



**RAJALAKSHMI**  
**ENGINEERING COLLEGE**  
An AUTONOMOUS Institution  
Affiliated to ANNA UNIVERSITY, Chennai

**REGULATION 2023**

**CURRICULUM AND SYLLABUS**

**M.Tech Data Science**

**Department of Information Technology**  
**Rajalakshmi Engineering College, Thandalam.**

**RAJALAKSHMI ENGINEERING COLLEGE**  
**(An Autonomous Institution, Affiliated to Anna University, Chennai)**  
**Choice Based Credit System (CBCS)**

**REGULATIONS – 2023**  
**CURRICULUM AND SYLLABUS**

**DEPARTMENT OF INFORMATION TECHNOLOGY**

**M.Tech Data Science**

**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.

**Curriculum 2023**

**SEMESTER I**

S. NO.	COURSE CODE	COURSE TITLE	Category	Contact Periods	L	T	P	C
<b>THEORY COURSES</b>								
1.	MH23114	Mathematics for Data Science	FC	4	3	1	0	4
2.	PG23111	Research Methodology and IPR	MC	3	3	0	0	3
3.	DS23111	Machine Learning Techniques	PC	3	3	0	0	3
4.	DS23112	Data Science Foundation	PC	3	3	0	0	3
<b>LAB ORIENTED THEORY COURSES</b>								
4.	CP23131	Advanced Data Structures and Algorithms	PC	5	3	0	2	4
5.	DS23131	Data Analysis and Visualization	PC	5	3	0	2	4
<b>NON-CREDIT COURSES</b>								
6.	AC23111	English for Research Paper Writing	MC	3	3	0	0	0
<b>Total</b>				<b>26</b>	<b>21</b>	<b>1</b>	<b>4</b>	<b>21</b>

**SEMESTER II**

SL. NO.	COURSE CODE	COURSE TITLE	Category	Contact Periods	L	T	P	C
<b>THEORY COURSES</b>								
1.	DS23211	Programming for Data Science	PC	3	3	0	0	3
2.		Professional Elective - I	PE	3	3	0	0	3
3.		Professional Elective - II	PE	3	3	0	0	3
<b>LAB ORIENTED THEORY COURSES</b>								
4.	DS23231	Big Data Analytics and Tools	PC	5	3	0	2	4
5.	DS23232	Cloud Computing Technologies	PC	5	3	0	2	4
<b>NON-CREDIT COURSES</b>								
6.	AC23211	Constitution of India	MC	3	3	0	0	0
<b>LABORATORY COURSES</b>								
7.	DS23221	Programming for Data Science Laboratory	PC	4	0	0	4	2
<b>Total</b>				<b>26</b>	<b>18</b>	<b>0</b>	<b>8</b>	<b>19</b>

**SEMESTER III**

Sl. NO.	COURSE CODE	COURSE TITLE	Category	Contact Periods	L	T	P	C
<b>THEORY COURSES</b>								
1.	DS23311	Security for Data Science	PC	3	3	0	0	3
2.		Professional Elective - III	PE	3	3	0	0	3
3.		Professional Elective - IV	PE	3	3	0	0	3
4.		Open Elective - I	OE	3	3	0	0	3
<b>LABORATORY COURSES</b>								
6.	DS23321	Project Phase - I	EEC	12	12	0	12	6
<b>Total</b>				<b>24</b>	<b>12</b>	<b>0</b>	<b>12</b>	<b>18</b>

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**SEMESTER IV**

Sl. NO.	COURSE CODE	COURSE TITLE	Category	Contact Periods	L	T	P	C
1.	DS23421	Project Phase - II	EEC	12	0	0	24	12
<b>Total</b>				<b>12</b>	<b>0</b>	<b>0</b>	<b>24</b>	<b>12</b>

PROGRAM ELECTIVES (PE)								
S.No	Course Code	Course Title	Category	Contact Periods	L	T	P	C
<b>Emerging Technologies</b>								
1.	DS23A11	AI for Computer Vision	PE	3	3	0	0	3
2.	DS23A12	Deep Learning Techniques	PE	3	3	0	0	3
3.	DS23A13	Natural Language Processing and Application	PE	3	3	0	0	3
4.	DS23A14	Industrial Internet of Things	PE	3	3	0	0	3
5.	DS23A15	AI-Powered Chat Bots	PE	3	3	0	0	3
6.	DS23A16	Drone Technologies	PE	3	3	0	0	3
7.	DS23A17	Augmented Reality	PE	3	3	0	0	3
<b>Business Analytics</b>								
1.	DS23B11	Social Network Analysis and Visualization	PE	3	3	0	0	3
2.	DS23B12	Health Care Data Analytics	PE	3	3	0	0	3
3.	DS23B13	Applied Business Analytics	PE	3	3	0	0	3
4.	DS23B14	Supply Chain and Logistics Analytics	PE	3	3	0	0	3
5.	DS23B15	Marketing and Retail Analytics	PE	3	3	0	0	3
6.	DS23B16	Financial and Risk Analytics	PE	3	3	0	0	3
7.	DS23B17	Recommender Systems	PE	3	3	0	0	3
8.	CP23B14	Predictive Modeling	PE	3	3	0	0	3

#### OPEN ELECTIVE COURSES OFFERED BY IT

SL. NO.	COURSE CODE	COURSE TITLE	Category	Contact Periods	L	T	P	C
1.	DS23O31	Python for Data Science	OE	5	1	0	4	3

**TOTAL CREDITS : 70**

#### Credit Distribution

Category	R2023
Mathematical courses FC	4
Professional core courses PC	30
Professional Elective Courses PE	12
Open Electives from other technical and /or emerging subjects OE	3
Project work, seminar and internship in industry or elsewhere EEC	18
Mandatory Courses [Environmental Sciences, Induction Program, Indian Constitution, The essence of Indian Knowledge Tradition] MC	3
<b>Total</b>	<b>70</b>

**SUMMARY OF ALL COURSES**

S.NO	Course Category	Credits per Semester				Total Credits
		1	2	3	4	
1.	FC	4				4
2.	PC	14	13	3		30
3.	PE		6	6		12
4.	OE			3		3
5.	EEC			6	12	18
6.	MC	3				3
	<b>Total</b>	<b>21</b>	<b>19</b>	<b>18</b>	<b>12</b>	<b>70</b>

**Credit Distribution**

Category	R2019	R2023
Mathematical courses FC / Basic Science BS	4	4
Professional core courses PC	31	30
Professional Elective Courses PE	13	12
Open Electives from other technical and /or emerging subjects OE	3	3
Project work, seminar and internship in industry or elsewhere EEC	18	18
Mandatory Courses [Environmental Sciences, Induction Program, Indian Constitution, The essence of Indian Knowledge Tradition] MC	3	3
<b>Total</b>	<b>72</b>	<b>70</b>

Subject Code	Subject Name (Theory Course)	Category	L	T	P	C
MH23114	MATHEMATICS FOR DATA SCIENCE	FC	3	1	0	4

Objectives:
<ul style="list-style-type: none"> <li>To List the ideal properties of different types of estimators and select the best estimators using different properties.</li> </ul>
<ul style="list-style-type: none"> <li>To introduce the principles and characteristics of the multivariate data analysis techniques.</li> </ul>
<ul style="list-style-type: none"> <li>To develop different discriminant functions and to examine certain difference amongst the different groups in terms of the prediction variables.</li> </ul>
<ul style="list-style-type: none"> <li>To compare and contrast the factor analytic model with other measurement models.</li> </ul>
<ul style="list-style-type: none"> <li>To provide Basic ideas and concepts of hierarchical and non-hierarchical cluster analysis.</li> </ul>

<b>UNIT-I</b>	<b>ESTIMATION THEORY</b>	<b>12</b>
Unbiased Estimators – method of moments – maximum likelihood estimation - curve fitting by principle of least squares – regression lines.		
<b>UNIT-II</b>	<b>MULTIVARIATE ANALYSIS</b>	<b>12</b>
Random vectors and matrices - mean vectors and covariance matrices –multivariate normal density and its properties - population principal components- principle components from standardized variables.		
<b>UNIT-III</b>	<b>DISCRIMINANT ANALYSIS</b>	<b>12</b>
Statistical background, linear discriminant function analysis, Estimating linear discriminant functions and their properties		
<b>UNIT-IV</b>	<b>FACTOR ANALYSIS</b>	<b>12</b>
Factor analysis model, Extracting common factors, determining number of factors, Transformation of factor analysis solutions, Factor scores.		
<b>UNIT-V</b>	<b>CLUSTER ANALYSIS</b>	<b>12</b>
Introduction, Types of clustering, Correlations and distances, clustering by partitioning methods, hierarchical clustering, overlapping clustering, K-Means Clustering-Profiling and Interpreting Clusters		
<b>Total Contact Hours: 60</b>		

Course Outcomes:
On completion of the course, students will be able to
<ul style="list-style-type: none"> <li>Apply the concept of estimation theory and curve fitting for forecasting in engineering and technology.</li> </ul>
<ul style="list-style-type: none"> <li>Carry out and apply commonly used multivariate data analysis techniques, and interpret results</li> </ul>
<ul style="list-style-type: none"> <li>Develop different discriminant functions and to examine certain difference amongst the different groups in terms of the prediction variables.</li> </ul>
<ul style="list-style-type: none"> <li>Describe the difference between exploratory factor analysis and principal components analysis.</li> </ul>
<ul style="list-style-type: none"> <li>Discover the basic concepts of cluster analysis, and a set of typical clustering methodologies, algorithms, and applications.</li> </ul>

SUGGESTED ACTIVITIES
<ul style="list-style-type: none"> <li>Problem solving sessions</li> <li>Implementation of small module</li> </ul>

SUGGESTED EVALUATION METHODS
<ul style="list-style-type: none"> <li>Tutorial problems</li> <li>Assignment problems</li> <li>Quizzes</li> <li>Class Presentation/Discussion</li> </ul>



<b>Text Book(s):</b>	
1.	Gupta S.C. and Kapoor V.K. "Fundamentals of Mathematical Statistics", Sultan and Sons.
2.	Richard A. Johnson and Dean W. Wichern, "Applied Multivariate Statistical Analysis", Pearson Education, Asia, Fifth Edition.
3.	T.W. Anderson. "An Introduction to Multivariate Statistical Analysis". Wiley, Third edition, 2003.

<b>Reference Books(s) / Web links:</b>	
1.	Jay L. Devore, "Probability and Statistics for Engineering and the Sciences", Thomson and Duxbury.
2.	D.A. Belsey, E. Kuh and R.E. Welsch, "Regression Diagnostics, Identifying Influential Data and Sources of Collinearity".
3.	M.R. Anderberg, "Cluster Analysis for Applications", Academic Press.

### CO-PO MAPPING

<b>PO</b> <b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
MH23114.1	2	3	–	3	3	2
MH23114.2	2	3	2	3	3	2
MH23114.3	2	3	2	3	3	2
MH23114.4	2	3	2	3	2	–
MH23114.5	3	3	2	3	2	–
<b>Average</b>	2.2	3	2	3	2.7	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
PG23111	Research Methodology and IPR	MC	3	0	0	3
<b>Objectives:</b>						
•	At the end of this course, the students will be able to understand the research problem formulation and analyse the research-related information by following research ethics.					
•	Inculcating the understanding of today's computer, and information technology and also understanding tomorrow's world of ideas and creativity.					
•	Emphasizing the role of IPR in individual and nation growth					
<b>UNIT-I</b>	<b>INTRODUCTION TO RESEARCH METHODOLOGY</b>					9
Objectives and Motivation of Research - Types of Research - Defining and Formulating the Research Problem - Errors in selecting a research problem - Features of research design, Different Research Designs- Criteria of good research - Problems encountered by researchers in India - Benefits to society in general.						
<b>UNIT-II</b>	<b>DATA ANALYSIS AND HYPOTHESIS TESTING</b>					9
Data collection: Primary data - Secondary data - Data organization - Sample design - Estimation of population - Parametric vs. non-parametric methods - Measures of central tendency and dispersion. ANOVA; Principles of least squares-Regression and correlation; Normal Distribution Properties of Normal Distribution; Testing of Hypothesis – Hypothesis Testing Procedure, Types of errors, t-Distribution - Chi-Square Test as a Test of Goodness of Fit - Use of statistical software.						
<b>UNIT-III</b>	<b>LITERATURE REVIEW AND RESEARCH REPORT WRITING</b>					9
Effective literature studies approach- Importance of literature survey - Sources of information– analysis – Plagiarism - Research ethics. Interpretation and Report Writing - Techniques and Precautions; Report Writing – Significance - Different Steps – Layout - Types of reports, Mechanics of Writing a Research Report - Precautions in Writing Reports; Format of the research report						
<b>UNIT-IV</b>	<b>INTRODUCTION TO INTELLECTUAL PROPERTY, TRADEMARKS, GRAPHICAL INDICATION AND INDUSTRIAL DESIGN</b>					9
Importance of intellectual property rights; types of intellectual property-international organizations; Purpose and function of trademarks - acquisition of trademark rights - protectable matter - selecting and evaluating trademark- trademark registration processes. Industrial designs and IC Layout design - Registrations of designs-Semiconductor Integrated circuits and layout design Act - Geographical indications-potential benefits of Geographical Indications.						
<b>UNIT-V</b>	<b>LAW OF COPYRIGHTS AND PATENTS</b>					9
Fundamental of copyright law - originality of material - rights of reproduction - rights to perform the work publicly - copyright ownership issues - copyright registration -notice of copyright, international copyright law. Law of patents: Foundation of patent law, patent searching process - ownership rights and transfer New Developments in IPR: Administration of Patent System.						
<b>Total Contact Hours:</b>						45

<b>Course Outcomes:</b>	
•	Understand the research problem and research process
•	To formulate the hypothesis, data collection and processing, analyzing the data using statistical methods
•	Interpret the observations and communicate the novel findings through a research report.
•	Apply the conceptual knowledge of intellectual property rights for filing patents and trademark registration process.
•	Understand adequate knowledge on copyright and patent law and rights..

<b>Text Book(s):</b>	
1.	C.R. Kothari, Research Methodology: Methods and Techniques, 2nd revised edition, New Age International Publishers, New Delhi, 2004.
2.	Deborah, E. Bouchoux, Intellectual property right, 5th edition, Cengage learning, 2017
3.	R. Panneerselvam, Research Methodology, PHI learning Pvt. Ltd., 2009.

<b>Reference Books(s) / Web links:</b>	
1.	Donald R. Cooper and Ramela S. Schindler, Business Research Methods, Tata McGraw- Hill Publishing Company Limited, New Delhi, 2000
2.	Uma Sekaran, Research Methods for Business, John Wiley and Sons Inc., New York, 2000.
3.	Ranjit Kumar, Research Methodology, Sage Publications, London, New Delhi, 1999.
4.	T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

### CO-PO MAPPING

<b>PO</b> <b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
PG23111.1	2	1	2	2	3	2
PG23111.2	2	2	2	2	2	2
PG23111.3	1	1	1	1	2	2
PG23111.4	1	2	2	2	3	2
PG23111.5	1	1	1	2	2	2
<b>Average</b>	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
DS23111	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 – silhouettes – 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		
		<b>Total Contact Hours</b> : <b>45</b>

Course Outcomes:	
<b>On completion of course students will be able to</b>	
•	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

Text Book(s):	
1.	P. Flach, “Machine Learning: The art and science of algorithms that make sense of data”, Cambridge University Press, 2012.
2.	K. P. Murphy, “Machine Learning: A probabilistic perspective”, MIT Press, 2012.
3.	M. Mohri, A. Rostamizadeh, and A. Talwalkar, “Foundations of Machine Learning”, MIT Press, 2012.

<b>Reference Books(s) / Web links:</b>	
1	Y. S. Abu-Mostafa, M. Magdon-Ismael, and H.-T. Lin, "Learning from Data", AMLBook Publishers, 2012.
2	C. M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2007
3	D. Barber, "Bayesian Reasoning and Machine Learning", Cambridge University Press, 2012.
4	T. M. Mitchell, "Machine Learning", McGraw Hill, 1997.
5	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
DS23111.1	3	2	-	2	-	1
DS23111.2	3	2	-	2	-	2
DS23111.3	2	2	1	2	-	1
DS23111.4	1	1	1	2	2	2
DS23111.5	1	1	-	2	2	1
<b>Average</b>	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
DS23112	<b>Data Science Foundation</b>	PC	3	0	0	3

<b>Objectives:</b>	
•	Provide you with the knowledge and expertise to become a proficient data scientist.
•	Demonstrate an understanding of statistics and machine learning concepts that are vital for data science
•	Produce Python code to statistically analyse a dataset
•	Critically evaluate data visualisations based on their design and use for communicating stories from data
•	To understand the application and recent trends in Data Science process

<b>UNIT I</b>	<b>INTRODUCTION</b>	<b>IN</b>
Introduction to core concepts and technologies: Introduction, Terminology, data science process, data science toolkit, Types of data, Example applications.		
<b>UNIT II</b>	<b>DATA COLLECTION AND MANAGEMEMNT</b>	<b>9</b>
Introduction, Sources of data, Data collection and APIs, Exploring and fixing data, Data storage and management, Using multiple data sources		
<b>UNIT III</b>	<b>DATA ANALYSIS</b>	<b>9</b>
Introduction, Terminology and concepts, Introduction to statistics, Central tendencies and distributions, Variance, Distribution properties and arithmetic, Samples/CLT, Basic machine learning algorithms, Linear regression, SVM, Naive Bayes.		
<b>UNIT IV</b>	<b>DATA VISUALISATION</b>	<b>9</b>
Introduction, Types of data visualisation, Data for visualisation: Data types, Data encodings, Retinal variables, Mapping variables to encodings, Visual encodings.		
<b>UNIT V</b>	<b>APPLICATIONS</b>	<b>9</b>
Applications of Data Science, Technologies for visualisation, Bokeh (Python). Recent trends in various data collection and analysis techniques, various visualization techniques, application development methods of used in data science		
<b>Total Contact Hours</b>		<b>: 45</b>

<b>Course Outcomes:</b>	
<b>On completion of course students will be able to</b>	
•	Explain how data is collected, managed and stored for data science
•	Understand the key concepts in data science, including their real-world applications and the toolkit used by data scientists
•	Implement data collection and management scripts using MongoDB
•	To understand the concepts of data visualization
•	To understand the application and recent trends in Data Science process

<b>Text Book(s):</b>	
1.	Cathy O’Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline. O’Reilly.
2.	Jure Leskovek, AnandRajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge University Press.

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	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
DS23111.1	3	2	-	-	3	-
DS23111.2	3	2	2	3	3	-
DS23111.3	2	3	2	3	2	2
DS23111.4	3	2	-	-	3	-
DS23111.5	3	3	2	3	3	2
<b>Average</b>	2.2	2.4	2	3	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 (Lab Oriented Theory course)	Category	L	T	P	C
CP23131	ADVANCED DATA STRUCTURES AND ALGORITHMS	PC	3	0	2	4

Objectives:						
•	To understand the usage of algorithms in computing.					
•	To learn and use hierarchical data structures and its operations.					
•	To learn the usage of graphs and its applications.					
•	To select and design data structures and algorithms that is appropriate for problems.					
•	To study about NP Completeness of problems.					

<b>UNIT-I</b>	<b>ROLE OF ALGORITHMS IN COMPUTING</b>	<b>9</b>
Algorithms –Introduction: Classical Algorithms–Analyzing Algorithms – Designing Algorithms– Growth of Functions: Asymptotic Notation – Standard Notations and Common Functions– Solving Recurrences: The Substitution Method – Master theorem method– The Recursion–Tree Method.		
<b>UNIT-II</b>	<b>HIERARCHICAL DATA STRUCTURES</b>	<b>9</b>
Binary Search Trees: Basics –Insertion, Deletion and Search– Red-Black Trees: Properties of Red-Black Trees – Rotations – Insertion – Deletion –B-Trees: Definition– Basic operations on B-Trees – Deleting a key from a B-Tree– Fibonacci Heaps: structure – Merge able-heap operations– Decreasing a key and deleting a Node–Bounding the maximum degree.		
<b>UNIT-III</b>	<b>GRAPHS</b>	<b>9</b>
Elementary Graph Algorithms: Representations of Graphs – Breadth-First Search – Depth-First Search – Topological Sort – Strongly Connected Components– Minimum Spanning Trees: Growing a Minimum Spanning Tree – Kruskal and Prim– Single-Source Shortest Paths: The Bellman-Ford algorithm – Single-Source Shortest paths in Directed Acyclic Graphs – Dijkstra,s Algorithm; All-Pairs Shortest Paths: Shortest Paths and Matrix Multiplication – The Floyd, Warshall Algorithm, Johnson`s algorithm for sparse graphs.		
<b>UNIT-IV</b>	<b>ALGORITHM DESIGN TECHNIQUES</b>	<b>9</b>
Dynamic Programming: Matrix-Chain Multiplication – Elements of Dynamic Programming –Longest Common Subsequence- Greedy Algorithms: An Activity-Selection Problem – Elements of the Greedy Strategy– Huffman Codes.		
<b>UNIT-V</b>	<b>NP COMPLETE AND NP HARD</b>	<b>9</b>
NP-Completeness: Polynomial Time – Polynomial-Time Verification – NP-Completeness and Reducibility – NP-Completeness Proofs – NP-Complete Problems		
		<b>Contact Hours</b> : <b>45</b>

List of Experiments			
1	Implementation of graph search algorithms.		
2	Implementation and application of network flow and linear programming problems.		
3	Implementation of algorithms using dynamic programming 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.		
		<b>Contact Hours</b>	: <b>45</b>
		<b>Total Contact Hours</b>	: <b>90</b>

Platform Needed:	
<b>HARDWARE</b> :	Personal Computer with Dual Core Processor with 4 GB RAM.
<b>SOFTWARE</b> :	C/C++/Java Compilers



<b>Course Outcomes:</b>	
On completion of the course, the students will be able to	
•	Design data structures and algorithms to solve computing problems.
•	Design algorithms using graph structure and various string-matching algorithms to solve real-life problems.
•	Understand the importance of Graphs and its applications.
•	Apply suitable design strategy for problem solving.
•	Differentiate NP complete and NP hard.

<b>Text Book(s):</b>	
1.	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, "Introduction to Algorithms", Third Edition, Prentice-Hall, 2011.
2.	Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, "Data Structures and Algorithms", Pearson Education, 2006.

<b>Reference Books(s):</b>	
1	Robert Sedgewick and Kevin Wayne, "Algorithms", Fourth Edition, Pearson Education.
2	S. Sridhar, "Design and Analysis of Algorithms", First Edition, Oxford University Press. 2014

#### CO-PO MAPPING

PO CO	PO1	PO2	PO3	PO4	PO5	PO6
CP23131.1	2	3	2	3	2	2
CP23131.2	2	3	2	3	2	2
CP23131.3	3	2				
CP23131.4	2	3	3	3	2	2
CP23131.5	3	2		2		
<b>Average</b>	2.4	2.7	2.33	2.75	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 (Lab Oriented Theory course)	Category	L	T	P	C
DS23131	DATA ANALYSIS AND VISUALIZATION	PC	3	0	2	4

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.

<b>UNIT I</b>	<b>INTRODUCTION TO DATA ANALYTICS</b>	<b>9</b>
Importance of analytics and visualization in the era of data abundance-- Review of probability, statistics and random processes-- Brief introduction to estimation theory		
<b>UNIT II</b>	<b>MACHINE LEARNING TECHNIQUES</b>	<b>9</b>
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.		
<b>UNIT III</b>	<b>REGRESSION AND CLASSIFICATION</b>	<b>9</b>
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.		
<b>UNIT IV</b>	<b>DATA VISUALIZATION</b>	<b>9</b>
Data visualization: Basic principles, categorical and continuous variables. - Exploratory graphical analysis. - Creating static graphs, animated visualizations - loops, GIFs and Videos.		
<b>UNIT V</b>	<b>DATA VISUALIZATION TOOLS</b>	<b>9</b>
Data visualization in Python and R, examples from Bokeh, Altair, ggPlot, ggplot2, ganimate, ImageMagick etc. - Introduction to Visualization Toolkit (VTK) for 3D computer graphics, image processing and visualization. - Visualization for deep learning.		
<b>Total Contact Hours</b>		<b>: 45</b>

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

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
<b>Contact Hours</b> : <b>45</b>	
<b>Total Hours</b> : <b>90</b>	

<b>Text Book(s):</b>	
1.	Alberto Cairo, The Functional Art: An Introduction to Information Graphics and Visualization, New Riders, Pearson Education, 2013.
2.	Nathan Yau, Data Points: Visualization That Means Something, Wiley, 2013.
3.	Charles D. Hansen and Chris R. Johnson, Visualization Handbook, Academic Press, 2004.

<b>Reference Books(s) / Web links:</b>	
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	. Edward Tufte, The Visual Display of Quantitative Information (2nd edition), Graphics Press, 2001.
4	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
<b>C01</b>	3	3	-	2	3	2
<b>C02</b>	3	3	-	2	3	2
<b>C03</b>	3	3	-	2	3	2
<b>C04</b>	3	3	-	2	3	2
<b>C05</b>	3	3	-	2	3	2
<b>Average</b>	3	3	-	2	3	2

Correlation levels 1, 2 or 3 are as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Subject Code	Subject Name	Category	L	T	P	C
AC23111	English for Research Paper Writing Common to all branches of M.E. /M.Tech – I Semester	MC	3	0	0	0

<b>Objectives:</b>						
●	To facilitate the students to express technical ideas in writing					
●	To train the students in using language structures appropriately					
●	To enable students to plan and organize the research paper					
●	To assist the students in understanding the structure and familiarize the mechanics of organized writing					
●	To equip the students to improvise academic English and acquire research writing skills					

<b>UNIT-I</b>	<b>INTRODUCTION TO RESEARCH WRITING</b>	9
Research – Types of Research - Selecting the Primary resources - Categorizing secondary sources - Discovering a researchable area and topic – Need Analysis - Research Question- Focus on the Research Problem- Developing Research Design – Framing the Hypothesis – Identifying the Scope of the Research - Writing – General and Academic Writing		
<b>UNIT-II</b>	<b>LANGUAGE OF WRITING</b>	9
Active reading – text mining – use of academic words – jargon's – ambiguities – use of expression – use of tense - proper voices – third person narration – phraseology – use of foreign words – use of quotes – interpreting quotes.		
<b>UNIT-III</b>	<b>THE FORMAT OF WRITING</b>	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		
<b>UNIT-IV</b>	<b>ORGANISING A RESEARCH PAPER</b>	9
Title- Abstract – Introduction – Literature review - Methodology - Results –Discussion – Conclusion - Appendices - Summarizing - Citation and Bibliography		
<b>UNIT-V</b>	<b>PUBLISHING PAPER</b>	9
Finding the Prospective publication or Journal - analyzing the credits - Reviewing - Revising –Plagiarism Check - Proofreading - Preparing the Manuscript- Submitting - Resubmitting - Follow up - Publishing		
<b>Total Contact Hours</b>		45
<b>Course Outcomes:</b> On completion of the 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		
● Follow the process of writing a research paper and write one		
● Emulate the process of publishing journal paper and publish papers		

**SUGGESTED ACTIVITIES**

- Group Discussions
- Writing review of literature
- Presentations
- Case study
- Writing a paper

**SUGGESTED EVALUATION METHODS**

- Assignment topics
- Quizzes
- Class Presentation/Discussion
- Continuous Assessment Tests

**Text Book(s):**

1.	Adrian Wallwork: “English for Writing Research Papers”, Springer Science Business Media, Second Edition, LLC 2011
2.	Stephen Howe and Kristina Henriksson: “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

**Reference Books(s) / Web links:**

1	Rowena Murray: The Handbook of Academic Writing: A Fresh Approach, Sarah Moore Open University Press, 2006
2	Stephen Bailey: Academic Writing: A Practical Guide for Students Routledge Falmer: 2003
3	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
AC23111.1	-	1	-	-	3	3
AC23111.2	-	-	-	-	3	1
AC23111.3	-	2	-	-	3	3
AC23111.4	-	1	-	-	2	3
AC23111.5	-	1	-	-	3	2
<b>Average</b>	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 (Theory course)	Category	L	T	P	C
DS23211	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.					

<b>UNIT I</b>	<b>INTRODUCTION TO DATA SCIENCE</b>	<b>9</b>
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		
<b>UNIT II</b>	<b>INTRODUCTION TO PYTHON PROGRAMMING</b>	<b>9</b>
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		
<b>UNIT III</b>	<b>DATA SCIENCE USING PYTHON</b>	<b>9</b>
Data Science Packages-Numpy,scipy, pandas-Building models and evaluation 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 evaluation with Scikit		
<b>UNIT IV</b>	<b>INTRODUCTION TO R</b>	<b>9</b>
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		
<b>UNIT V</b>	<b>DATA SCIENCE USING R</b>	<b>9</b>
Association –Classification – Clustering – Time series Analysis-Text Analysis–Prediction Algorithm-Image Analytics – Video Analytics – Data base analytics		
		<b>Total Contact Hours</b>
		<b>: 45</b>

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					

TextBooks:						
1	Wes McKinney, "Python for Data Analysis", O'Reilly Media.2012					
2	Sebastian Raschka, "Python Machine Learning",Packpub.com,2015					

Reference Books(s) / Web links:						
1	<a href="https://www.datacamp.com/courses/statistical-thinking-in-python-part-1">https://www.datacamp.com/courses/statistical-thinking-in-python-part-1</a>					

### CO-PO MAPPING

<b>PO</b> <b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
DS23211.1	3	3	1	1	2	2
DS23211.2	3	3	1	1	3	1
DS23211.3	3	3	1	1	3	1
DS23211.4	3	3	1	1	3	2
DS23211.5	3	3	1	1	3	2
<b>Average</b>	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 (Lab Oriented Theory course)	Category	L	T	P	C
DS23231	BIG DATA ANALYTICS AND TOOLS	PC	3	0	2	4

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

<b>UNIT I</b>	<b>UNDERSTANDING BIG DATA</b>	<b>9</b>
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		
<b>UNIT II</b>	<b>NOSQL DATA MANAGEMENT</b>	<b>9</b>
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		
<b>UNIT III</b>	<b>BASICS OF HADOOP</b>	<b>9</b>
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		
<b>UNIT IV</b>	<b>MAPREDUCE APPLICATIONS</b>	<b>9</b>
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		
<b>UNIT V</b>	<b>HADOOP RELATED TOOLS</b>	<b>9</b>
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.		
<b>Total Contact Hours</b>		<b>: 45</b>

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 data analytics



<b>List of Experiments</b>	
1.	(i).Perform setting up and Installing Hadoop in its two operating modes: <ul style="list-style-type: none"> <li>· Pseudo distributed</li> <li>· Fully distributed.</li> </ul> (ii).Use web based tools to monitor your Hadoop setup
2.	Implement the following file management tasks in Hadoop: <ul style="list-style-type: none"> <li>• Adding files and directories</li> <li>• Retrieving files</li> <li>• Deleting files</li> </ul>
3.	Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm. <ul style="list-style-type: none"> <li>• Find the number of occurrence of each word appearing in the input file(s)</li> <li>• Performing a MapReduce Job for word search count (look for specific keywords in a file)</li> </ul>
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. <ul style="list-style-type: none"> <li>• Find average, max and min temperature for each year in NCDC data set?</li> <li>• 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.</li> </ul>
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 Scalar Data analytics using Apache Spark on Amazon food dataset, find all the pairs of items frequently reviewedtogether.
11.	Write a single Spark application that: <ul style="list-style-type: none"> <li>• Transposes the original Amazon food dataset, obtaining a PairRDD of the type</li> <li>• A Counts the frequencies of all the pairs of products reviewed together;</li> <li>• Writes on the output folder all the pairs of products that appear more than once and their frequencies.</li> </ul> The pairs of products must be sorted by frequency.
<b>Total Contact Hours</b>	
<b>: 40</b>	

**TextBooks:**

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.

<b>Reference Books(s) / Web links:</b>	
1	Tom White, "Hadoop: The Definitive Guide", Third Edition, O'Reilley, 2012.
2	Eric Sammer, "Hadoop Operations", O'Reilley, 2012.
3	E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilley, 2012
4	Lars George, "HBase: The Definitive Guide", O'Reilley, 2011.
5	Eben Hewitt, "Cassandra: The Definitive Guide", O'Reilley, 2010.
6	Alan Gates, "Programming Pig", O'Reilley, 2011.

### CO-PO MAPPING

<b>PO</b> <b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
DS23231.1	1	1	1	1	2	2
DS23231.2	2	2	0	0	2	2
DS23231.3	2	2	0	0	1	1
DS23231.4	3	3	1	1	2	2
DS23231.5	3	3	1	1	3	3
<b>Average</b>	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 (Lab Oriented Theory course)	Category	L	T	P	C
DS23232	CLOUD COMPUTING TECHNOLOGIES	PC	3	0	2	4

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 the cloud
•	To understand the features of the cloud simulator
•	To apply different cloud programming models as per need

<b>UNIT I</b>	<b>CLOUD ARCHITECTURE AND MODEL</b>	<b>9</b>
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.		
<b>UNIT II</b>	<b>VIRTUALIZATION</b>	<b>9</b>
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.		
<b>UNIT III</b>	<b>CLOUD INFRASTRUCTURE</b>	<b>9</b>
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		
<b>UNIT IV</b>	<b>PROGRAMMING MODEL</b>	<b>9</b>
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.		
<b>UNIT V</b>	<b>SECURITY IN THE CLOUD</b>	<b>9</b>
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.		
		<b>Total Contact Hours : 45</b>

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.

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 a Service
5	Implementation of identity management
6	Write a program for web feed
7	Study and implementation of Single-Sign-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
<b>Total Contact Hours : 40</b>	

<b>TextBooks:</b>	
1	Kai Hwang, Geoffrey C Fox, Jack G Dongarra, “Distributed and Cloud Computing, 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.

<b>Reference Books(s) / Web links:</b>	
1	George Reese, “Cloud Application Architectures: Building Applications and Infrastructure in the Cloud” O'Reilly
2	James E. Smith, Ravi Nair, “Virtual Machines: Versatile Platforms for Systems and Processes”, Elsevier/Morgan Kaufmann, 2005.
3	Katarina Stanoevska-Slabeva, Thomas Wozniak, Santi Ristol, “Grid and Cloud Computing – A Business Perspective on Technology and Applications”, Springer
4	Ronald L. Krutz, Russell Dean Vines, “Cloud Security – A comprehensive Guide to Secure Cloud Computing”, Wiley – India, 2010.
5	RajkumarBuyya, Christian Vecchiola, S.TamaraiSelvi, Mastering Cloud Computing”, TMGH, 2013.
6	Gautam Shroff, Enterprise Cloud Computing, Cambridge University Press, 2011
7	Michael Miller, Cloud Computing, Que Publishing,2008

**CO-PO MAPPING:**

CO	PO1	PO2	PO3	PO4	PO5	PO6
DS23232.1	1	1	0	0	1	1
DS23232.2	2	2	0	0	2	2
DS23232.3	3	3	0	0	3	3
DS23232.4	3	3	0	0	3	3
DS23232.5	3	3	0	0	3	3
<b>Average</b>	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
AC23211	<b>CONSTITUTION OF INDIA</b> Common to all branches of M.E. /M.Tech – II Semester	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 make the students aware of the Constitutional and the Non- Constitutional bodies
●	To help the students understand the relationships exist between union and states
●	To make the students understand the sacrifices made by the freedom fighters.

<b>UNIT-I</b>	<b>INTRODUCTION</b>	9
Historical Background - Constituent Assembly of India - Philosophical foundations of the Indian Constitution - Features - Basic Structure – Preamble.		
<b>UNIT-II</b>	<b>UNION GOVERNMENT - EXECUTIVE, LEGISLATURE AND JUDICIARY</b>	9
Union and its territory - Citizenship - Fundamental Rights - Directive Principles of State Policy (DPSP) - Fundamental Duties. President - Vice President - Prime Minister - Central Council of Ministers - Cabinet Committees - Parliament: Committees, Forums and Groups - Supreme Court.		
<b>UNIT-III</b>	<b>STATE GOVERNMENT &amp; UNION TERRITORIES: STATE GOVERNMENT : EXECUTIVE, LEGISLATURE AND JUDICIARY</b>	9
Governor - Chief Minister - State Council of Ministers - State Legislature - High Court - Subordinate Courts - Panchayati Raj – Municipalities-Union Territories - Scheduled and Tribal Areas.		
<b>UNIT-IV</b>	<b>RELATIONS BETWEEN UNION AND STATES</b>	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.		
<b>UNIT-V</b>	<b>CONSTITUTIONAL BODIES AND AMENDMENTS</b>	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.		
		<b>Total Contact Hours</b>
		45
<b>Course Outcomes:</b> 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.		
● Apprehend and abide by the rules of the Indian constitution.		
● Comprehend the functions of state Government and Local bodies.		
● Gain Knowledge on constitution functions and role of constitutional bodies and amendments of constitution.		

**SUGGESTED ACTIVITIES**

- Online Quizzes
- Poster presentations
- Presentations
- Group Discussions
- Case study

**Text Books**

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 / Web links**

1	Sharma, Brij Kishore, "Introduction to the Constitution of India", Prentice Hall of India, New Delhi, 7th edition, 2015.
2	Subhash Kashyap, "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.

**CO-PO MAPPING**

PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6
AC23211.1	3	3	2	2	1	2
AC23211.2	3	-	2	-	-	
AC23211.3	3	2	2	2	1	2
AC23211.4	3	2	-	2	-	-
AC23211.5	3	2	-	2	1	2
<b>Average</b>	3	2	2	2	1	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
DS23221	PROGRAMMING FOR DATA SCIENCE LABORATORY	PC	0	0	4	2

**Objectives:**

- Learn the basics of Python Programming and Control statements
- Understand the concepts of Numpy, Pandas
- Understand the concept of basic statistics
- Learn the basics of Correlation and Regression Analysis
- Understand the concepts of Machine Learning Algorithms

**Description of the Experiments**

**Total Contact Hours: 30**

1. Working with Numpy arrays
2. Working with Pandas data frames
3. Basic plots using Matplotlib
4. Frequency distributions
5. Summary of Statistics - mean, median, mode, standard deviation and variance
6. Correlation and scatter plots
7. Regression Analysis
8. Implementation of Decision tree-based ID3 Algorithm
9. Implementation of Naïve Bayesian classifier
10. Implementation of k-Nearest Neighbour Algorithm
11. Implementation of K-Means Clustering Algorithm

<b>Course Outcomes:</b>
<ul style="list-style-type: none"> <li>• Use the basics of Python Programming in problem solving and conditionals and loops.</li> </ul>
<ul style="list-style-type: none"> <li>• Apply Numpy, Pandas and SciPy for numerical and statistical data</li> </ul>
<ul style="list-style-type: none"> <li>• Understand to implement Correlation Analysis</li> </ul>
<ul style="list-style-type: none"> <li>• Implemented the Regression Analysis on real world data sets</li> </ul>
<ul style="list-style-type: none"> <li>• Implemented Machine Learning Algorithms</li> </ul>

<b>SUGGESTED EVALUATION METHODS (if Any) (UNIT/ Module Wise) – could suggest topic</b>
<ul style="list-style-type: none"> <li>• Experiment based viva</li> </ul>
<ul style="list-style-type: none"> <li>• Quizzes</li> </ul>
<ul style="list-style-type: none"> <li>• Mind map</li> </ul>
<ul style="list-style-type: none"> <li>• Mini Projects</li> </ul>

<b>Web links for virtual lab (if any)</b>
<ul style="list-style-type: none"> <li>• <a href="https://www.python.org/shell/">https://www.python.org/shell/</a></li> </ul>
<ul style="list-style-type: none"> <li>• <a href="https://python-iitk.vlabs.ac.in/">https://python-iitk.vlabs.ac.in/</a></li> </ul>
<ul style="list-style-type: none"> <li>• <a href="https://www.hackerrank.com/domains/python">https://www.hackerrank.com/domains/python</a></li> </ul>

#### CO-PO MAPPING

<b>PO \ CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
DS23221.1	3	-	2	2	2	1
DS23221.2	-	3	2	-	-	-
DS23221.3	3	-	-	2	2	1
DS23221.4	-	3	2	-	-	-
DS23221.5	3	2	3	2	2	2
<b>Average</b>	3	2.7	2.3	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
DS23311	Security for Data Science	PC	3	0	0	3

Objectives:
<ul style="list-style-type: none"> <li>To Understand the Intersection of Cyber Security and Data Science</li> </ul>
<ul style="list-style-type: none"> <li>To Identify and Mitigate Security Risks in Data Science Projects</li> </ul>
<ul style="list-style-type: none"> <li>To Apply Data Privacy Regulations and Best Practices</li> </ul>
<ul style="list-style-type: none"> <li>To Implement Secure Data Handling Practices</li> </ul>
<ul style="list-style-type: none"> <li>To Utilize Machine Learning for Threat Detection and Security Analysis</li> </ul>

<b>UNIT-I</b>	<b>Introduction to Cyber Security and Data Science</b>	9
Overview of Cyber Security and Data Science - Definitions and Concepts - Intersection of Cyber Security and Data Science - Cyber Threat Landscape - Types of Cyber Threats - Attack Vectors and Techniques - Impact of Cyber Attacks on Data Science Processes - Foundations of Data Science - Data Collection and Sources - Data Storage and Management - Data Processing and Analysis Techniques		
<b>UNIT-II</b>	<b>Foundations of Cyber Security</b>	9
Principles of Cyber Security - Confidentiality, Integrity, and Availability (CIA) - Authentication and Authorization - Encryption and Cryptography - Secure Data Handling - Data Classification and Sensitivity - Data Masking and Anonymization - Secure Data Transfer and Sharing - Data Privacy and Compliance - Privacy Regulations ( GDPR, HIPAA) - Data Governance and Compliance Frameworks - Ethical Considerations in Data Science and Cyber Security		
<b>UNIT-III</b>	<b>Data Privacy and Protection</b>	9
Data Privacy and Protection -Secure Data Sharing and Transfer - Secure File Transfer Protocols - Secure Data Exchange Platforms - Securing Data Collection Systems - Best Practices for Secure Data Storage - Cloud Security and Data Privacy - Secure Data Transfer and Backup Strategies - Data Retention Policies and Compliance		
<b>UNIT-IV</b>	<b>Threat Detection and Incident Response</b>	9
Threat Detection and Incident Response - Security Information and Event Management (SIEM) - Log Management and Analysis - Real-time Threat Detection - Incident Response Frameworks - Preparation, Identification, Containment, Eradication, Recovery - Forensic Analysis Techniques - Machine Learning for Cyber Security - Threat Prediction and Classification - Behavioural Analysis and User Profiling		
<b>UNIT-V</b>	<b>Advanced Topics in Cyber Security for Data Science</b>	9
Advanced Topics in Cyber Security for Data Science - Adversarial Machine Learning - Evasion Attacks - Defence Mechanisms - Secure Machine Learning Models - Privacy-Preserving Machine Learning - Federated Learning - Ethical and Legal Considerations - Bias and Fairness in Cyber Security - Ethical Hacking and Responsible Disclosure		
<b>Total Contact Hours:45</b>		

Course Outcomes:
<ul style="list-style-type: none"> <li>To Understand the Fundamentals of Cyber Security</li> </ul>
<ul style="list-style-type: none"> <li>To Implement Secure Data Handling Practices</li> </ul>
<ul style="list-style-type: none"> <li>To Analyse Security Risks in Data Science Projects</li> </ul>
<ul style="list-style-type: none"> <li>To Develop Threat Detection and Response Strategies</li> </ul>
<ul style="list-style-type: none"> <li>To Design Ethical and Privacy-Preserving Data Science Solutions</li> </ul>

SUGGESTED ACTIVITIES (if any) (UNIT/ Module Wise) – Could suggest topic
<ul style="list-style-type: none"> <li>Problem solving sessions</li> <li>Flipped classroom - Comparing SOA with Client-Server and Distributed architectures</li> <li>Survey on various storage technologies</li> <li>Activity Based Learning</li> <li>Implementation of small module</li> </ul>

### SUGGESTED EVALUATION METHODS

- Tutorial problems
- Assignment problems
- Quizzes
- Class Presentation/Discussion

### Text Books

1	M Lakshminanth "Indian Polity", McGraw Hill Education, 5th edition 2017.
2	Durga Das Basu, "Introduction to the Constitution of India ", Lexis Nexis, New Delhi., 21stedition, 2013.

### Reference Books(s) / Web links:

1.	"Data Science for Cyber-Security" by Nicholas A Heard , Niall M Adams , Patrick Rubin delanchy, Publisher: World Scientific Europe Ltd , 2018
2.	"Cryptography and Network Security - Principles and Practice" by William Stallings 7 <sup>th</sup> Edition , Pearson, 2017.
3.	"Security Data Science: The Guide to Analyzing Threats and Attacks" by Julian Hillebrand and Heiko Tietze, Publisher: Springer
4.	Security, Privacy, and Trust in Modern Data Management (Data-Centric Systems and Applications) by Milan Petkovic, Willem Jonker 2007th Edition, Springer

### CO-PO MAPPING

PO CO	PO1	PO2	PO3	PO4	PO5	PO6
DS23311.1	3	-	1	-	2	1
DS23311.2	2	3	2	2	2	2
DS23311.3	3	1	2	1	2	1
DS23311.4	-	3	2	2	2	1
DS23311.5	1	2	3	2	3	2
<b>Average</b>	2.25	2.25	2	1.75	2.75	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
DS23A11	AI for Computer Vision	PE	3	0	0	3

Objectives:
<ul style="list-style-type: none"> <li>To understand ML models to read the images, train, evaluate, and predict.</li> </ul>
<ul style="list-style-type: none"> <li>To explore the use of computer vision for object detection and image segmentation problems.</li> </ul>
<ul style="list-style-type: none"> <li>To understanding concept of preprocessing, training and evaluation of data set.</li> </ul>
<ul style="list-style-type: none"> <li>To design the model for containerized pipeline and no-code image classification system</li> </ul>
<ul style="list-style-type: none"> <li>To demonstrate the model prediction and to solve a variety of problems</li> </ul>

UNIT-I	AI Models for Vision	9
A Datasets for Machine Perception - A Linear Model Using Keras - A Neural Network Using Keras. Image Vision : Pretrained Embeddings - Convolutional Networks - Modular Architectures - Neural Architecture Search Designs. Beyond Convolution: The Transformer Architecture – Choosing a Model.		
UNIT-II	Object Detection, Segmentation and Creating Vision Datasets	9
Object Detection – Segmentation. Creating Vision Datasets : Collecting Images – Data types – Manual Labeling – Labeling at Scale – Automated Labeling – Bias – Creating a Datasets		
UNIT-III	Preprocessing , Training and Continuous Evaluation	9
Preprocessing : Reasons for Preprocessing – Size and Resolution – Data Augmentation – Forming Input Images. Training Pipeline : Efficient Ingestion – Saving Model State – Distribution Strategy – Serverless ML . Model Quality and Continuous Evaluation : Monitoring – Model Quality Metrics – Quality Evaluation		
UNIT-IV	Model Predictions and Trends in Production ML	9
Model Predictions : Making Predictions – Online Prediction – Batch and Stream Prediction – Edge ML. Trends in Production ML : Machine Learning Pipelines – Explainability – No-Code Computer Vision		
UNIT-V	Advanced Vision Problems	9
Object Measurement – Counting – Pose Estimation – Image Search. Image and Text Generations: Image Understanding – Image Generation –Image Captioning .		
<b>Total Contact Hours: 45</b>		

Course Outcomes:
<ul style="list-style-type: none"> <li>Design and select the AI Model for Computer Vision tasks</li> </ul>
<ul style="list-style-type: none"> <li>Create an end-to-end model pipeline to train, evaluate and deploy.</li> </ul>
<ul style="list-style-type: none"> <li>Preprocesses images to data augmentation and support learnability.</li> </ul>
<ul style="list-style-type: none"> <li>Deploy image models as web services or on-edge device.</li> </ul>
<ul style="list-style-type: none"> <li>Implementations to image generation, counting and pose detection problems</li> </ul>

SUGGESTED ACTIVITIES
<ul style="list-style-type: none"> <li>Problem solving sessions</li> <li>Mini Projects</li> </ul>

### SUGGESTED EVALUATION METHODS

- Tutorial problems
- Assignment problems
- Quizzes
- Class Presentation / Discussion

### Text Book(s):

1. Valliappa Lakshmanan, Martin Gerner, and Ryan Gillard, "Practical Machine Learning for Computer Vision", O'Reilly Media, First Edition, 2021.
2. David A. Forsyth and Jean Ponce, "Computer Vision a Modern approach", Pearson Education, Second Edition, 2015.

### Reference Books(s) / Web links:

1. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer- Texts in Computer Science, Second Edition, 2022.
2. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.
3. Christopher M. Bishop; Pattern Recognition and Machine Learning, Springer, 2006
4. E. R. Davies, Computer and Machine Vision, Fourth Edition, Academic Press, 2012.

### CO-PO MAPPING

PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6
DS23A11.1	-	3	2	-	2	1
DS23A11.2	2	3	-	-	2	2
DS23A11.3	3	2	1	-	1	2
DS23A11.4	-	1	1	2	3	1
DS23A11.5	2	3	3	2	-	1
<b>Average</b>	2.33	2.4	1.75	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
DS23A12	Deep Learning Techniques	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.

<b>UNIT I</b>	<b>INTRODUCTION TO DEEP LEARNING</b>	<b>9</b>
Introduction to Neural Network, Activation Functions, Multilayer Perceptron, Back Propagation Learning		
<b>UNIT II</b>	<b>CONVOLUTIONAL NEURAL NETWORKS (CNN)</b>	<b>9</b>
CNN History- Understanding CNN Layers -CNN Models – ALEXNET-VGG-GoogleNet-RESNET - CNN Application on image processing and text processing.		
<b>UNIT III</b>	<b>RECURRENT NEURAL NETWORKS (RNN)</b>	<b>9</b>
Introduction to RNN Model Long Short-Term memory (LSTM) Recursive Neural Tensor Network Theory Recurrent Neural Network Model		
<b>UNIT IV</b>	<b>UNSUPERVISED LEARNING</b>	<b>9</b>
Applications of Unsupervised Learning-Restricted Boltzmann Machine-Collaborative Filtering with RBM		
<b>UNIT V</b>	<b>AUTO ENCODERS</b>	<b>9</b>
Introduction to Autoencoders- Types of Autoencoders- and Applications- Autoencoders- Deep Belief Network		
<b>Total Contact Hours</b>		<b>: 45</b>

<b>Course Outcomes: On completion of course students will be able to</b>	
•	Understand the fundamental principles, theory and approaches for learning with deep neural networks
•	Implement the main variants of deep learning (such as 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 TensorFlow.

<b>SUGGESTED ACTIVITIES</b>	
•	Problem solving sessions
•	Mini Projects

<b>SUGGESTED EVALUATION METHODS</b>	
•	Tutorial problems
•	Assignment problems
•	Quizzes
•	Class Presentation/Discussion

<b>Text Book(s):</b>	
1.	Ian Goodfellow, Yoshua Bengio and Aaron Courville, "Deep Learning", The MIT Press
2.	Rajiv Chopra, Deep Learning: A Practical Approach, Khanna Publication

<b>Reference Books(s) / Web links:</b>	
1.	MOOC, Deep Learning By Google, <a href="https://in.udacity.com/course/deep-learning--ud730">https://in.udacity.com/course/deep-learning--ud730</a>
2.	MOOC, Deep Learning <a href="https://www.coursera.org/specializations/deep-learning">https://www.coursera.org/specializations/deep-learning</a>

### CO-PO MAPPING

PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6
DS23A12.1	3	-	2	-	-	1
DS23A12.2	-	3	2	2	3	2
DS23A12.3	3	2	1	-	-	1
DS23A12.4	3	2	1	-	-	1
DS23A12.5	-	-	3	3	3	2
<b>Average</b>	3	2.33	1.8	2.	3	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
DS23A13	Natural Language Processing and Applications	PE	3	0	0	3

Objectives:
<ul style="list-style-type: none"> <li>To understand the algorithms available for the processing of linguistic information and computational properties of natural languages.</li> </ul>
<ul style="list-style-type: none"> <li>To conceive basic knowledge on various morphological, syntactic and semantic NLP tasks.</li> </ul>
<ul style="list-style-type: none"> <li>To familiarize various NLP software libraries and data sets publicly available</li> </ul>
<ul style="list-style-type: none"> <li>To develop systems for various NLP problems with moderate complexity.</li> </ul>
<ul style="list-style-type: none"> <li>To learn various strategies for NLP system evaluation and error analysis.</li> </ul>

UNIT-I	INTRODUCTION	9
<p>Introductions: Regular Expressions, Text Normalization, Edit Distance, N-Grams, Evaluating Language Models , Sampling sentences from a language model , Generalization and Zeros, Naive Bayes Classifiers and Training , Naive Bayes as a Language Model , Precision, Recall, F-measure , Test sets and Cross-validation, Classification with Logistic Regression, Multinomial logistic regression, Learning in Logistic Regression, Lexical Semantics, Vector Semantics, Words and Vectors.</p>		
UNIT-II	NEURAL NETWORKS AND NEURAL LANGUAGE MODEL	9
<p>Neural Networks and Neural Language Models : Feedforward Neural Networks, Classification, Language Modelling, Training Neural Nets, Training the neural language model, Part-of-Speech Tagging, Named Entities and Named Entity Tagging, HMM Part-of-Speech Tagging, Conditional Random Fields (CRFs) ,RNNs as Language Models, RNNs for other NLP tasks, Stacked and Bidirectional RNN architectures, LSTM, Evaluation of Named Entity.</p>		
UNIT-III	MACHINE TRANSLATION AND INFORMATION RETRIEVAL	9
<p>Machine Translation and Information Retrieval : Language Divergences and Typology, Machine Translation using Encoder-Decoder, Details of the Encoder-Decoder Model ,Translating in low-resource situations, Information Retrieval, IR-based Factoid Question Answering, Entity Linking , Knowledge-based Question Answering, Using Language Models to do QA , Classic QA Models, Simple Frame-based Dialogue Systems, The Dialogue-State Architecture , Evaluating Dialogue Systems , Dialogue System Design, The Automatic Speech Recognition Task, Feature Extraction for ASR: Log Mel Spectrum, Speech Recognition Architecture.</p>		
UNIT-IV	CONTEXT FREE GRAMMAR	9
<p>Context-Free Grammars , Parsing and Semantics : Context-Free Grammars, Treebanks ,Grammar Equivalence and Normal Form , Ambiguity , CKY Parsing: A Dynamic Programming Approach, Span-Based Neural Constituency Parsing, Evaluating Parsers, Dependency Relations, Transition-Based Dependency Parsing, Graph-Based Dependency Parsing, Model-Theoretic Semantics, First-Order Logic , Event and State Representations , Description Logics .</p>		
UNIT V	SEMANTICS AND SENTIMENTS	9
<p>Semantic ,Sentiment and Coreference : Semantic Roles, Problems with Thematic Roles , The Proposition Bank and FrameNet, Semantic Role Labeling , Selectional Restrictions, Emotion, Creating Affect Lexicons by Human Labeling, Semi-supervised Induction of Affect Lexicons, Supervised Learning of Word Sentiment , Using Lexicons for Sentiment and affect Recognition , Lexicon-based methods for Entity-Centric Affect, Coreference Linguistic Background, Tasks and Datasets, Mention Detection, Architectures for Coreference Algorithms, Classifiers using hand-built features, A neural mention-ranking algorithm, Evaluation of Coreference Resolution , Winograd Schema problems , Gender Bias in Coreference.</p>		
<b>Total Contact Hours:</b>		<b>45</b>

Course Outcomes:
<ul style="list-style-type: none"> <li>Describe the concepts of morphology, syntax, semantics, discourse &amp; pragmatics of natural language.</li> </ul>
<ul style="list-style-type: none"> <li>Demonstrate understanding of the relationship between NLP and statistics &amp; machine learning.</li> </ul>
<ul style="list-style-type: none"> <li>Discover various linguistic and statistical features relevant to the basic NLP task, namely, spelling correction, morphological analysis, parts-of-speech tagging, parsing and semantic analysis.</li> </ul>
<ul style="list-style-type: none"> <li>Develop systems for various NLP problems with moderate complexity.</li> </ul>
<ul style="list-style-type: none"> <li>Evaluate NLP systems, identify shortcomings and suggest solutions for these shortcomings.</li> </ul>

**SUGGESTED ACTIVITIES (if any) (UNIT/ Module Wise) – Could suggest topic**

- Research problem literature study.
- Comparison on various algorithms.
- Case study discussion.
- Develop the small applications.

**SUGGESTED EVALUATION METHODS (if Any) (UNIT/ Module Wise) – could suggest topic**

- Tutorial problems
- Assignment problems
- Quizzes
- Class Presentation/Discussion

**Text Book(s):**

1. Jurafsky Dan and Martin James H. “Speech and Language Processing” ,3rd Edition, 2018.
2. Jurafsky D. and Martin J. H., “Speech and language processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition”, 2nd Edition, Upper Saddle River, NJ: Prentice-Hall, 2008.
3. Rajesh Arumugam, Rajalingappa Shanmugamani “Hands-on natural language processing with python: A practical guide to applying deep learning architectures to your NLP application”. PACKT publisher, 2018.

**Reference Books(s) / Web links:**

1. James Allen “Natural Language Understanding”, Pearson Publication 8th Edition. 2012.
2. Christopher D. Manning and Hinrich Schütze, “ Foundations of Natural Language Processing”, 6<sup>th</sup> Edition, The MIT Press Cambridge, Massachusetts London, England, 2003.
3. Alexander Clark, Chris Fox, Shalom Lappin, “The Handbook of Computational Linguistics and Natural Language Processing”, Wiley-Blackwell, 2012
4. Chris Manning and HinrichSchütze, “Foundations of Statistical Natural Language Processing”, 2nd edition, MITPress Cambridge, MA, 2003

**CO-PO MAPPING**

<b>PO</b> <b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
DS23A13.1	3	2	-	-	-	-
DS23A13.2	2	3	2	3	2	2
DS23A13.3	2	3	-	2	2	1
DS23A13.4	2	3	2	-	3	2
DS23A13.5	2	2	1	3	3	2
<b>Average</b>	2.2	2.6	1.66	2.67	2.5	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
DS23A14	Industrial Internet Of Things	PE	3	0	0	3

Objectives:
<ul style="list-style-type: none"> <li>Basics of IIOT Systems</li> </ul>
<ul style="list-style-type: none"> <li>Implementation of various networks and Systems</li> </ul>
<ul style="list-style-type: none"> <li>Data monitoring and Control</li> </ul>
<ul style="list-style-type: none"> <li>Approaches to Cyber physical Systems</li> </ul>
<ul style="list-style-type: none"> <li>Applications in IIOT</li> </ul>

<b>UNIT-I</b>	<b>Introduction to Industrial IoT (IIoT) Systems</b>	8
The Various Industrial Revolutions, Role of Internet of Things (IoT) & Industrial Internet of Things (IIoT) in Industry, Industry 4.0 revolutions, Support System for Industry 4.0, Smart Factories.		
<b>UNIT-II</b>	<b>Implementation systems for IIoT</b>	10
Sensors and Actuators for Industrial Processes, Sensor networks, Process automation and Data Acquisitions on IoT Platform, Microcontrollers and Embedded PC roles in IIoT, Wireless Sensor nodes with Bluetooth, WiFi, and LoRa Protocols and IoT Hub systems		
<b>UNIT-III</b>	<b>IIoT Data Monitoring &amp; Control</b>	9
IoT Gate way, IoT Edge Systems and It's Programming, Cloud computing, Real Time Dashboard for Data Monitoring, Data Analytics and Predictive Maintenance with IIoT technology		
<b>UNIT-IV</b>	<b>Cyber Physical Systems</b>	9
Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis		
<b>UNIT-V</b>	<b>Industrial IoT- Applications</b>	9
Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management. Case Studies of IIoT Systems –Industry 5.0 – Mini project		
<b>Total Contact Hours:</b>		<b>45</b>

Course Outcomes: On completion of the course the students will be able to learn
<ul style="list-style-type: none"> <li>The principles and evolution of IIOT</li> </ul>
<ul style="list-style-type: none"> <li>Knowledge of theory and practice related to Industrial IoT Systems</li> </ul>
<ul style="list-style-type: none"> <li>Understand of Data monitoring and Control measures in IIOT</li> </ul>

- Ability to identify, formulate and solve engineering problems by using Industrial IoT
- Ability to implement real field problem by gained knowledge of Industrial applications with IoT capability

**SUGGESTED ACTIVITIES**

- Implementation of small module

**SUGGESTED EVALUATION METHODS**

- Class Presentation/Discussion

**Text Book(s):**

1. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress Publisher , 2017
2. Bartodziej, Christoph Jan , The Concept Industry 4.0 An Empirical Analysis of Technologies and Applications in Production Logistics, Springer Publisher, 1<sup>st</sup> Edition, 2016
3. Rajkamal , Embedded System: Architecture, Programming and Design, 3<sup>rd</sup> Edition, McGraw Hill Education, 2017.

**Reference Books(s) / Web links:**

1. Dr. OvidiuVermesan, Dr. Peter Friess, “Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems”, River Publishers, 2013.

**CO-PO MAPPING**

PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6
DS23A14.1	3	2	-	-	-	-
DS23A14.2	2	3	1	2	2	1
DS23A14.3	3	2	1	2	-	-
DS23A14.4	-	2	2	2	3	2
DS23A14.5	2	2	2	2	3	2
<b>Average</b>	2.5	2.2	1.5	2	3	1.67

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
DS23A15	AI Powered Chat Bot	PE	3	0	0	3

Objectives:
<ul style="list-style-type: none"> <li>To understand the fundamentals of natural language processing (NLP) and its applications in chatbot development</li> </ul>
<ul style="list-style-type: none"> <li>To provide students with practical skills in programming languages and frameworks commonly used in chatbot development, such as Python and TensorFlow.</li> </ul>
<ul style="list-style-type: none"> <li>To equip students with the knowledge of integrating chatbots with different platforms and services, including social media, websites, and messaging applications</li> </ul>
<ul style="list-style-type: none"> <li>To enable students to develop real-world chatbot projects that address specific use cases and business needs.</li> </ul>

<b>UNIT-I</b>	<b>Introduction to Chatbots</b>	9
Overview of chatbots and their applications, Types of chatbots: rule-based vs. AI-powered, Evolution of chatbot technology		
<b>UNIT-II</b>	<b>Natural Language Processing (NLP) Fundamentals</b>	9
Introduction to NLP and its applications, Tokenization, stemming, and lemmatization , Named Entity Recognition (NER) and Part-of-Speech (POS) tagging		
<b>UNIT-III</b>	<b>Chatbot Architecture</b>	9
Understanding the architecture of AI-powered chatbots, Components: NLP engine, dialogue manager, integration with external systems, Design considerations for scalability and performance		
<b>UNIT-IV</b>	<b>Chatbot Development Tools and Frameworks</b>	9
Overview of popular chatbot development frameworks (e.g., Rasa, Dialogflow) , Hands-on exploration of development environments, Building a simple chatbot prototype		
<b>UNIT-V</b>	<b>Deployment and Integration</b>	9
Deployment options for chatbots (e.g., web, mobile, messaging platforms) , Integrating chatbots with backend systems and APIs, Testing and monitoring chatbot performance		
<b>Total Contact Hours: 45</b>		

Course Outcomes:
<ul style="list-style-type: none"> <li>Design and implement AI-powered chatbots using various NLP and machine learning techniques.</li> </ul>
<ul style="list-style-type: none"> <li>Utilize programming languages and frameworks effectively to develop and deploy chatbots.</li> </ul>
<ul style="list-style-type: none"> <li>Integrate chatbots with different platforms and services to enhance user interaction.</li> </ul>
<ul style="list-style-type: none"> <li>Evaluate and improve chatbot performance through testing and analysis.</li> </ul>
<ul style="list-style-type: none"> <li>Develop innovative chatbot solutions to address real-world problems and business</li> </ul>

SUGGESTED ACTIVITIES
<ul style="list-style-type: none"> <li>Activity Based Learning</li> <li>Capstone Projects</li> </ul>

SUGGESTED EVALUATION METHODS
<ul style="list-style-type: none"> <li>Assignment problems</li> <li>Quizzes</li> <li>Project Presentation</li> </ul>

<b>Text Book(s):</b>
1. Steven Bird, Ewan Klein, and Edward Loper, "Natural Language Processing with Python : Analyzing Text with the Natural Language Toolkit", O'Reilly Publisher, 2009.
2. Aurélien Géron , "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow", Third Edition, Concepts, Tools, and Techniques to Build Intelligent Systems, Shroff/O'Reilly Publisher, 2022

<b>Reference Books(s) / Web links:</b>
1. Online documentation and tutorials for chatbot development frameworks (e.g., Rasa, Dialogflow)
2. Research papers and articles on chatbot technology and applications

**CO-PO MAPPING**

<b>PO</b> <b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
DS23A15.1	2	3	2	2	3	-
DS23A15.2	2	3	-	2	3	-
DS23A15.3	2	3	2	2	3	2
DS23A15.4	2	3	-	2	3	2
DS23A15.5	2	3	2	2	3	2
<b>Average</b>	2	3	2	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
DS23A16	Drone Technologies	PE	3	0	0	3

Objectives:
<ul style="list-style-type: none"> <li>Understand the basic principles of drone technology</li> </ul>
<ul style="list-style-type: none"> <li>Learn about the various components of drone design</li> </ul>
<ul style="list-style-type: none"> <li>Learn about the various types of Drones and its applications.</li> </ul>
<ul style="list-style-type: none"> <li>Design various types of Drones</li> </ul>

<b>UNIT-I</b>	<b>Introduction to Drone Technology</b>	9
Overview of drone technology and its applications , Components of a drone: frame, motors, propellers, flight controller, sensors, and communication systems, Components of a drone: frame, motors, propellers, flight controller, sensors, and communication systems, Drone types and classifications.		
<b>UNIT-II</b>	<b>Introduction to Drone Hardware and Software</b>	9
Drone hardware components and their functionalities, Introduction to drone programming with SDKs (Software Development (Kits), Setting up a drone, basic flight maneuvers, and controlling drones via SDK		
<b>UNIT-III</b>	<b>Computer Vision for Drones</b>	9
Introduction to computer vision and its applications in drones. Image processing techniques: filtering, edge detection, and feature extraction Object detection and recognition algorithms: Haar cascades, HOG (Histogram of Oriented Gradients), and deep learning-based approaches		
<b>UNIT-IV</b>	<b>Autonomous Navigation</b>	9
Principles of autonomous navigation for drones , Path planning algorithms: A* algorithm, Dijkstra's algorithm, and potential field methods. Simultaneous Localization and Mapping (SLAM) techniques for drones. Reinforcement learning for drone navigation		
<b>UNIT-V</b>	<b>Applications of Drones with Machine Learning</b>	9
Real-world applications of drones with machine learning: precision agriculture, wildlife monitoring, search and rescue, surveillance, and package delivery. Ethical considerations and legal regulations in drone technology		
<b>Total Contact Hours: 45</b>		

Course Outcomes:
<ul style="list-style-type: none"> <li>Introduce the drone technology and drone types.</li> </ul>
<ul style="list-style-type: none"> <li>Apply ethical considerations and privacy principles in the development and deployment of machine learning-enabled drones</li> </ul>
<ul style="list-style-type: none"> <li>Analyse the role of machine learning in enhancing drone capabilities and solving complex tasks.</li> </ul>
<ul style="list-style-type: none"> <li>Integrate sensor data fusion techniques with machine learning algorithms to enhance situational awareness and decision-making on drones.</li> </ul>
<ul style="list-style-type: none"> <li>Apply computer vision techniques for tasks such as object detection, classification, and tracking using drone-mounted sensors.</li> </ul>

### SUGGESTED ACTIVITIES

- Activity Based Learning
- Capstone Projects

### SUGGESTED EVALUATION METHODS

- Assignment problems
- Quizzes
- Project Presentation

### Text Book(s):

1. Sachi Nandan Mohanty, J. V. R. Ravindra, G. Surya Narayana, Chinmaya Ranjan Pattnaik, Y. Mohamed Sirajudeen, Drone Technology : Future Trends and Practical Applications, Wiley-Scrivener Publisher, 2023.
2. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, Third Edition, Shroff/O'Reilly Publisher, 2022.

### Reference Books(s) / Web links:

1. Documentation and tutorials for drone hardware and software (e.g., DJI Developer, PX4 Autopilot)
2. Online courses and tutorials on machine learning (e.g., Coursera, Udacity, Kaggle)
3. Research papers and articles on drone applications and machine learning techniques

### CO-PO MAPPING

PO \ CO	PO1	PO2	PO3	PO4	PO5	PO6
DS23A16.1	3	1	-	-	-	-
DS23A16.2	1	2	3	2	2	2
DS23A16.3	1	3	1	2	3	2
DS23A16.4	-	3	1	2	3	1
DS23A16.5	1	3	-	2	2	1
<b>Average</b>	1.5	2.4	1.7	2	2.5	1.5

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
DS23A17	Augmented Reality	PE	3	0	0	3

Objectives:
<ul style="list-style-type: none"> <li>Describe how AR systems work and list the applications of AR.</li> </ul>
<ul style="list-style-type: none"> <li>Understand and analyse the hardware requirement of AR.</li> </ul>
<ul style="list-style-type: none"> <li>Use computer vision concepts for AR and describe AR Software</li> </ul>
<ul style="list-style-type: none"> <li>Analyze and understand the working of various state of the art AR Techniques</li> </ul>
<ul style="list-style-type: none"> <li>Acquire knowledge of Devices &amp; Components</li> </ul>

<b>UNIT-I</b>	<b>Introduction to Augmented Reality (A.R)</b>	9
Defining augmented reality, history of augmented reality, The Relationship between Augmented Reality and Other Technologies-Media, Technologies, Other Ideas Related to the Spectrum between Real and Virtual Worlds, applications of augmented reality.		
<b>UNIT-II</b>	<b>Augmented Reality Hardware</b>	9
<b>Augmented Reality Hardware – Displays:</b> Audio Displays, Haptic Displays, Visual Displays, Other sensory displays, Visual Perception, Requirements and Characteristics, Spatial Display Model. <b>Processors</b> – Role of Processors, Processor System Architecture, Processor Specifications. <b>Tracking &amp; Sensors</b> - Tracking, Calibration, and Registration, Characteristics of Tracking Technology, Stationary Tracking Systems, Mobile Sensors, Optical Tracking, Sensor Fusion.		
<b>UNIT-III</b>	<b>Computer Vision for Augmented Reality &amp; A.R. Software</b>	9
<b>Computer Vision for Augmented Reality &amp; A.R. Software:</b> Computer Vision for Augmented Reality - Marker Tracking, Multiple-Camera Infrared Tracking, Natural Feature Tracking by Detection, Simultaneous Localization and Mapping, Outdoor Tracking <b>Augmented Reality Software:</b> Introduction, Major Software Components for Augmented Reality Systems, Software used to Create Content for the Augmented Reality Application.		
<b>UNIT-IV</b>	<b>AR Techniques- Marker based &amp; Markerless tracking</b>	9
<b>AR Techniques- Marker based &amp; Markerless tracking:</b> Marker-based approach- Introduction to marker-based tracking, types of markers, marker camera pose and identification, visual tracking, mathematical representation of matrix multiplication. <b>Marker types:</b> Template markers, 2D barcode markers, imperceptible markers. <b>Marker-less approach:</b> Localization based augmentation, real world examples. <b>Tracking methods-</b> Visual tracking, feature based tracking, hybrid tracking, and initialization and recovery.		
<b>UNIT-V</b>	<b>AR Devices &amp; Components</b>	9
<b>AR Devices &amp; Components : AR Components</b> – Scene Generator, Tracking system, monitoring system, display, Game scene <b>AR Devices</b> – Optical See- through HMD, Virtual retinal systems, Monitor bases systems, Projection displays, and Video see-through systems.		
<b>Total Contact Hours:45</b>		

Course Outcomes:
<ul style="list-style-type: none"> <li>Describe how AR systems work and list the applications of AR.</li> </ul>
<ul style="list-style-type: none"> <li>Understand and analyze the hardware requirement of AR.</li> </ul>
<ul style="list-style-type: none"> <li>Use computer vision concepts for AR and describe AR Software</li> </ul>
<ul style="list-style-type: none"> <li>Analyse and understand the working of various state of the art AR Techniques</li> </ul>
<ul style="list-style-type: none"> <li>Acquire knowledge of AR Devices</li> </ul>

**SUGGESTED ACTIVITIES (if any) (UNIT/ Module Wise) – Could suggest topic**

- Problem solving sessions – application of AR in innovative ideas
- Survey on various AR projects
- Activity Based Learning
- Implementation of small module

**SUGGESTED EVALUATION METHODS (if Any) (UNIT/ Module Wise) – could suggest topic**

- Tutorial problems
- Assignment problems
- Quizzes
- Class Presentation/Discussion

**Text Book(s):**

1. Dieter Schmalstieg, Tobias Hollerer, Augmented Reality: Principles & Practice , Pearson Education India; First edition, Addison-Wesley Publisher , 2016.
2. Allan Fowler-AR Game Development, 1st Edition, A press Publications, 2018

**Reference Books(s) / Web links:**

1. Designing for Mixed Reality, Kharis O'Connell Published by O'Reilly Media, Inc., 2016.
2. Sanni Siltanen- Theory and applications of marker-based augmented reality. Julkaisija – Utgivare Publisher. 2012.

**CO-PO MAPPING**

<b>PO</b> <b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
DS23A17.1	3	2	-	2	2	1
DS23A17.2	2	3	-		1	1
DS23A17.3	2	3	2	2	3	2
DS23A17.4	1	3	-	2	2	1
DS23A17.5	2	3	1	-	-	-
<b>Average</b>	2	2.8	1.5	2	2	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
DS23B11	Social Network Analysis and Visualization	PE	3	0	0	3

Objectives:
<ul style="list-style-type: none"> <li>To understand the components and entities of the social network.</li> </ul>
<ul style="list-style-type: none"> <li>To comprehend user sentiments and recommend the essential information appropriately.</li> </ul>
<ul style="list-style-type: none"> <li>To understand various types of mining communities in web social networks.</li> </ul>
<ul style="list-style-type: none"> <li>To model and understand human behaviour in social web and related communities.</li> </ul>
<ul style="list-style-type: none"> <li>To learn visualization of social networks.</li> </ul>

UNIT-I	Social Network Data	9
What are Network Data?-Boundary specification and Sampling-Types of networks-Network data, Measurements and collection-Data sets-Electronic sources for network analysis: Electronic discussion networks, Blogs and online communities-Web based networks-Application of social network analysis.		
UNIT-II	Mathematical Representations of Social Networks	9
Sociometric Notation-Algebraic Notation-Graphs and Matrices-Directed Graphs-Signed Graphs and Signed Directed Graph-Valued Graph and Valued Directed Graphs-Matrices-Properties.		
UNIT-III	Roles and Positions	9
Structural Equivalence-Positional Analysis –Measuring Structural Equivalence-Representation of Network Positions-Block models-Building Blocks-Interpretations-Relational Algebras-Notations and Algebraic operations.		
UNIT-IV	Dyadic and Triadic Methods	9
Dyads-Simple Distributions-Statistical Analysis of the number of arcs-Conditional uniform distributions-Statistical Analysis of the number of Mutual-Triads-Random Models and Substantive Hypotheses-Distribution of a triad Census-Testing Structural hypotheses.		
UNIT-V	Visualization and Application of Social Networks	9
Graph theory-Centrality-Clustering-Node Edge Diagrams-Matrix representation- Visualizing online social networks , Visualizing online social networks with matrix based representations-Matrix and Node-Link Diagrams-Hybrid Representations-Applications-Cover networks-Community Welfare-Collaboration networks-Co Citation Networks.		
<b>Total Contact Hours: 45</b>		

Course Outcomes:
<ul style="list-style-type: none"> <li>Illustrate the basic concepts of social networks.</li> </ul>
<ul style="list-style-type: none"> <li>Analyse the networks to find prominent actors and relate social network models.</li> </ul>
<ul style="list-style-type: none"> <li>Detect and analyse the communities in social networks.</li> </ul>
<ul style="list-style-type: none"> <li>Predict human behaviour in social web and related communities.</li> </ul>
<ul style="list-style-type: none"> <li>Visualize social networks.</li> </ul>

<b>Text Book(s):</b>
1. Wasserman Stanley, and Katherine Faust, Social Network Analysis: Methods and Applications, Structural Analysis in the Social Sciences. Cambridge University Press, 2012 Online Edition.
2. Albert-László Barabási, Network Science, Cambridge University Press, 1st edition, 2016.
3. Tanmoy Chakraborty, “Social Network Analysis”, Wiley 2021

<b>Reference Books(s) / Web links:</b>
1. Peter Mika, —Social Networks and the Semantic Webl, First Edition, Springer 2007.
2. Borko Furht, —Handbook of Social Network Technologies and Applicationsl, 1st Edition, Springer, 2010

<b>SUGGESTED ACTIVITIES</b>
<ul style="list-style-type: none"> <li>• Case study Discussion</li> <li>• Flipped classroom – Comparing of Graph Models.</li> <li>• Activity Based Learning:-  Mind Mapping- Dyadic and Triad  Borko Furht, —Handbook of Social Network Technologies and Applicationsl, 1st Edition, Springer, 2010  ic methods,  Gallery Walk- Network Positions,  Role Play- Matrix and Node.</li> </ul>

<b>SUGGESTED EVALUATION METHODS</b>
<ul style="list-style-type: none"> <li>• Mini Projects</li> <li>• Assignment problems</li> <li>• Quizzes</li> </ul>

**CO-PO MAPPING**

<b>PO</b> <b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
DS23B11.1	3	2	-	2	-	-
DS23B11.2	2	3	-	2	2	1
DS23B11.3	2	3	2	2	1	-
DS23B11.4	2	-	3	2	3	2
DS23B11.5	2	3	1	2	1	-
<b>Average</b>	2.2	2.75	2	2	1.75	1.5

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
DS23B12	Health Care Data Analytics	PE	3	0	0	3

Objectives:
<ul style="list-style-type: none"> <li>To explore the various forms of electronic health care information.</li> </ul>
<ul style="list-style-type: none"> <li>To learn the techniques adopted to analyse health care data.</li> </ul>
<ul style="list-style-type: none"> <li>To understand the predictive models for clinical data</li> </ul>

<b>UNIT-I</b>	<b>INTRODUCTION</b>	9
Introduction to Healthcare Data Analytics – Healthcare Data Sources and Basic Analytics – Advanced Data Analytics for Healthcare - Applications and Practical Systems for Healthcare – Resources for Healthcare Data Analytics – Electronics Health Records – Benefits of EHR – Barriers of Adopting EHR.		
<b>UNIT-II</b>	<b>BIOMEDICAL IMAGE ANALYSIS</b>	9
Biomedical Image Analysis - Biomedical Imaging Modalities -Object Detection -Image Segmentation -Image Registration-Feature Extraction-Mining of Sensor Data in Healthcare -Challenges in Healthcare Data Analysis - Sensor Data Mining Applications- Nonclinical Healthcare Applications		
<b>UNIT-III</b>	<b>NATURAL LANGUAGE PROCESSING</b>	9
Natural Language Processing and Data Mining for Clinical Text- Natural Language Processing - Mining Information from Clinical Text - Challenges of Processing Clinical Reports - Mining the Biomedical Literature - Information Extraction . - Text Mining Environments – Applications - Integration with Clinical Text Mining		
<b>UNIT-IV</b>	<b>ADVANCED DATA ANALYTICS</b>	9
Advanced Data Analytics for Healthcare - Basic Statistical Prediction Models - Alternative Clinical Prediction Models – Temporal Data Mining for Healthcare Data - Association Analysis - Temporal Pattern Mining - Sensor Data Analysis - Other Temporal Modeling Methods		
<b>UNIT-V</b>	<b>PREDICTIVE MODELS</b>	9
Predictive Models for Integrating Clinical and Genomic Data - Issues and Challenges in Integrating Clinical and Genomic Data - Different Types of Integration - Different Goals of Integrative Studies - Validation -Information Retrieval for Healthcare - Knowledge-Based Information in Healthcare - Content of Knowledge-Based Information Resources – Indexing – Retrieval		
<b>Total Contact Hours:</b>		<b>45</b>

Course Outcomes:
<ul style="list-style-type: none"> <li>Analyze health care data using appropriate analytical techniques.</li> </ul>
<ul style="list-style-type: none"> <li>Apply analytics for decision making in healthcare services.</li> </ul>
<ul style="list-style-type: none"> <li>Apply NLP for generating clinical reports</li> </ul>
<ul style="list-style-type: none"> <li>Apply data mining to integrate health data from multiple sources and develop efficient clinical decision support systems.</li> </ul>
<ul style="list-style-type: none"> <li>Apply Predictive modeling in healthcare services</li> </ul>

**SUGGESTED ACTIVITIES**

- Problem solving sessions
- Flipped classroom - Comparing SOA with Client-Server and Distributed architectures
- Survey on various storage technologies
- Activity Based Learning
- Implementation of small module

**SUGGESTED EVALUATION METHODS**

- Tutorial problems
- Assignment problems
- Quizzes
- Class Presentation/Discussion

**Text Book(s):**

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.

**Reference 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. Wellness Management A Lifestyle Approach for Health, Fitness and Energy - Rajasekhar Kali Venkata – Notion press

**CO-PO MAPPING**

<b>PO</b> <b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
DS23B12.1	1	3	1	2	2	1
DS23B12.2	2	3	1	2	2	1
DS23B12.3	2	3	1	1	3	-
DS23B12.4	2	3	1	1	3	-
DS23B12.5	2	3	1	1	3	1
<b>Average</b>	1.8	3	1	1.4	2.7	3

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
DS23B13	Applied Business Analytics	PE	3	0	0	3

Objectives:
<ul style="list-style-type: none"> <li>To understand the Analytics Life cycle.</li> </ul>
<ul style="list-style-type: none"> <li>To comprehend the process of acquiring Business Intelligence.</li> </ul>
<ul style="list-style-type: none"> <li>To understand various types of analytics for Business Forecasting.</li> </ul>
<ul style="list-style-type: none"> <li>To model the supply chain management for Analytics.</li> </ul>
<ul style="list-style-type: none"> <li>To apply analytics for Enterprise Reporting.</li> </ul>

UNIT I	Introduction	9
What is Business Analytics?- Evolution of Business Analytics-Scope of Business Analytics-Data for Business Analytics-models in Business Analytics-Problem Solving with Analytics		
UNIT II	Business Intelligence	9
BI Component Framework-Who is BI for?-BI users-BI Applications-BI roles and Responsibilities-Types of Decisions-Decision Support Systems-OPAL-Analytic functions.		
UNIT III	Business Forecasting	9
Qualitative and Judgmental Forecasting-Statistical Forecasting Models-Forecasting Models for stationary time series-Models for Time series with linear trend, seasonality and Selecting Appropriate Time-Series-Based Forecasting Models.		
UNIT IV	HR and Supply Chain Analytics	9
Human Resources-Planning and Recruitment-Training and development-Supply chain network-Planning Demand. Inventory and Supply-Logistics-Analytics applications in HR and Supply chain-Applying HR Analytics to make a prediction of the demand for hourly employees for a year.		
UNIT V	Enterprise Reporting	9
Reporting perspectives common to all levels of enterprise-Report standardization and Presentation Practices-Enterprise Reporting Characteristics in OLAP world-Balanced Scorecard-Dashboards-How to create Dashboard?-Scorecard vs. Dashboard.		
<b>Total Contact Hours: 45</b>		

Course Outcomes:
<ul style="list-style-type: none"> <li>Explain the real world business problems and model with analytical solutions.</li> </ul>
<ul style="list-style-type: none"> <li>Identify the business processes for extracting Business Intelligence.</li> </ul>
<ul style="list-style-type: none"> <li>Apply Predictive Analytics for business forecasting.</li> </ul>
<ul style="list-style-type: none"> <li>Apply Analytics for supply chain and logistics management.</li> </ul>
<ul style="list-style-type: none"> <li>Use Analytics for Enterprise Reporting.</li> </ul>

**SUGGESTED ACTIVITIES**

- Case study Discussion
- Flipped classroom – Comparing of Forecasting Models.
- Activity Based Learning  
Mind Mapping- Supply Chain network,  
Gallery Walk- HR Planning and Recruitment,  
Role Play- Decision Support Systems

**SUGGESTED EVALUATION METHODS**

- Mini Projects
- Assignment problems
- Quizzes

**Text Book(s):**

1. R. Evans James, Business Analytics, 2<sup>nd</sup> Edition, Pearson, 2017.

2. R.N. Prasad, Semma Archarya, Fundamentals of Business Analytics, 2<sup>nd</sup> Edition, Wiley, 2016.

**Reference Books(s) / Web links:**

1. Philip Kotler and Kevin Keller, Marketing Management, 15<sup>th</sup> Edition, PHI, 2016. 2.

2. VSP RAO, Human Resource Management, 3<sup>rd</sup> Edition, Excel Books, 2010.

**CO-PO MAPPING**

<b>PO</b> <b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
DS23B13.1	2	1	2	3	3	2
DS23B13.2	2	3	2	2	-	2
DS23B13.3	2	2	2	2	3	-
DS23B13.4	2	3	1	2	2	-
DS23B13.5	2	3	-	2	1	-
<b>Average</b>	2	2.4	1.75	2.2	2.25	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
DS23B14	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					

<b>UNIT-I</b>	<b>INTRODUCTION TO SUPPLY CHAIN</b>	<b>9</b>
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.		
<b>UNIT-II</b>	<b>NETWORK PLANNING AND VALUE OF INFORMATION</b>	<b>9</b>
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.		
<b>UNIT-III</b>	<b>DISTRIBUTION STRATEGY</b>	<b>9</b>
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.		
<b>UNIT-IV</b>	<b>LOGISTICS IN SUPPLY CHAIN</b>	<b>9</b>
Role of transportation in supply chain – factors affecting transportations decision – Design option for transportation network – Tailored transportation – Routing and scheduling in transportation. Introduction to Vendor Management – Challenges – Importance- Steps Involved in Vendor Management		
<b>UNIT-V</b>	<b>SUPPLY CHAIN AND INFORMATION TECHNOLOGY</b>	<b>9</b>
The role IT in supply chain- The supply chain IT frame work Customer Relationship Management – Internal supply chain management – supplier relationship management – future of IT in supply chain – E-Business in supply chain. Supply Chain with Information Technology-Case Study: Supply Chain Whirl-Technology Standard-IT standard -IT Infrastructure-SOA- RFID-Case Study: Amazon story of Dabbawallas.		
<b>Total Contact Hours</b>		<b>: 45</b>

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
•	Explore Design option for transportation network and Vendor Management.
•	Discuss the impacts of geo-political and technological trends/developments on the value chain.

**SUGGESTED ACTIVITIES (if any)**

## UNIT 1 / Introduction to Supply Chain Management

- A new practical game which helps students to understand how the concept of supply chain management (SCM) works.

**SUGGESTED EVALUATION METHODS**

- Assignment problems
- Quizzes
- Class Presentation/Discussion

**Text Book(s):**

1. Sunil Chopra, Peter Meindl and Kalra, "Supply Chain Management, Strategy, Planning, and Operation", Pearson Education, 2010.

2. Supply Chain and Logistics Management Made Easy, Paul A. Myerson, Person Education, Inc., 2015.

**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. Chadwick, T. and Rajagopal, S. (1995): Strategic Supply Management: An Implementation Toolkit, Butterworth-Heinemann, Oxford, UK.

4. Jeremy F. Shapiro. Modeling the Supply Chain. Duxbury Thomson Learning, 2001

5. <https://nptel.ac.in/courses/110107074/>

6. Journal: Supply Chain Management: An International Journal (Available on [www.emeraldinsight.com](http://www.emeraldinsight.com))

**CO-PO MAPPING**

PO CO	PO1	PO2	PO3	PO4	PO5	PO6
DS23B14.1	2	3	-	1	3	-
DS23B14.2	2	3	2	2	1	2
DS23B14.3	2	3	2	2	-	2
DS23B14.4	2	3	2	2	2	-
DS23B14.5	3	2	2	3	3	2
<b>Average</b>	2.2	2.8	2	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
DS23B15	Marketing and Retail Analytics	PE	3	0	0	3

Objectives:
<ul style="list-style-type: none"> <li>To understand the basic concepts of Marketing Analytics</li> </ul>
<ul style="list-style-type: none"> <li>Understand the marketing segmentation and various business strategy</li> </ul>
<ul style="list-style-type: none"> <li>Understand the dynamics of product, service and price analytics.</li> </ul>
<ul style="list-style-type: none"> <li>To understand the concept, process and management of retail business</li> </ul>
<ul style="list-style-type: none"> <li>To develop an understanding of the retail strategy and planning process</li> </ul>

UNIT-I	Introduction to Marketing Analytics	9
Meaning, characteristics, advantages and disadvantages of marketing analytics, Concept of marketing analytics, Analytical modelling and metrics in marketing, Market Data Sources (Primary and Secondary). Market Sizing: Stakeholders, Applications & Approaches (Top-down and Bottom-up), PESTLE Market Analysis, Porter Five Force Analysis.		
UNIT-II	Market Segmentation and Business Strategy	8
Market segmentation: market segmentation, target market, marketing positioning. Business strategy: strategic scenarios and strategic decision models, business forecasting, predictive analytics in marketing, data mining, balanced scorecard, critical success factors.		
UNIT-III	Product, Service and Price Analytics	9
Price Decisions - Pricing objectives - Pricing policies and constraints - Different pricing method - New product pricing, Product Mix pricing strategies and Price adjustment strategy ,Product and Service Analytics: Conjoint analysis, portfolio resource allocation, decision tree models, product and service metrics, attribute preference testing. Price analytics: pricing techniques and assessments, price metrics, profitable pricing, price discrimination		
UNIT-IV	Introduction to Retailing and Retail Planning Process	9
An overview of Retailing - Types of stores - Product Retailing vs. Service Retailing - Non store Retailing - Retail strategy - Achieving competitive advantage and positioning Retailing environment - Legal, Social, Economic, Technological, issues - Trends in the Indian Retailing Industry. Retail store location and layout - Country/Region analysis - Trade area analysis - Site evaluation and selection - Store design and layout - Comprehensive store planning - Exterior design and layout - Interior store design and layout - Interior design elements.		
UNIT-V	Retailing & Advertising Analysis Market Basket Analysis	11
Computing two way and three-way lift, RFM Analysis, Allocating Retail Space and Sales Resources: Identifying the sales to marketing effort relationship & its modeling, optimizing sales effort Advertising Analysis: Measuring the Effectiveness of Advertising, Pay per Click (PPC) Online Advertising		
<b>Total Contact Hours: 45</b>		

Course Outcomes:
<ul style="list-style-type: none"> <li>Understand the importance of marketing analytics for forward looking and systematic allocation of marketing resources</li> </ul>
<ul style="list-style-type: none"> <li>Comprehend the concept of marketing analytics and various analytical modelling. and understand the marketing segmentation and various business strategy.</li> </ul>
<ul style="list-style-type: none"> <li>Students will develop analytical skill for effective market decision making in real life environment.</li> </ul>
<ul style="list-style-type: none"> <li>Understand the impact of retailing on the economy and Understand the functions of retail business and</li> </ul>

various retail formats

- Understand how retailing fits within the broader disciplines of business and marketing

#### **SUGGESTED ACTIVITIES**

- Group Discussions
- Writing review of literature
- Presentations
- Case study

#### **SUGGESTED EVALUATION METHODS**

- Assignment topics
- Quizzes
- Class Presentation/Discussion
- Continuous Assessment Tests

#### **Text Book(s):**

1. Sorger, S. ,Marketing Analytics: Strategic Models and Metrics, Admiral Press, 2013
2. Winston, W.L. Marketing Analytics: Data-Driven Techniques with Microsoft Excel, Wiley, First Edition, 2014
3. Chetan Bajaj, Tuli & Srivastava, RETAIL MANAGEMENT, Oxford University Press, New Delhi.2010
4. Giridhar Joshi, INFORMATION TECHNOLOGY FOR RETAIL, Oxford University Press, New Delhi.2009

#### **Reference Books(s) / Web links:**

1. Gary Lilen, Arvind Rangaswamy,and Arnaud DeBruyn,Marketing Engineering and Analytics, Decision Pro, Inc.
2. Mike Grigby “ Marketing Analytics” 2nd Edition 2018, Kogan page
3. Swapna Pradhan, RETAIL MANAGEMENT, TEXT & CASES, Tata McGraw-Hill Publishing company, New Delhi, 2008.
4. Ron Hasty and James Reardon, RETAIL MANAGEMENT. McGraw-Hill Publication, International Edition

## CO-PO MAPPING

<b>PO</b> <b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
DS23B15.1	3	2	2	3	-	-
DS23B15.2	3	2	3	3	-	2
DS23B15.3	2	3	-	3	3	2
DS23B15.4	3	2	2	3	2	2
DS23B15.5	3	2	2	2	2	2
<b>Average</b>	2.8	2.2	1.8	2.8	2.33	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
DS23B16	Financial and Risk Analytics	PE	3	0	0	3

Objectives:
<ul style="list-style-type: none"> <li>To understand the basics of Financial and Risk Analytics</li> </ul>
<ul style="list-style-type: none"> <li>To learn the basics of Financial Research and Operational Risk</li> </ul>
<ul style="list-style-type: none"> <li>To study the financial decision making and Risk Management</li> </ul>
<ul style="list-style-type: none"> <li>To learn the Functional Framework for Evaluating Financial Visualization Products</li> </ul>
<ul style="list-style-type: none"> <li>To learn and implement preserving digital records</li> </ul>

UNIT-I	INTRODUCTION TO FINANCIAL AND RISK ANALYTICS	9
<p>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.</p>		
UNIT-II	THE OFFICE ON FINANCIAL RESEARCH AND OPERATIONAL RISK	9
<p>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.</p>		
UNIT-III	FINANCIAL DECISION MAKING AND RISK MANAGEMENT	9
<p>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</p>		
UNIT-IV	A FUNCTIONAL FRAMEWORK FOR EVALUATING FINANCIAL VISUALIZATION PRODUCTS	9
<p>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.</p>		

<b>UNIT-V</b>	<b>PRESERVING DIGITAL RECORDS</b>	<b>9</b>
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.		
<b>Total Contact Hours:45</b>		
<b>Course Outcomes:</b>		
<b>On completion of the course, students will be able to</b>		
<ul style="list-style-type: none"> <li>● Have experience in the basics of Financial and Risk Analytics</li> </ul>		
<ul style="list-style-type: none"> <li>● Apply programming knowledge of Operational Risk</li> </ul>		
<ul style="list-style-type: none"> <li>● Manage financial decision making and Risk Management</li> </ul>		
<ul style="list-style-type: none"> <li>● Gain how to evaluate Financial Visualization Products.</li> </ul>		
<ul style="list-style-type: none"> <li>● Apply knowledge in implementing preserving digital records</li> </ul>		

<b>Text Book(s):</b>
1. Dennis G. Uyemura, Donald R. van Deventer , Financial Risk Analytics: A Term Structure Model Approach for Banking, Insurance, & Investment Management, Irwin Professional Publishing ,1996.
2. Victoria Lemieux Financial Analysis and Risk Management: Data Governance, Analytics and Life Cycle Management, 2013 Edition, Kindle Edition, Springer.
3. Bart Baesens , Daniel Roesch, Credit Risk Analytics: Measurement Techniques, Applications, and Examples in SAS, 1st Edition, Kindle Edition, Wiley, 2016

<b>Reference Books(s) / Web links:</b>
1. Jimmy Skoglund, Financial Risk Management, Applications in Market, Credit, Asset and Liability Management and Firmwide Risk, Wiley, 2015.
2. Mark J. Bennett, Dirk L. Hugen , Financial Analytics with R : Building a Laptop Laboratory for Data Science, 1 <sup>st</sup> Edition, Cambridge University Press, 2016.

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### CO-PO MAPPING

<b>PO CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
DS23B16.1	3		2	2	2	-
DS23B16.2	2	3	2	3	-	1
DS23B16.3	2	3	2	2	-	1
DS23B16.4	2	3	2	3	2	1
DS23B16.5	2	3	2	3	2	2
<b>Average</b>	2.2	3	2	2.	2	1.25

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
DS23B17	Recommender System	PE	3	0	0	3

Objectives:
<ul style="list-style-type: none"> <li>Basics of Linear Algebra and issues of Recommender System</li> </ul>
<ul style="list-style-type: none"> <li>Collaborative Filtering Models</li> </ul>
<ul style="list-style-type: none"> <li>Methods of Recommender System</li> </ul>
<ul style="list-style-type: none"> <li>Various Design Strategies in Recommender System</li> </ul>
<ul style="list-style-type: none"> <li>Evaluation Procedures</li> </ul>

<b>UNIT-I</b>	<b>Introduction</b>	9
Recommender system functions, Linear Algebra notation: Matrix addition, Multiplication, transposition, and inverses; covariance matrices, Understanding ratings, Applications of recommendation systems, Issues with Recommender system.		
<b>UNIT-II</b>	<b>Collaborative Filtering</b>	9
User-based nearest neighbour recommendation, Item based nearest neighbour recommendation, Model based and pre-processing based approaches, Attacks on collaborative Recommender systems		
<b>UNIT-III</b>	<b>Content-based recommendation</b>	9
High level architecture of content-based systems, Advantages and drawbacks of content based filtering, Item profiles, Discovering features of documents, Obtaining item features from tags, Representing item profiles, Methods for learning user profiles, Similarity based retrieval, Classification algorithms.		
<b>UNIT-IV</b>	<b>Knowledge based recommendation and Hybrid approaches</b>	9
Knowledge representation and reasoning, Constraint based Recommender, Case based Recommender Opportunities for hybridization, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade Meta-level, Limitations of hybridization strategies.		
<b>UNIT-V</b>	<b>Evaluating Recommender System</b>	9
Introduction, General properties of evaluation research, Evaluation designs, Evaluation on historical datasets, Error metrics, Decision-Support metrics, User-Centered metrics		
<b>Total Contact Hours:45</b>		

Course Outcomes: On completion of the course the students will be able to learn
<ul style="list-style-type: none"> <li>To understand basic techniques and problems in the field of Recommender systems</li> </ul>
<ul style="list-style-type: none"> <li>Evaluate Types of Recommender systems: non-personalized, content based, collaborative filtering</li> </ul>
<ul style="list-style-type: none"> <li>Apply algorithms and techniques to develop Recommender Systems that are widely used in the Internet industry</li> </ul>
<ul style="list-style-type: none"> <li>To develop state-of-the-art Recommender systems</li> </ul>
<ul style="list-style-type: none"> <li>To know the evaluation of Recommender systems</li> </ul>

**SUGGESTED ACTIVITIES (if any) (UNIT/ Module Wise) – Could suggest topic**

- Quizzes

**SUGGESTED EVALUATION METHODS**

- Class Presentation/Discussion

**Text Book(s):**

1. Jannach D., Zanker M. and FelFering A., Recommender Systems: An Introduction, Press, Illustrated Edition, Cambridge University Press, 2010

**Reference Books(s) / Web links:**

1. Ricci F., Rokach L., Shapira D., Kantor B.P., Recommender Systems Handbook, 2011 edition, kindle edition, Springer Publisher

2. Manouselis N., Drachsler H., Verbert K., Duval E., Recommender Systems For Learning, (SpringerBriefs in Electrical and Computer Engineering Book 0) 2013th Edition, Kindle Edition, Springer Publisher

**CO-PO MAPPING**

<b>PO</b> <b>CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
DS23B17.1	3	2	-	2	-	-
DS23B17.2	-	3	3	3	3	3
DS23B17.3	2	3	2	3	2	2
DS23B17.4	2	3	2	3	2	-
DS23B17.5	2	3	2	3	3	3
<b>Average</b>	<b>2.25</b>	<b>2.8</b>	<b>2.25</b>	<b>2.8</b>	<b>2.5</b>	<b>2.7</b>

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
CP23B14	Predictive Modeling	PE	3	0	0	3

Objectives:	
•	To understand the terms and terminologies of predictive modeling.
•	To study the various predictive models, their merits, demerits and application.
•	To get exposure to various analytical tools available for predictive modeling.
•	To learn the predictive modeling markup language.
•	To get familiar with the technologies in predictive modeling.

UNIT I	INTRODUCTION TO PREDICTIVE MODELING	9
Core ideas in data mining - Supervised and unsupervised learning - Classification vs. Prediction - Steps in data mining- SEMMA Approach - Sampling -Pre-processing - Data cleaning - Data Partitioning - Building a model - Statistical models - Statistical models for predictive analytics.		
UNIT II	PREDICTIVE MODELING BASICS	9
Data splitting – Balancing- Over fitting –Oversampling –Multiple Regression Artificial neural networks (MLP) - Variable importance- Profit/loss/prior probabilities - Model specification - Model selection - Multivariate Analysis.		
UNIT III	PREDICTIVE MODELS	9
Association Rules-Clustering Models –Decision Trees- Ruleset Models- KNearest Neighbors – Naive Bayes - Neural Network Model – Regression Models – Regression Trees – Classification & Regression Trees (CART) – Logistic Regression – Multiple Linear Regression Scorecards – Support Vector Machines – Time Series Models - Comparison between models - Lift chart Assessment of a single model.		
UNIT IV	PREDICTIVE MODELING MARKUP LANGUAGE	9
Introduction to PMML – PMML Converter - PMML Structure – Data Manipulation in PMML – PMML Modeling Techniques - Multiple Model Support – Model Verification.		
UNIT V	TECHNOLOGIES AND CASE STUDIES	9
Weka – RapidMiner – IBM SPSS Statistics- IBM SPSS Modeler – SAS Enterprise Miner – Apache Mahout – R Programming Language.-Real time case study with modeling and analysis.		
		<b>Total Contact Hours</b> : <b>45</b>

Course Outcomes:	
On completion of course students will be able to	
•	Design and analyze appropriate predictive models.
•	Define the predictive models using PMML.
•	Apply statistical tools for analysis.
•	Use various analytical tools available for predictive modeling.
•	Apply predictive modeling markup language in data manipulation.

**SUGGESTED ACTIVITIES**

- Problem solving sessions
- Mini Projects

**SUGGESTED EVALUATION METHODS**

- Tutorial problems
- Assignment problems
- Quizzes
- Class Presentation/Discussion

**Text Book(s):**

1. Jannach D., Zanker M. and FelFering A., Recommender Systems: An Introduction, Press, Illustrated Edition, Cambridge University Press, 2010

**REFERENCE BOOKS / WEB LINKS:**

1. Kattamuri S. Sarma, “Predictive Modeling with SAS Enterprise Miner: Practical Solutions for Business Applications”, 3rd Edition, SAS Publishing, 2017.
2. Alex Guazzelli, Wen-Ching Lin, Tridivesh Jena, James Taylor, “PMML in Action Unleashing the Power of Open Standards for Data Mining and Predictive Analytics”, 2nd Edition, Create Space Independent Publishing Platform, 2012.
3. Ian H. Witten, Eibe Frank, “Data Mining: Practical Machine Learning Tools and Techniques”, Morgan Kaufmann Series in Data Management Systems, Morgan Kaufmann, 3rd Edition, 2011.
4. Eric Siegel, “Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die”, 2nd Edition, Wiley, 2016.
5. Conrad Carlberg, “Predictive Analytics: Microsoft Excel”, 1st Edition, Que Publishing, 2012.
6. Jeremy Howard, Margit Zwemer, Mike Loukides, “Designing Great Data Products- Inside the Drivetrain train Approach, a Four-Step Process for Building Data Products – Ebook”, 1st Edition, O'Reilly Media, March 2012.

**WEB REFERENCES:**

1. <https://nptel.ac.in/courses/108108111/>
2. <https://www.coursera.org/learn/predictive-modeling-analytics>

**ONLINE RESOURCES:**

1. <https://bookdown.org/egarpor/PM-UC3M/>
2. <https://cics.nd.edu/research/applications/materials/>

Subject Code	Subject Name (Lab Oriented Theory Course)	Category	L	T	P	C
DS23031	Python For Data Science	OE	2	0	2	3
<b>Objectives:</b>						
<ul style="list-style-type: none"> <li>• Have a thorough understanding of the Supervised learning techniques</li> <li>• Study the various probability-based learning techniques</li> <li>• Know the basic concepts of decision tree and unsupervised models</li> <li>• Familiarize the basic concepts of neural networks.</li> <li>• Understand the working of graphical models of machine learning algorithms.</li> </ul>						

<b>UNIT-I</b>	<b>INTRODUCTION TO DATA SCIENCE</b>	6
Introduction - Data Science, 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, ANOVA		
<b>UNIT-II</b>	<b>REGRESSION MODELS</b>	6
The Machine Learning Landscape – Types of Machine Learning – Main Challenges of Machine Learning – Testing and Validating – End to End Machine Learning Project – Regression: Linear Regression – Training Models - Polynomial Regression – Other Regression Models: Lasso, Ridge regression, ElasticNet - Logistic Regression.		
<b>UNIT-III</b>	<b>LINEAR MODELS</b>	6
Revisiting Core ML concept: Bias-variance trade-off. Classification using support vectors: – Linear SVM classification – Nonlinear SVM classification. Probabilistic classifier: Classification using Naïve Bayes. Decision trees: Training and Visualizing a Decision Tree - Making Predictions - Estimating Class Probabilities - The CART Training Algorithm - Computational Complexity - Gini Impurity or Entropy - Regularization Hyperparameters.		
<b>UNIT-IV</b>	<b>UNSUPERVISED LEARNING AND TREE MODELS</b>	6
Unsupervised Learning Techniques: Clustering: K-Means - Limits of K-Means - Using Clustering for Image Segmentation - Using Clustering for Pre-processing - Using Clustering for Semi-Supervised Learning - DBSCAN - Other Clustering Algorithms. Ensemble learning and Random Forests: Voting Classifiers - Bagging and Pasting - Random Forests - Extra- Trees - Feature Importance – Boosting AdaBoost - Gradient Boosting		
<b>UNIT-V</b>	<b>INTRODUCTION TO NEURAL NETWORKS</b>	6
Introduction to Artificial Neural Networks with Keras - Biological Neurons - Logical Computations with Neurons - The Perceptron - The Multilayer Perceptron and Backpropagation Regression MLPs - Classification MLPs		
<b>Contact Hours:</b>		<b>30</b>

<b>List of Experiments</b>		
1	A python program to perform pre-processing on tabular, text and Image data.	
2	A python program to do a data exploratory analysis to develop deep insights from a dataset.	
3	A python program to implement linear and polynomial regression.	
4	A python program to implement logistic regression algorithm.	
5	A python program to implement decision tree and Random forest algorithms.	
6	A python program to implement Naïve Bayes classification algorithm.	
7	A python program to analyze the difference in accuracy between perceptron vs logistic Regression.	
8	A python program perform Face Recognition using Support Vector Machines.	
9	A python program to implement neural networks.	
10	A mini project implementing the techniques learnt for a socially relevant problem statement.	
<b>Contact Hours</b>		<b>: 15</b>
<b>Total Contact Hours</b>		<b>: 45</b>

**Course Outcomes:**

On completion of the course, the students will be able to

- Distinguish between, supervised, unsupervised and semi-supervised learning.
- Modify existing machine learning algorithms to improve classification efficiency.
- Use unsupervised models for clustering data.
- Build a basic neural network for real-time data.
- Design systems that uses the appropriate graph models of machine learning.

**SUGGESTED ACTIVITIES (if any) (UNIT/ Module Wise) – Could suggest topic**

- Problem solving sessions
- Activity Based Learning
- Implementation of small module

**SUGGESTED EVALUATION METHODS (if Any) (UNIT/ Module Wise) – could suggest topic**

- Tutorial problems
- Assignment problems
- Quizzes
- Class Presentation/Discussion

**Text Book(s):**

1. AurélienGéron, “Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow”, 2nd Edition. September 2019, O’Reilly Media, Inc.,
2. Stephen Marsland, “Machine Learning – An Algorithmic Perspective”, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
3. Richard O.Duda, Peter E. Hard, David G. Stork, Pattern Recognition, 2ed, An Indian Adaptation, Wiley, May 2021

**Reference Book(s)/Web link(s)**

1. Peter Flach, “Machine Learning: The Art and Science of Algorithms that Make Sense of Data”, First Edition, Cambridge University Press, 2012.
2. Tom M Mitchell, “Machine Learning”, First Edition, McGraw Hill Education, 2013.
3. Trevor Hastie, Robert Tibshirani and Jerome Friedman, “The Elements of Statistical Learning (ESL)”, 2<sup>nd</sup> edition, Springer, 2016.

### CO-PO MAPPING

<b>PO CO</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
DS23O31.1	2	3	-	-	-	-
DS23O31.2	2	3	2	3	2	2
DS23O31.3	2	3	-	2	2	-
DS23O31.4	2	3	2	3	3	2
DS23O31.5	2	3	2	3	3	2
<b>Average</b>	2	3	2	5.5	2.75	2

Correlation levels 1, 2 or 3 are as defined below:

1: Slight (Low) 2: Moderate (Medium)

3: Substantial (High) No correlation : “-“