2)- Taxonomy- Applications- Design Principles for Active Rules- Temporal Databases: Overview of Temporal Databases TSQL2- Deductive Databases-Recursive Queries in SQL- Spatial Databases- Spatial Data Types - Spatial Relationships- Spatial Data Structures-Spatial Access Methods- Spatial DB Implementation.		
UNIT III	**XML DATABASES**	**9**
XML Databases: XML Data Model – DTD – XML Schema – XML Querying – Web Databases – Open Database Connectivity.		
UNIT IV	**MOBILE DATABASES**	**9**
Mobile Databases: Location and Handoff Management - Effect of Mobility on Data Management - Location Dependent Data Distribution - Mobile Transaction Models Concurrency Control - Transaction Commit Protocols		
UNIT V	**MULTIMEDIA DATABASES**	**9**
Multidimensional Data Structures – Image Databases – Text / Document Databases – Video Databases –Audio Databases – Multimedia Database Design.		
	Total Contact Hours : 60	

Course Outcomes: On completion of course students will be able to	
●	Understand the design of databases
●	Acquire knowledge on parallel databases and its applications.
●	Acquire knowledge on distributed databases and its applications.
●	Explain the usage and applications of object oriented and intelligent databases and Understand the emerging databases like mobile, xml, cloud and big data
●	Explain the special databases like Multimedia, text/document databases

Reference Books(s) / Web links:	
1	Carlo Zaniolo, Stefano Ceri, Christos Faloutsos, Richard T.Snodgrass, V.S.Subrahmanian, Roberto Zicari, ―Advanced Database Systems‖, Morgan Kaufmann publishers,2006.
2	C.J.Date, A.Kannan, S.Swamynathan, ―An Introduction to Database Systems‖, Eighth Edition, Pearson Education, 2012.
3	*Bipin Desai,*". An Introdcution to *Database* System. Galgotia Publications Pvt Ltd-New Delhi 2012.
4	Henry F Korth, Abraham Silberschatz, S. Sudharshan, ―Database System Concepts‖, Sixth Edition, McGraw Hill, 2011.
5	R. Elmasri, S.B. Navathe, ―Fundamentals of Database Systems‖, Sixth Edition, Pearson Education/Addison Wesley, 2010.

CO-PO MAPPING

PO CO	PO1	PO2	PO3	PO4	PO5	PO6
C01	3	2	0	0	1	1
C02	3	3	0	0	1	1
C03	3	3	0	0	1	1
C04	2	2	0	0	2	2
C05	2	2	0	0	2	2
Average	2.6	2.4	0	0	1.4	1.4

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
DS19P22	VIDEO ANALYTICS	PE	3	0	0	3

Objectives:	
●	To know the fundamental concepts of big data and analytics
●	To learn various techniques for mining data streams
●	To acquire the knowledge of extracting information from surveillance videos.
●	To learn Event Modelling for different applications.
●	To understand the models used for recognition of objects in videos.

UNIT I	INTRODUCTION TO BIG DATA & DATA ANALYSIS	9
Introduction to Big Data Platform – Challenges of Conventional systems – Web data- Evolution of Analytic scalability- analytic processes and tools- Analysis Vs Reporting- Modern data analytic tools- Data Analysis: Regression Modeling- Bayesian Modeling- Rule induction.		
UNIT II	**MINING DATA STREAMS**	**9**
Introduction to Stream concepts- Stream data model and architecture – Stream Computing- Sampling data in a Stream- Filtering Streams- Counting distinct elements in a Stream- Estimating moments- Counting oneness in a window- Decaying window- Real time Analytics platform(RTAP) applications- case studies.		
UNIT III	**VIDEO ANALYTICS**	**9**
Introduction- Video Basics - Fundamentals for Video Surveillance- Scene Artifacts- Object Detection and Tracking: Adaptive Background Modelling and Subtraction- Pedestrian Detection and TrackingVehicle Detection and Tracking- Articulated Human Motion Tracking in Low-Dimensional Latent Spaces		
UNIT IV	**BEHAVIOURAL ANALYSIS & ACTIVITY RECOGNITION**	**9**
Behavioural Analysis- Human Activity Recognition-Complex Activity Recognition- Activity modelling using 3D shape, Video summarization, shape based activity models- Suspicious Activity Detection		
UNIT V	**HUMAN FACE RECOGNITION & GAIT ANALYSIS**	**9**
Overview of Recognition algorithms – Human Recognition using Face: Face Recognition from still images, Face Recognition from video, Evaluation of Face Recognition Technologies- Human Recognition using gait: HMM Framework for Gait Recognition, View Invariant Gait Recognition, Role of Shape and Dynamics in Gait Recognition		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
●	Work with big data platform and its analysis techniques.
●	Design efficient algorithms for mining the data from large volumes.
●	Work with surveillance videos for analytics.
●	Design of optimization algorithms for better analysis and recognition of objects in a scene.
●	Model a framework for Human Activity Recognition.

Reference Books(s) / Web links:	
1	AnandRajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 2012.
2	Michael Berthold, David J.Hand, Intelligent Data Analysis, Springer, 2007.
3	Rama Chellappa, Amit K.Roy-Chowdhury, Kevin Zhou.S, "Recognition of Humans and their Activities using Video", Morgan&Claypool Publishers, 2005.
4	Yunqian Ma, Gang Qian, "Intelligent Video Surveillance: Systems and Technology", CRC Press (Taylor and Francis Group), 2009.

CO-PO MAPPING:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6
C01	3	2	-	2	1	1
C02	2	3	-	-	2	2
C03	3	3	1	-	2	2
C04	1	3	-	1	2	2
C05	2	2	1	-	3	3
Average	2.2	2.6	0.4	0.6	2	2

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
DS19P23	DEEP LEARNING	PE	3	0	0	3

Objectives:	
●	To understand the fundamental principles, theory and approaches for learning with deep neural networks
●	To learn the main variants of deep learning (such convolutional and recurrent architectures), and their typical applications
●	To understand the key concepts, issues and practices when training and modelling with deep architectures
●	To understand how deep learning fits within the context of other ML approaches
●	To learn deep learning algorithms in application of choice using tensor flow.

UNIT I	**INTRODUCTION TO DEEP LEARNING**		**9**
Linear Regression -Nonlinear Regression- Logistic Regression Activation			
UNIT II	**CONVOLUTIONAL NEURAL NETWORKS (CNN)**		**9**
CNN History- Understanding CNNs- CNN Application			
UNIT III	**RECURRENT NEURAL NETWORKS (RNN)**		**9**
Intro to RNN Model Long Short-Term memory (LSTM) Recursive Neural Tensor Network Theory Recurrent Neural Network Model			
UNIT IV	**UNSUPERVISED LEARNING**		**9**
Applications of Unsupervised Learning-Restricted Boltzmann Machine-Collaborative Filtering with RBM			
UNIT V	**AUTO ENCODERS**		**9**
Introduction to Autoencoders and Applications- Autoencoders- Deep Belief Network			
	Total Contact Hours	**:**	**45**

Course Outcomes: On completion of course students will be able to	
●	Understand the fundamental principles, theory and approaches for learning with deep neural networks
●	Implement the main variants of deep learning (such convolutional and recurrent architectures), and their typical applications
●	Understand the key concepts, issues and practices when training and modeling with deep architectures.
●	Understand how deep learning fits within the context of other ML approaches.
●	Apply deep learning algorithms in application of choice using tensor flow.

Reference Books(s) / Web links:	
1	Ian Goodfellow, YoshuaBengio and Aaron Courville, “Deep Learning”, The MIT Press
2	Rajiv Chopra, Deep Learning: A Practical Approach, Khanna Publication
3	MOOC, Deep Learning By Google, https://in.udacity.com/course/deep-learning--ud730
4	MOOC, Deep Learning https://www.coursera.org/specializations/deep-learning

CO-PO MAPPING

PO CO	PO1	PO2	PO3	PO4	PO5	PO6
C01	2	3	1	2	3	-
C02	3	3	-	2	3	-
C03	3	3	-	3	3	-
C04	3	3	1	3	3	1
C05	3	3	1	3	3	1
Average	2.8	3	0.6	2.6	3	0.4

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
DS19P24	FINITE ELEMENTS: THEORY AND ALGORITHMS	PE	3	0	0	3

Objectives:	
●	To understand the Sobolev spaces and finite element spaces
●	To learn the Biharmonic equation
●	To study and understand the Parabolic problems
●	To analyse the Systems in solid and fluid mechanics
●	To learn the implementation of the finite element method

UNIT I	SOBOLEV SPACES AND FINITE ELEMENT SPACES	9
Banach and Hilbert spaces - Weak derivatives - Sobolev spaces - Elliptic scalar problems - Simplices and barycentric coordinates - Simplicial finite elements and local spaces - Construction of finite element spaces - The concept of mapped finite elements: Affine mappings - Finite elements on rectangular and brick meshes - Mapped finite elements: General bijective mappings - Mapped Q k finite element - Isoparametric finite elements.		
UNIT II	**BIHARMONIC EQUATION**	**9**
Transformation formulas - Affine equivalent finite elements - Canonical interpolation - Local and global interpolation error - Improved L 2 error estimates by duality - Interpolation of less smooth functions - Deflection of a thin clamped plate - Weak formulation of the biharmonic equation - Conforming finite element methods - Nonconforming finite element methods.		
UNIT III	**PARABOLIC PROBLEMS**	**9**
Conservation of energy - A general parabolic problem of second order - Weak formulation of initial boundary value problems - Semidiscretization by finite elements - Time discretization - Finite elements for high-dimensional parabolic problems.		
UNIT IV	**SYSTEMS IN SOLID AND FLUID MECHANICS**	**9**
Linear elasticity - Mindlin–Reissner plate - Conservation of mass and momentum - Weak formulation of the Stokes problem - Conforming discretizations of the Stokes problem - Nonconforming discretizations of the Stokes problem - The nonconforming Crouzeix–Raviart element - Further inf–sup stable finite element pairs - Equal order stabilized finite elements - Navier–Stokes problem with mixed boundary conditions - Time discretization and linearization of the Navier–Stokes problem.		
UNIT V	**IMPLEMENTATION OF THE FINITE ELEMENT METHOD**	**9**
Mesh handling and data structure - Numerical integration - Sparse matrix storage - Assembling of system matrices and load vectors - Inclusion of boundary conditions - Solution of the algebraic systems - Object-oriented C++ programming.		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
●	Understand the Sobolev spaces and finite element spaces.
●	Apply the Biharmonic equation.
●	Solve the Parabolic problems.
●	Analyse the Systems in solid and fluid mechanics.
●	Implement the finite element method.

Reference Books(s) / Web links:	
1	SasikumaarGanesan , Lutz Tobiska,"Finite Elements", Cambridge University Press
2	T R Chandrupatla and A D Belegundu," Introduction to Finite Elements in Engineering"

CO-PO MAPPING

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6
C01	2	1	3	1	2	1
C02	2	1	3	1	2	1
C03	2	1	3	1	2	1
C04	2	1	3	1	2	1
C05	2	1	3	1	2	1
Average	2	1	3	1	2	1

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
DS19P25	INFORMATION RETRIEVAL TECHNIQUES	PE	3	0	0	3

Objectives:	
●	To understand the basics of information retrieval with pertinence to modeling, query operations and indexing
●	To get an understanding of machine learning techniques for text classification and clustering.
●	To understand the various applications of information retrieval giving emphasis to multimedia IR, web search
●	To understand the concepts of digital libraries.
●	To know about Indexing and Searching.

UNIT I	INTRODUCTION MOTIVATION	9
Basic Concepts – Practical Issues - Retrieval Process – Architecture - Boolean Retrieval –Retrieval Evaluation – Open Source IR Systems–History of Web Search – Web Characteristics–The impact of the web on IR —IR Versus Web Search–Components of a Search engine		
UNIT II	**MODELING**	**9**
Taxonomy and Characterization of IR Models – Boolean Model – Vector Model - Term Weighting – Scoring and Ranking –Language Models – Set Theoretic Models - Probabilistic Models – Algebraic Models – Structured Text Retrieval Models – Models for Browsing		
UNIT III	**INDEXING**	**9**
Static and Dynamic Inverted Indices – Index Construction and Index Compression. Searching - Sequential Searching and Pattern Matching. Query Operations -Query Languages – Query Processing - Relevance Feedback and Query Expansion - Automatic Local and Global Analysis – Measuring Effectiveness and Efficiency		
UNIT IV	**CLASSIFICATIONAND CLUSTERING**	**9**
Text Classification and Naïve Bayes – Vector Space Classification – Support vector machines and Machine learning on documents. Flat Clustering – Hierarchical Clustering –Matrix decompositions and latent semantic indexing – Fusion and Meta learning		
UNIT V	**SEARCHINGTHE WEB**	**9**
Searching the Web –Structure of the Web –IR and web search – Static and Dynamic Ranking – Web Crawling and Indexing – Link Analysis - XML Retrieval Multimedia IR: Models and Languages – Indexing and Searching Parallel and Distributed IR – Digital Libraries		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
●	Build an Information Retrieval system using the available tools
●	Identify and design the various components of an Information Retrieval system
●	Apply machine learning techniques to text classification and clustering which is used for efficient Information Retrieval
●	Design an efficient search engine and analyze the Web content structure.
●	Gained knowledge about Support Vector Machine.

Reference Books(s) / Web links:	
1	Christopher D. Manning, PrabhakarRaghavan, HinrichSchutze, ―Introduction to Information Retrieval‖, Cambridge University Press, First South Asian Edition,2008.
2	Ricardo Baeza – Yates, Berthier Ribeiro – Neto, ―Modern Information Retrieval: The concepts and Technology behind Search‖ (ACM Press Books), Second Edition,2011.
3	Stefan Buttcher, Charles L. A. Clarke, GordonV. Cormack, ―Information Retrieval Implementing and Evaluating Search Engines , The MIT Press, Cambridge, Massachusetts London, England, 2010.

CO-PO MAPPING

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6
C01	3	2	1	-	2	-
C02	3	2	-	-	2	-
C03	3	2	1	1	2	1
C04	3	2	-	1	2	1
C05	3	2	1	1	3	1
Average	3	2	1	1	2.2	1

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
DS19P26	NATURAL LANGUAGE PROCESSING	PE	3	0	0	3

Objectives:	
●	To provide the understanding of Natural Language Processing and challenges involved in that area.
●	To provide the student with knowledge of various levels of analysis involved in NLP
●	To understand language modeling,
●	To gain knowledge in automated natural language generation and machine translation

UNIT I	OVERVIEW AND LANGUAGE MODELING	8
Overview: Origins and challenges of NLP-Language and Grammar-Processing Indian Languages-NLP Applications-Information Retrieval.LanguageModeling: Introduction-Various Grammar-based Language Models-Statistical Language Model		
UNIT II	**WORD LEVEL AND SYNTACTIC ANALYSIS**	**9**
Word Level Analysis: Introduction- Regular Expressions-Finite-State Automata-Morphological Parsing-Spelling Error Detection and correction-Words and Word classes-Part-of Speech Tagging. Syntactic Analysis: Introduction-Context-free Grammar-ConstituencyParsing-Probabilistic Parsing		
UNIT III	**SEMANTIC ANALYSIS AND DISCOURSE PROCESSING**	**10**
Semantic Analysis: Introduction- Meaning Representation-Lexical SemanticsAmbiguity-Word Sense Disambiguation.Discourse Processing: Introduction- cohesion-Reference ResolutionDiscourse Coherence and Structure		
UNIT IV	**NATURAL LANGUAGE GENERATION AND MACHINE TRANSLATION**	**9**
Natural Language Generation: Introduction-Architecture of NLG SystemsGeneration Tasks and Representations-Application of NLG.Machine Translation: Introduction-Problems in Machine TranslationCharacteristics of Indian Languages- Machine Translation Approaches-Translation involving Indian Languages		
UNIT V	**INFORMATION RETRIEVAL AND LEXICAL RESOURCES**	**9**
Information Retrieval: Introduction-Design features of Information Retrieval Systems-Classical, Non-classical, Alternative Models of Information Retrieval – EvaluationLexical Resources: Introduction-WordNet-FrameNet-Stemmers-POS TaggerResearch Corpora		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
●	Analyse the challeges and model the natural language
●	Perform word level and syntactic analysis
●	Do semantic analysis and discourse processing
●	Automate natural language generation and machine translation
●	Evaluate information retrieval and laexical resources

Reference Books(s) / Web links:	
1	Tanveer Siddiqui, U.S. Tiwary, “Natural Language Processing and Information Retrieval”, Oxford University Press, 2008.
2	Daniel Jurafsky and James H Martin, ”Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition”, Prentice Hall, 2nd Edition, 2008.
3	James Allen, Bejamin/cummings, “Natural Language Understanding”, 2nd edition, 1995. C

CO-PO MAPPING

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6
C01	3	2	1	1	1	1
C02	3	2	1	1	2	1
C03	3	2	1	1	1	1
C04	3	2	1	1	3	1
C05	3	2	1	1	1	1
Average	3	2	1	1	1.6	1

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
DS19P27	SOCIAL NETWORK ANALYSIS	PE	3	0	0	3

Objectives:	
●	Describe the concepts and measures in social network analysis
●	Explain the modelling and visualization of social networks
●	Learn the Text preprocessing and Text summarization techniques
●	Study the different types of Text classification algorithms
	Learn the various Text Clustering algorithms

UNIT I	INTRODUCTION TO SOCIAL NETWORK ANALYSIS	9
Introduction to Web - Limitations of current Web – Development of Semantic Web – Emergence of the Social Web - Network analysis - Development of Social Network Analysis - Key concepts and measures in network analysis - Electronic sources for network analysis - Electronic discussion networks, Blogs and online communities, Web based networks.		
UNIT II	**MODELLING AND VISUALIZING SOCIAL NETWORKS**	**9**
Visualizing Online Social Networks, Graph Representation - Centrality- Clustering - Node-Edge Diagrams, Visualizing Social Networks with Matrix-Based Representations Matrix -Link Diagrams, Hybrid Representations - Modelling and aggregating social network data - Ontological representation of social individuals, Ontological representation of social relationships.		
UNIT III	**TEXT MINING IN SOCIAL MEDIA**	**9**
Introduction-Text Preprocessing- Tokenization, Stop word removal, Stemming; Information Extraction from Text-Named Entity Recognition, Relation Extraction, Unsupervised Information Extraction; Text Summarization Techniques-Topic Representation Approaches, Influence of Context; Dimensionality Reduction and Topic Modelling		
UNIT IV	**TEXT CLASSIFICATION ALGORITHMS**	**9**
Introduction-Feature Selection for Text Classification-Gini Index, Information Gain, Mutual Information,χ2-Statistic ,Feature Transformation Methods: Supervised LSI, Supervised Clustering for Dimensionality Reduction, Linear Discriminant Analysis, Generalized Singular Value Decomposition, Interaction of Feature Selection with Classification; Probabilistic and Naive Bayes Classifiers- Bernoulli Multivariate Model, Multinomial Distribution, Mixture Modelling for Text Classification; Proximity-based Classifiers; Classification of Linked and Web Data; Meta-Algorithms for Text Classification- Classifier Ensemble Learning, Data Centered Methods: Boosting and Bagging, Optimizing Specific Measures of Accuracy		
UNIT V	**TEXT CLUSTERING ALGORITHMS**	**9**
Introduction-Feature Selection and Transformation Methods for Text Clustering- Feature Selection Methods, LSI-based Methods, Non-negative Matrix Factorization; Distance-based Clustering Algorithms- Agglomerative and Hierarchical Clustering Algorithms, Distance-based Partitioning Algorithms, A Hybrid Approach: The Scatter-Gather Method; Word and Phrase-based Clustering- Clustering with Frequent Word Patterns, Leveraging Word Clusters for Document Clusters, Co-clustering Words and Documents, Clustering with Frequent Phrases; Online Clustering with Text Streams; Clustering Text in Networks; Semi-Supervised Clustering.		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
●	Interpret the measures in social network analysis
●	Illustrate and design social network
●	Apply the various preprocessing techniques on text
●	Implement various Text Classification techniques
●	Compare and contrast Text classification and Text Clustering

TEXT BOOKS

1. Peter Mika, “Social networks and the Semantic Web”, Springer, 1 st edition 2007.
2. Borko Furht, “Handbook of Social Network Technologies and Applications”, Springer, 1st edition, 2010.
3. Charu. Aggarwal, ChengxiangZhai, “Mining Text data”, Springer, 2012.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6
C01	3	3	-	2	3	2
C02	3	3	-	2	3	2
C03	3	3	-	2	3	2
C04	3	3	-	2	3	2
C05	3	3	-	2	3	2
Average	3	3	-	2	3	2

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : “-”

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
DS19P28	RECOMMENDATION SYSTEMS	PE	3	0	0	3

Objectives:	
•	To study the basic concepts and functions of recommendation systems.
•	To learn about various model based and neighborhood collaborative filters.
•	To study various components of content and knowledge – based systems.
•	To learn ensemble and hybrid – based systems.
•	Understand and evaluate the recommendation systems based on various metrics.

UNIT-I	INTRODUCTION TO RECOMMENDER SYSTEMS	9
Introduction – Goals – Basic Models – Collaborative Filtering Model – Content Based Recommender Systems – Knowledge Based Recommender Systems – Demographic Recommender Systems – Hybrid and Ensemble Based Recommender Systems – domain specific challenges – Context Based Recommender Systems – Time-Sensitive Recommender Systems – Location Based Recommender Systems – Social Recommender Systems – Advanced Topics and Applications.		
UNIT-II	**NEIGHBORHOOD AND MODEL-BASED COLLABORATIVE FILTERING**	**9**
Neighborhood: Introduction – Key Properties – Predicting Ratings – Clustering – Dimensionality Reduction – Regression Modeling – Graph Models. Model: Introduction – Decision and Regression Trees – Rule Based Collaborative Filtering – Naive Baye's Collaborative Filtering – Latent Factor Models – Integrating Factorization and Neighborhood Models.		
UNIT-III	**CONTENT AND KNOWLEDGE-BASED RECOMMENDER SYSTEMS**	**9**
Content: Introduction – Basic Components – Preprocessing and Feature Extraction – Learning User Profiles and Filtering – Content Based Versus Collaborative Recommendations – Using Content Based Models for Collaborative Filtering. Knowledge: Introduction – Constraint Based Recommender Systems – Case Based Recommenders – Persistent Personalization in Knowledge-Based Systems.		
UNIT-IV	**ENSEMBLE-BASED AND HYBRID RECOMMENDER SYSTEMS**	**9**
Introduction – Ensemble Methods from the Classification Perspective – Weighted Hybrids – Switching Hybrids – Cascade Hybrids – Feature Augmentation Hybrids – Meta Level Hybrids – Feature Combination Hybrids – Mixed Hybrids.		
UNIT-V	**EVALUATING RECOMMENDER SYSTEMS**	**9**
Evaluating: Introduction – Evaluation Paradigms – General Goals of Evaluation Design: Accuracy, Coverage, Confidence and Trust, Novelty, Serendipity, Diversity, Robustness and Stability and Scalability– Design Issues in Offline Recommender Evaluation – Accuracy Metrics in Offline Evaluation – Limitations of Evaluation Measures – Case study on Recommender Systems.		
	Total Contact Hours : 45	

Course Outcomes:	
On completion of the course, students will be able to	
•	Describe the basic concepts and various techniques for making recommendations.

●	Design the key properties of neighborhood and model-based collaborative filtering.
●	Design recommendation system based on content and knowledge.
●	Develop a new hybrid recommender systems.
●	Evaluate recommender systems on the basis of measuring metrics such as coverage, confidence and trust.

Text Book:	
1	Charu C. Aggarwal, "Recommender Systems", Springer Cham Heidelberg New York Dordrecht London ©Springer International Publishing Switzerland 2016.
Reference Books(s) / Web links:	
1	Ricci F., Rokach L., Shapira D., Kantor B.P., Recommender Systems Handbook, Springer, 2011.
2	Manouselis N., Drachsler H., Verbert K., Duval E., Recommender Systems for Learning, Springer, 2013.
3	Jannach D., Zanker M. and FelFering A., Recommender Systems: An Introduction, Cambridge University Press (2011), 1st ed.

CO-PO MAPPING

PO **CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
C01	3	3	-	2	3	2
C02	3	2	-	1	2	2
C03	3	2	-	1	2	2
C04	3	2	-	1	2	2
C05	2	3	-	-	2	1
Average	2.8	2.4	-	1	2.2	1.8

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
DS19P31	HEALTH CARE ANALYTICS	PE	3	0	0	3

Objectives:	
●	To explore the various forms of electronic health care information.
●	To learn the techniques adopted to analyse health care data.
●	To understand the predictive models for clinical data

UNIT I	INTRODUCTION	9
Introduction to Healthcare Data Analytics- Electronic Health Records– Components of EHR- Coding Systems- Benefits of EHR- Barrier to Adopting EHRChallenges- Phenotyping Algorithms.		
UNIT II	**ANALYSIS**	**9**
Biomedical Image Analysis- Mining of Sensor Data in Healthcare- Biomedical Signal Analysis- Genomic Data Analysis for Personalized Medicine.		
UNIT III	**ANALYTICS**	**9**
Natural Language Processing and Data Mining for Clinical Text- Mining the Biomedical- Social Media Analytics for Healthcare.		
UNIT IV	**ADVANCED DATA ANALYTICS**	**9**
Advanced Data Analytics for Healthcare– Review of Clinical Prediction Models- Temporal Data Mining for Healthcare Data- Visual Analytics for Healthcare- Predictive Models for Integrating Clinical and Genomic Data- Information Retrieval for Healthcare- Privacy-Preserving Data Publishing Methods in Healthcare.		
UNIT V	**APPLICATIONS**	**9**
Applications and Practical Systems for Healthcare– Data Analytics for Pervasive Health- Fraud Detection in Healthcare- Data Analytics for Pharmaceutical Discoveries- Clinical Decision Support Systems- Computer-Assisted Medical Image Analysis Systems- Mobile Imaging and Analytics for Biomedical Data.		
	Total Contact Hours : 45	

Course Outcomes: On completion of course students will be able to	
●	Analyze health care data using appropriate analytical techniques.
●	Apply analytics for decision making in healthcare services.
●	Apply data mining to integrate health data from multiple sources and develop efficient clinical decision support systems.

Text Books(s) / Web links:	
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.

Text Books(s) / Web links:	
1	Trevor L. Strome (2013). Healthcare Analytics for Quality and Performance Improvement. John Wiley & Sons, Inc
2	Principles of Health Interoperability HL7 and SNOMED (Health Information Technology Standards), Springer Publication by Tim Benson
3	Health Service Marketing – A Practitioners Guide - Richard K. T. - Springer New York.
4	Wellness Management A Lifestyle Approach for Health, Fitness and Energy - Rajasekhar Kali Venkata – Notion press
5	Vittinghoff E., Glidden, D.V., Shiboski, S.C. and McCulloch, C.E. (2005) Regression Methods in Biostatistics.
6	DeVellis, Robert F. (2012). Scale Development: Theory and Applications; Third Edition. Thousand Oaks, CA: Sage Publications

CO-PO MAPPING

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6
C01	2	3	-	1	3	2
C02	2	3	-	1	3	2
C03	2	3	-	1	3	2
C04	2	3	-	1	3	2
C05	2	3	-	1	3	2
Average	2	3	-	1	3	2

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
DS19P32	FINANCIAL AND RISK ANALYTICS	PE	3	0	0	3

Objectives:	
●	To understand the basics of Financial and Risk Analytics
●	To learn the basics of Financial Research and Operational Risk
●	To study the financial decision making and Risk Management
●	To learn the Functional Framework for Evaluating Financial Visualization Products.
●	To learn and implement preserving digital records

UNIT-I	INTRODUCTION TO FINANCIAL AND RISK ANALYTICS	9
Records and Information Management for Financial Analysis and Risk Management: Financial Decision Process: Theory and Practice, Terminology, Governance, Analytics, Long-Term Digital Preservation. Monitoring Financial Stability in a Complex World :Introduction ,Legacy Financial Supervision ,Firm-Level Supervision and Disintermediation ,Financial Innovation and the Complexity of Data Management, Scalability of Data Management, Systemic Supervision and the Network of Counterparty Claims , Networks and Information ,An Example: Rehypothecation of Repo Collateral, Implications for Supervisory Implementation.		
UNIT-II	**THE OFFICE ON FINANCIAL RESEARCH AND OPERATIONAL RISK**	**9**
On Operational Risk, Tasks and Risks of the OFR, First Principles ,OFR and Data, Data Collection, Standardizing Financial Contracts ,The Role of Standardized Contract Types .The Core Problem :Separation of Data and Algorithms in Natural Sciences , Separation of Data and Algorithms in the Financial Sector, The ‘‘Mechanical’’ Parts of Finance , The Subjective Parts of Finance , Combining the Mechanical and the Subjective .Appendix A: Exotic Products :Standardization in the Financial Sector, Standardization of the Outliers , The Boundary Between Standard and Nonstandard CTS. Appendix B: A Simple Data Model and Process: Introduction, Entity Relationship, The Contract Table and Validation, The Cash-flow Engine, The Mapping Process.		
UNIT-III	**FINANCIAL DECISION MAKING AND RISK MANAGEMENT**	**9**
Using Conceptual Models to Theorize about the Relationship between Records and Risk in the Global Financial Crisis: Records and Managerial Decisions, Information Problems and Growth, Information Problems and Financial Systems, Information Problems and Decision-Making in the Financial Industry , Analyzing the Financial Domain Using Conceptual Modelling ,Conceptual Modelling as a Nontechnical Analysis Tool, Using Conceptual Modelling in the Analysis of Financial Transactions., Using Conceptual Modelling to Analyze the MBS Supply Chain, Analysis of the Conceptual Models. Financial Decision Process: Theory and Practice, The Experimental Methodology, Laboratory Experiments, Surveys/Financial Literacy, Visual Analytics for Financial Decision-Making, Decision Process and the Role of Visual Analytics, Information Processing and Search, Risk and Decision-Making, Research Challenges, Problems in Economics and Information Management, Moving Knowledge into Practice.		
UNIT-IV	**A FUNCTIONAL FRAMEWORK FOR EVALUATING FINANCIAL VISUALIZATION PRODUCTS**	**9**
Introduction, Motivations for a Functional Evaluation Framework of VA in Finance, Developing a Functional Evaluation Framework of VA Tools, Methodology ,Evaluating a Sample Set of Visualizations and Interaction Techniques, Evaluating a Sample Set of VA Products and APIs, Limitations , The Functional Evaluation Framework of VA in Finance, Applied to Several Commercial and Research VA Toolkits , Case Study on the Process of Applying VA with Real-World Constraints in a Boutique Asset Management Firm , Conclusion and Future Work: Putting a Value on Visual Analytics , Case Study on the Process of Applying VA with Real-world Constraints in a Boutique Asset Management Firm , Project Management and Design Methodology, Data ,Analytic Problem , VA Solution.		
UNIT-V	**PRESERVING DIGITAL RECORDS**	**9**
Coping with Messiness and Fogginess in Financial Information Management: Material and Social Aspects of Representations in Proprietary Trading and Custodial Services : Introduction , Messiness and Fogginess, The		

Invisibility of Financial Records and the Interplay Between Messiness and Fogginess, Proprietary Trading: Investing in Fogginess , Custodial Services: The Craft of Coping with Messiness and Fogginess. Preserving Digital Records: InterPARES Findings and Developments : Introduction ,Overview of the Three Phases, The Core Theoretical Foundation, Research Foci Research Design and Methodology ,Major Outcomes of InterPARES 1 and 2, InterPARES 3 TEAM Canada Findings and Products , Discussion of InterPARES Findings, Conclusion and Implications for Financial Data Management.			
	Total Contact Hours	**:**	**45**

Course Outcomes: On completion of the course, students will be able to	
●	Have experience in the basics of Financial and Risk Analytics
●	Apply programming knowledge of Operational Risk
●	Manage financial decision making and Risk Management
●	Gain how to evaluate Financial Visualization Products.
●	Apply knowledge in implementing preserving digital records

Text Books:	
1	Financial Risk Analytics: A Term Structure Model Approach for Banking, Insurance, & Investment Management Hardcover – Import, 1 Sep 996by Dennis G. Uyemura (Author), Donald R. van Deventer (Author)
2	Financial Analysis and Risk Management Data Governance, Analytics and Life Cycle Management, Editor Victoria Lemieux Library, Archival and Information Studies University of British Columbia Vancouver, BC Canada, Springer.
3	Credit Risk Analytics: Measurement Techniques, Applications, and Examples in SAS (Wiley and SAS Business Series) 1st Edition, Kindle Edition by Bart Baesens (Author), Daniel Roesch (Author)
Reference Books:	
1	Financial Risk Management, Applications in Market, Credit, Asset and Liability Management and Firmwide Risk JIMMY SKOGLUND WEI CHEN, Wiley, Copyright © 2015 by SAS Institute.
2	Financial Analytics with RBuilding a Laptop Laboratory for Data Science by Mark J. Bennett, Dirk L. Hugen

CO-PO MAPPING

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6
C01	3	3	1	2	2	2
C02	3	3	1	2	3	1
C03	3	3	1	2	3	1
C04	3	3	1	2	3	2
C05	3	3	1	2	3	2
Average	3	3	1	2	2.8	1.6

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
DS19P33	MARKETING AND RETAIL ANALYTICS	PE	3	0	0	3

Objectives:	
●	To understand the basics of Marketing
●	To understand and implement marketing Strategy
●	To understand the basics of product and services in marketing
●	To understand the retail analytics
●	To apply predictive analytic techniques on retail and marketing

UNIT-I	INTRODUCTION TO MARKETING	9
Statistical Measures,Understanding the marketplace and consumer needs, Designing a Customer Driven Marketing-Strategy, Building Customer Relationships, Consumer Behaviour and Business Buyer Behaviour Analysis using R		
UNIT-II	**MARKETING STRATEGY**	**9**
Consumer Behaviour and marketing Strategy,Market Segmentation and Product Positioning, Market Segmentation, Market Targeting,Target Market Strategies, Product Positioning and Differentiation, Choosing a Differentiation and Positioning Strategy,Logistic Regression for Market Basket Analysis..		
UNIT-III	**PRODUCT AND SERVICE**	**9**
Products and services, product and service classifications, consumer products, industrial products, product and service decisions, product and service attributes, product support services, services marketing – the nature and characteristics of a service,Case Study-Panel Regression.		
UNIT-IV	**RETAIL ANALYTICS**	**9**
Customer Analytics Overview; Quantifying Customer Value. Using Stata for Basic Customer Analysis. Predicting Response with RFM Analysis, Statistics Review, Predicting Response with Logistic Regression, Predicting Response with Neural Networks, Predicting Response with Decision Trees.		
UNIT-V	**PREDICTIVE RETAIL ANALYTICS**	**9**
The digital evolution of retail marketing, Digital natives, Constant connectivity Social interaction, Predictive modelling, Keeping track, Data availability, Efficiency optimization, Dependent Variables Techniques.		
	Total Contact Hours : 45	

Course Outcomes: On completion of the course, students will be able to	
●	Understand the basics of Marketing
●	Implement marketing Strategy
●	Understand the basics of product and services in marketing
●	understand the retail analytics
●	Apply predictive analytic techniques on retail and marketing

Text Books:	
1	Kotler, P., Keller, K. L. ,Koshy, A., Jha, M. Marketing Management: A South Asian Perspective. New Delhi: Pearson Education , 14th edn,.2013.
2	Mike Grigsby,Marketing Analytics:A practical guide to improving consumer insights using data techniques, Kogan Page 2nd Edition.2018.
3	Rajan, S. Marketing Management. India: New Delhi: Tata McGraw-Hill Education. 4thedn,2005.

CO-PO MAPPING

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6
C01	3	2	0	0	1	1
C02	3	3	0	0	1	1
C03	3	3	0	0	1	1
C04	2	2	0	0	2	2
C05	2	2	0	0	2	2
Average	2.6	2.4	0	0	1.4	1.4

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
DS19P34	SUPPLY CHAIN AND LOGISTICS ANALYTICS	PE	3	0	0	3

Objectives:	
●	To understand the importance of Supply Chain Analytics and Network Planning Design of Logistics Network
●	To analyze the level of uncertainty associated with the supply of products and services to targeted customer segments
●	To explicate applications of Analytics in a Supply Chain.
●	To explore the technical standards and Business processes integrated with Supply Chain

UNIT-I	INTRODUCTION TO SUPPLY CHAIN	9
Supply chain Management-Introduction-Evolution-Analytics-Supply chain planning- Different views of Supply chain-Key issues-Supply chain strategy-Supply Chain Drivers-Strategic fit in Supply chain-Demand Forecasting in Supply chain-Case Study: Meditech Surgical.		
UNIT-II	**NETWORK PLANNING AND VALUE OF INFORMATION**	**9**
Network Design-parameters and requirements of network-Inventory positioning and Logistics Co-ordination-Case Study: Bis Corporation-Supply Contracts- Strategic Components-Contracts -Make to Stock-Asymmetric In-formation-Non Strategic Components-Bull whip effect-Sharing and Incentives-Effective Forecast-Coordination of Systems-Lead-Time Reduction-Case study: Reebok NFL Replica Jerseys.		
UNIT-III	**DISTRIBUTION STRATEGY**	**9**
Push, Pull, Push-Pull Systems-Impact of Lead Time-Demand driven Strategies-Impact of Internet on Supply Chain Strategies – Case Study: Great Inventory Correction-Distribution Strategies –Direct Shipment-Intermediate Storage Points-Transshipment-Selection of Strategy-Case Study: Amazon.com's European Distribution Strategy-Third Party Logistics-Retailer-Supplier Partnerships-Distributor Integrator.		
UNIT-IV	**STRATEGIC ALLIANCES**	**9**
Outsourcing-Benefits-Risks-Procurement Strategies-E-Procurement-Case study: Zara-Solectron-Forces-Types-Risk management-Issues in Supply Chain management-Regional Differences-Case Study: Walmart-Logistics-Design-Supplier Integration-Customer Value-Smart Pricing-Case Study: Made to Measure-Start Bucks Economics.		
UNIT-V	**IT ENABLEMENT OF SUPPLY CHAIN**	**9**
Goals-Decision Support System-IT for Supply Chain Excellence-Sales and Operation Planning-Supply Chain with Information Technology-Case Study: Supply Chain Whirl-Technology Standard-IT standard -IT Infrastructure-SOA-RFID-Case Study: Amazon story of Dabbawallas.		
	Total Contact Hours :	**45**

Course Outcomes: On completion of the course, students will be able to	
●	Identify and Analyze Business Models, Business Strategies and, corresponding Competitive Advantage.
●	Formulate and implement Best Practices and Strategies for Design and Distribution
●	Plan the effective Logistics operations for optimum utilization of resources
●	Configure a supply chain for an organization from a global perspective that accounts for commercial, social and legal implications.
●	Discuss the impacts of geo-political and technological trends/developments on the value chain.

Reference Books(s) / Web links:	
1	D. Simchi-Levi, P. Kaminsky, E. Simchi-Levi, and Ravi Shankar, Designing and Managing the Supply Chain concepts, Strategies and Case studies, Third Edition, Tata McGraw Hill, New Delhi, 2008.
2	Supply chain management by Sunil Chopra, and Peter Meindl, Pearson Jeremy F. Shapiro. Modeling the Supply Chain. Duxbury Thomson Learning
3	Supply Chain and Logistics Management Made Easy, Paul A. Myerson, Person Education, Inc., 2015.
4	Chadwick, T. and Rajagopal, S. (1995): Strategic Supply Management: An Implementation Toolkit, Butterworth-Heinemann, Oxford, UK.
5	Jeremy F. Shapiro. Modeling the Supply Chain. Duxbury Thomson Learning, 2001
6	https://nptel.ac.in/courses/110107074/
7	Journal: Supply Chain Management: An International Journal (Available on www.emaraldinsight.com)

CO-PO MAPPING

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6
C01	3	2	-	-	2	-
C02	3	3	2	-	-	2
C03	2	1	1	-	1	1
C04	2	2	2	-	-	2
C05	3	2	-	-	-	2
Average	2.6	2	1.6	0	1.5	1.75

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
CP19O31	BUSINESS ANALYTICS	OE	3	0	0	3

Objectives:	
•	To understand the role of business analytics within an organization.
•	To analyze data using statistical and data mining techniques.
•	To gain an understanding of how managers use business analytics to formulate and solve business problems.
•	To become familiar with processes needed to develop, report, and analyze business data.
•	To use decision-making tools/Operations research techniques.

UNIT-I	INTRODUCTION	9
Business analytics: Overview of Business analytics– Scope of Business analytics– Business Analytics Process– Relationship of Business Analytics Process and organization – competitive advantages of Business Analytics– Statistical Tools: Statistical Notation– Descriptive Statistical methods– Review of probability distribution and data modelling– sampling and estimation methods overview.		
UNIT-II	**REGRESSION AND VISUALIZATION**	**9**
Trendiness and Regression Analysis: Modelling Relationships and Trends in Data– simple Linear Regression. – Important Resources– Business Analytics Personnel– Data and models for Business analytics– problem solving– Visualizing and Exploring Data–Business Analytics Technology.		
UNIT-III	**ANALYTICAL MODELS**	**9**
Organization Structures of Business analytics–Team management–Management Issues– Designing Information Policy– Outsourcing– Ensuring Data Quality– Measuring contribution of Business analytics– Managing Changes. Descriptive Analytics– predictive analytics– predicative Modelling– Predictive analytics analysis– Data Mining and Methodologies– Prescriptive analytics and its step in the business analytics Process– Prescriptive Modelling–nonlinear Optimization.		
UNIT-IV	**FORECASTING TECHNIQUES**	**9**
Qualitative and Judgmental Forecasting– Statistical Forecasting Models– Forecasting Models for Stationary Time Series– Forecasting Models for Time Series with a Linear Trend– Forecasting Time Series with Seasonality– Regression Forecasting with Casual Variables– Selecting Appropriate Forecasting Models– Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform– New-Product Development Model–Newsvendor Model– Overbooking Model– Cash Budget Model.		
UNIT-V	**DECISION ANALYSIS**	**9**
Decision Analysis: Formulating Decision Problems– Decision Strategies with the without Outcome Probabilities– Decision Trees– The Value of Information, Utility and Decision Making– Recent Trends in: Embedded and collaborative business intelligence– Visual data recovery– Data Storytelling and Data journalism.		
	Total Contact Hours : 45	

Course Outcomes: Upon completion of the course, the students will be able to	
•	Demonstrate knowledge of data analytics.
•	Think critically in making decisions based on data and deep analytics.
•	Use technical skills in predicative and prescriptive modeling.
•	Translate data into clear, actionable insights.
•	Make decisions using various tools.
Reference Book(s):	
1	Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, "Business analytics Principles, Concepts, and Applications", Pearson FT Press, 2014.

2	James R Evans, "Business Analytics", Pearson's Education, 2016.

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6
C01	2	3	2	2	2	3
C02	2	2	1	2	3	2
C03	3	2	3	3	2	2
C04	2	3	3	2	3	2
C05	2	3	3	2	3	3
Average	2.2	2.6	2.4	2.2	2.6	2.4

Correlation levels 1, 2 or 3 are as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)
No correlation : "-"