Curriculum Framework and Syllabus for

Master of Science (M.Sc) in Data Science

For the students admitted from the academic year 2019-2020

(BASED ON CHOICE BASED CREDIT SYSTEM (CBCS))

2019-2020

Board of Studies (Post Graduate) Meeting was held on 22.09.2018 and

Approved by Academic Council on 10.04.2019

POST GRADUATE DEPARTMENT OF DATA SCIENCE

NEHRU MEMORIAL COLLEGE

[Nationally Accredited with 'A' Grade by NAAC]
An Autonomous College affiliated to Bharathidasan University
Puthanampatti—621 007

NEHRU MEMORIAL COLLEGE

[Nationally Accredited with 'A' Grade by NAAC]
An Autonomous College affiliated to Bharathidasan University
Puthanampatti—621 007

POST GRADUATE DEPARTMENT OF DATA SCIENCE

In the Golden Jubilee (1967-2017) celebration of our college, we are the first institution to introduce Data Science programs under Bharathidasan University affiliated colleges in the academic year 2017-2018.

Data Science is the study of generalizable extraction of knowledge from data. Being a data scientist requires an integrated skill set spanning mathematics, statistics, machine learning, databases and other branches of computer science along with a good understanding of the craft of problem formulation to engineer effective solutions. This course will introduce students to this rapidly growing field and equip them with some of its basic principles and tools. Students will learn concepts, techniques and tools they need to deal with various facets of data science practice, including data collection and integration, exploratory data analysis, predictive modelling, descriptive modelling. The focus in the treatment of these topics will be on breadth, rather than depth, and emphasis will be placed on integration and synthesis of concepts and their application to solving problems. To make the learning contextual, real datasets from a variety of disciplines will be used.

Vision

Towards enlighten enhance ensure knowledge conforming to international standards.

Mission

To be seamless platform for engagement between industry and public research in big data analytics.

To nurture data science innovative solutions to address real-world challenges.

NEHRU MEMORIAL COLLEGE

[Nationally Accredited with 'A' Grade by NAAC]
An Autonomous College affiliated to Bharathidasan University
Puthanampatti—621 007

POST GRADUATE DEPARTMENT OF DATA SCIENCE

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO1: Prepare graduates to become data professionals with comprehensive knowledge

PEO2: Prepare graduates to become continuous learner with societal focus

PEO3: Prepare graduates to become data scientist/data analyst/ Entrepreneurs in the Data Science industry

PEO4: To inspire the students to involve in data science competitions

PROGRAMME OUTCOME (PO)

PO1: Become knowledgeable in the subject of DATA SCIENCE and apply the principles of the same to the needs of the Employer/Institution/Enterprise/Society

PO2: Gain Analytical skills in the in the field/area of DATA SCIENCE

PO3: Understand and appreciate professional's ethics, community living and nation Building initiatives

PO4: To classify the relevant problems and understand the methods in data science

PO5: To apply the acquired knowledge to devise solutions to solve the real world problems

PO6: To distil complex data into actionable insights and analyse the methodology

PROGRAMME SPECIFIC OUTCOME (PSO)

PSO1: Apply Knowledge of data science in the domain of mathematics and computer science.

PSO2: solve the complex problems in the field of data science with an understanding of the societal, legal, and cultural impacts of the solution

PSO3: To provide a comprehensive understanding of machine learning techniques

PSO4: To introduce data analytics for various domain of interest

PSO5: To experience in implementation of methods involved in Data Science

NEHRU MEMORIAL COLLEGE

Curriculum for M.Sc. Data Science –Batch 2019 onwards

PROGRAM STRUCTURE

- **Program Duration** **:** 2 Years
- **Medium of Instruction** **:** English
- **Credit System** **: Total number of credits: 90**
- **Mandatory attendance to appear for examination:** Attendance**:** 75%

Overview of the Curriculum					
Semester	**Core course**	**Elective course**	**Practical**	**Project**	**Total**
Semester 1	4	--	1	--	24
Semester 2	2	2 (CEC-1, OECC-1)	1		22
Semester 3	2	2	1		22
Semester 4	2	1	1	1	22

Total:90

CREDIT DISTRIBUTION			
S.NO	**CATEGORY OF COURSES**	**CREDITS**	**% OF CREDITS TO TOTAL CREDITS**
1	Core Courses (10)	50	55.6
2	Core Practicals (4)	16	17.8
3	Elective Course (5) – [CEC-4 + OEC-1]	20	22.2
4	Project (1)	04	04.4
	Total	**90**	**100**

PROGRAM CORE, ELECTIVE, OPEN ELECTIVE AND PRATICAL COURSES

SEMESTER	**NUMBER OF CORE COURSES**	**CREDITS**	**NUMBER OF ELECTIVE COURSES (CEC-4,OEC-1)**	**CREDITS**	**NUMBEROF PRACTICALS /PROJECTS**	**CREDITS**
1	4	20			1	4
2	2	10	2 (CEC-1,OEC-1)	8	1	4
3	2	10	2	8	1	4
4	2	10	1	4	2	8
	Total credits for core courses (10)	**50**	**Total credits for elective courses (5)**	**20**	**Total credits for practical and projects (4+1)**	**20**

NEHRU MEMORIAL COLLEGE

Curriculum for M.Sc. Data Science – Batch 2019 onwards

Average Percentage of the Courses having Focus on Skills, Employability and Knowledge

Courses	Employability	Skill	Knowledge based	
CC-I			**Y**	
CC-II			**Y**	
CC-III			**Y**	
CC-IV		**Y**		
CC-V	**Y**			
CC-VI		**Y**		
CC-VII			**Y**	
CC-VIII	**Y**			
CC-IX			**Y**	
CC-X		**Y**		
CC-XI	**Y**			
CC-XII			**Y**	
CC-XIII		**Y**		
CC-XIV	**Y**			
CC-XV	**Y**			
CEC-I	**Y**			
OEC-I			**Y**	
CEC-II		**Y**		
CEC-III			**Y**	
CEC-IV	**Y**			
Total	7	5	8	
Percentage	**36.84**	**26.32**	**36.84**	**100**

NEHRU MEMORIAL COLLEGE

Curriculum for M.Sc. Data Science – Batch 2019 onwards

Revised syllabus -2019(percentage of modification of syllabus from 2017 syllabus)

Core Courses

Mathematics for Data Science
Advanced Data Base Systems
Data Mining Techniques
Information Security
Database Systems & Data mining lab
Probability and Statistical Computing
Artificial Intelligence and Machine Learning
Machine Learning Lab (Python/R)
Multivariate Techniques
Big Data Analytics
Big Data Analytics –Lab
Deep Learning
Predictive Analytics
Predictive Analytics –Lab

Core Elective Courses

Python Programming
R Programming
Natural Language Processing
Financial Risk Analytics
Cloud and Web Intelligence
Customer Relationship Management
Business Intelligence
Image and Video Analytics

Open Elective Courses

Social Media Mining
Health Care Data Analytics

Project

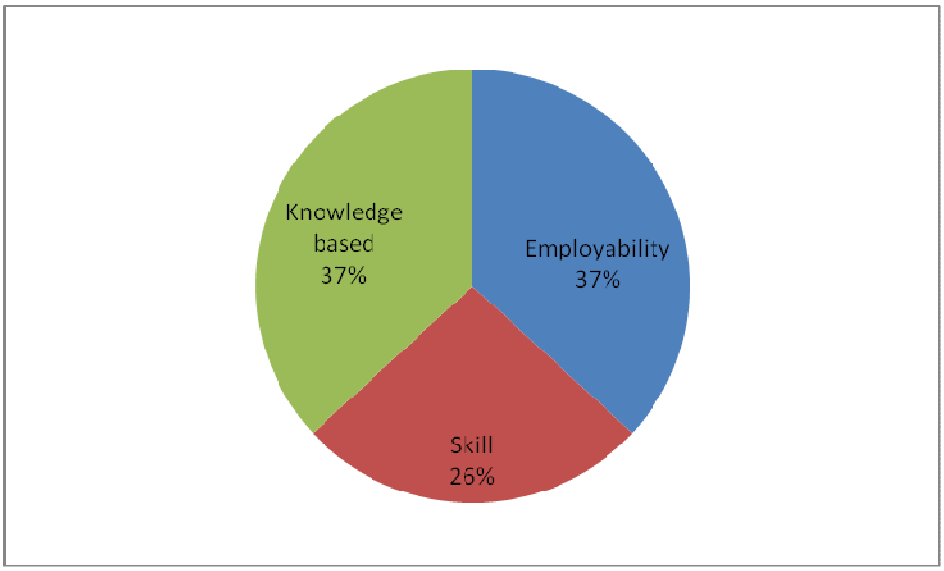
Project /Internship

The following new courses are introduced in the revised syllabus

Business Intelligence
Natural Language Processing
Social Media Mining
Customer Relationship Management
Financial Risk Analytics
Health Care Data Analytics
Deep Learning
Image and Video Analytics

Revised Syllabus-2019

Employability	36.84
Skill	26.32
Knowledge based	36.84



NEHRU MEMORIAL COLLEGE

Curriculum for M.Sc. Data Science – Batch 2019 onwards

Objectives of the Programme:

1. Prepare graduates to become data professionals with comprehensive knowledge
2. Prepare graduates to become continuous learner with societal focus
3. Prepare graduates to become data scientist/data analyst/ Entrepreneurs in the Data Science industry

The board of studies for Post Graduate Data Science Department includes the following members:

Chairman:

Mrs. S. MALA, **M.C.A., M.B.A., M.Phil. (Ph.D)**
Assistant Professor Department of Data Science Nehru Memorial College Puthanampatti

University Representative

Dr. P. MURUGANANTHAM, M.SC., B.ED., PGDCA. M.Phil., Ph.D.,
Associate Professor Department of Mathematics
Jamal Mohamed College (Autonomous)
Tiruchirappalli – 620 020

Subject Experts:

Dr. U.SRINIVASULU REDDY MCA., M.Phil., Ph.D.,
Assistant Professor, Department of Computer Applications
National Institute of Technology, Tiruchirappalli – 620 015.

Dr. P. KALAVATHI, M.C.A., M.Phil., Ph.D.,
Professor & Head, Department of Computer Science& Applications
The Gandhigram Rural Institute,Gandhigram 624 302

Alumni Representative

Mr. MADHU PRASAD RAMALINGAM
Associate Tech Lead, Encoretheme Technologies, Chennai

Board Members:

DR.A.R.PONPERIASAMY M.Sc(Phy)., M.Sc(CS).,PGDCA.,M.C.A., M.Phil.,Ph.D.,
Principal and Professor of Computer Science, Nehru Memorial College
Mrs. S. MALA, M.C.A., MBA, M.Phil. (Ph.D)
Assistant Professor in Data Science, Nehru Memorial College
Ms. P. KALPANA, M.Sc., M.Phil. M.B.A., SET. (Ph.D)
Assistant Professor in Computer Science, Nehru Memorial College
Dr. K. SRIDEVI, M.Sc., M.Phil. SET. NET., Ph.D
Assistant Professor in Computer Science, Nehru Memorial College
Mr. T. YOGESWARAN, M.Sc., M.Phil.
Assistant Professor in Mathematics, Nehru Memorial College

NEHRU MEMORIAL COLLEGE

M.Sc. Data Science – Course Structure under CBCS - Batch 2019 onwards

Sem	Course	Course Code	Subjects	Ins. Hrs/ Week	Crs	Exam Hrs	Marks		
							Int	Ext	Total
I	CC-I	19PDS101	Mathematics for Data Science	6	5	3	25	75	100
	CC-II	19PDS102	Advanced Data Base Systems	6	5	3	25	75	100
	CC-III	19PDS103	Data Mining Techniques	6	5	3	25	75	100
	CC-IV	19PDS104	Information Security	6	5	3	25	75	100
	CC-V	19PDS105L	Data Base Systems & Data Mining Lab	6	4	3		60	100
	TOTAL			**30**	**24**				**500**
II	CC-VI	19PDS206	Probability and Statistical Computing	6	5	3	25	75	100
	CC-VII	19PDS207	Artificial Intelligence and Machine Learning	6	5	3	25	75	100
	CC-VIII	19PDS208L	Machine Learning Lab (Python/R)	6	4	3	40	60	100
	CEC-I	19PDS215a	Python Programming	6	4	3	25	75	100
		19PDS215b	R Programming						
	OEC-I	19PDS216a	Health Care Data Analytics	6	4	3	25	75	100
		19PDS216b	Social Media Mining						
	TOTAL			**30**	**22**				**500**
III	CC-IX	19PDS309	Multivariate Techniques	6	5	3	25	75	100
	CC-X	19PDS310	Big Data Analytics	6	5	3	25	75	100
	CC-XI	19PDS311 L	Big Data Analytics –Lab	6	4	3	40	60	100
	CEC-II	19PDS317a	Natural Language Processing						
		19PDS317b	Financial Risk Analytics	6	4	3	25	75	100
	CEC-III	19PDS318a	Cloud and Web Intelligence						
		19PDS318b	Customer Relationship Management	6	4	3	25	75	100
	TOTAL			**30**	**22**				**500**
IV	CC-XII	19PDS412	Deep Learning	6	5	3	25	75	100
	CC-XIII	19PDS413	Predictive Analytics	6	5	3	25	75	100
	CC-XIV	19PDS414	Predictive Analytics –Lab	6	4	3	40	60	100
	CEC-IV	19PDS419a	Business Intelligence						
		19PDS419b	Image and Video Analytics	6	4	3	25	75	100
	Project	19PDS420 L	Internship/Project Work	6	4	-	25	75	100
	TOTAL			**30**	**22**				**500**
				120	**90**				**2000**

Note: Course : CC - Core Course CEC - Core Elective Course OEC – Open Elective Course , Course Code: 19: Year, PDS: Post graduate Data Science, 101: Subject numerical code of subjects, L refers Lab.

	Core course		Electives		Practicals	Total credits
I	CC-I (5) Mathematics for data science	CC-II (5) Advanced data base systems	CC-III (5) Data Mining Techniques	CC-IV (5) Information Security	CC-V (4) Database (SQL) & Mining lab	24
II	CC-VI (5) Probability and Statistical Computing	CC-VII (5) Artificial Intelligence & Machine Learning	CEC – I (4) Python programming R programming	OEC-I (4) Health Care Data Analytics Social Media Mining	CC-VIII (4) Machine Learning (Python/R lab)	22
III	CC-IX (5) Multivariate Techniques	CC-X (5) Big Data Analytics	CEC-II (4) Natural Language Processing Financial Risk Analytics	CEC-III (4) Cloud and Web Intelligence CRM	CC-XI (4) Big Data Analytics lab (Hadoop , Mongo DB)	22
IV	CC-XII (5) Deep Learning	CC-XIII (5) Predictive analytics	CEC-IV (4) Business Intelligence Image & Video Analytics	CC-XV (4) Project / Internship	CC-XIV (4) Predictive Analytics lab (Rapid Miner)	22

NEHRU MEMORIAL COLLEGE

M.Sc. Data Science – Course Structure under CBCS - Batch 2019 onwards

Sem	Course	Course code	Subjects	L	T	P	C
I	CC-I	19PDS101	Mathematics for Data Science	6	6	0	5
	CC-II	19PDS102	Advanced Data Base Systems	6	6	0	5
	CC-III	19PDS103	Data Mining Techniques	6	6	0	5
	CC-IV	19PDS104	Information Security	6	6	0	5
	CC-V	19PDS105L	Data Base Systems & Data Mining Lab	6	0	6	4
II	CC-VI	19PDS206	Probability and Statistical Computing	6	6	0	5
	CC-VII	19PDS207	Artificial Intelligence and Machine Learning	6	6	0	5
	CC-VIII	19PDS208L	Machine Learning Lab (Python/R)	6	0	6	4
	CEC-I	19PDS215a	Python Programming	6	6	0	4
		19PDS215b	R Programming		6	0	
	OEC-I	19PDS216a	Health Care Data Analytics	6	6	0	4
		19PDS216b	Social Media Mining		6	0	
III	CC-IX	19PDS309	Multivariate Techniques	6	6	0	5
	CC-X	19PDS310	Big Data Analytics	6	6	0	5
	CC-XI	19PDS311L	Big Data Analytics –Lab	6	0	6	4
	CEC-II	19PDS317a	Natural Language Processing		6	0	
		19PDS317b	Financial Risk Analytics	6	6	0	4
	CEC-III	19PDS318a	Cloud and Web Intelligence		6	0	
		19PDS318b	Customer Relationship Management	6	6	0	4
IV	CC-XII	19PDS412	Deep Learning	6	6	0	5
	CC-XIII	19PDS413	Predictive Analytics	6	6	0	5
	CC-XIV	19PDS414L	Predictive Analytics –Lab	6	0	6	4
	CEC-IV	19PDS419a	Business Intelligence		6	0	
		19PDS419b	Image and Video Analytics	6	6	0	4
	PROJECT	19PDS420L	Internship/Project Work	6	0	6	4
			GRAND TOTAL	**120**			**90**

L: LECTURE|T:THEROY|P:PRACTICAL|C: CREDITS

NEHRU MEMORIAL COLLEGE

M.Sc. Data Science – Course Structure under CBCS - Batch 2019 onwards

LIST OF ELECTIVES COURSES

Sem	Course	Course Code	Subjects
II	CEC-I	19PDS115a	Python Programming
II	CEC-I	19PDS115a	R Programming
II	OEC-I	19PDS216a	Health Care Data Analytics
II	OEC-I	19PDS216b	Social Media Mining
III	CEC-II	19PDS217a	Natural Language Processing
III	CEC-II	19PDS217b	Financial Risk Analytics
III	CEC-III	19PDS318a	Cloud and Web Intelligence
III	CEC-III	19PDS318b	Customer Relationship Management
IV	CEC-V	19PDS419a	Business Intelligence
IV	CEC-V	19PDS419b	Image and Video Analytics

NEHRU MEMORIAL COLLEGE

M.Sc. Data Science – Course Structure under CBCS - Batch 2019 onwards

INTERNAL AND EXTERNAL ASSESSMENT

Theory

Internal: 25marks

Distribution	Marks
Seminar	5
Assignment	5
CIA Test I	7.5
CIA Test II	7.5
Total	**25**

External: 75 marks

Question Paper Pattern for Internal and External Assessment:

Section A: 20 Questions x 2 Mark = 20 Marks
(Two Questions from each unit)
Section B: 5 Questions x 5 Marks = 25 Marks
(Internal Choice and one question from each unit)
Section C: 3 Questions x 10 Marks = 30 Marks
(Answer any three out of 5 questions and one question from each unit)

Practical

Internal: 40 marks

Marks Distribution: Test1 = 15 Marks
Test2 =15 Marks
Observation =10 Marks
Total = 40 Marks

External: 60 marks

Marks Distribution: Practical = 50 Marks
Record = 10 Marks
Total = 60 Marks

Project: 100 marks

Marks Distribution: Internal (2 reviews) : 25 Marks
Report Evaluation : 50 Marks
Viva Voce : 25 Marks
Total : 100 Marks (25+75)

NEHRU MEMORIAL COLLEGE

M.Sc. Data Science – Course Structure under CBCS - Batch 2019 onwards

Knowledge Level

K1-Acquire/Remember; **k2**-Understanding; **k3**-Apply; **k4**-Evaluate; **k5**-Analyze

1. Part-I, II and III

Theory (External + Internal=75+25=100 marks)

External/Internal				
Knowledge Level	**Section**	**Marks**	**Hrs**	**Total**
K1-k4	**A(Answer all)**	**10x2=20**	**3**	**75**
K3-k5	**B(Either or Pattern)**	**5 x5 =25**		
K1,k3-k5	**C(Answer 3 out of 5)**	**3x10=30**		

Internal				
Components	**Maximum Marks**	**Conversion**	**Hrs**	**Total**
CA1	**75**	**7.5**	**3**	**25**
CA2	**75**	**7.5**	**3**	
Seminar	**20**	**5**	**-**	
Assignment	**20**	**5**		
			Total	**100**

Class	Course	Course code	Mathematics for Data Science	Sem	Hrs / week	Credits
M.Sc (Data Science)	CC-I	19PDS101		I	6	5

Cognitive Level	**K – 2 Understand** **K – 3 Apply** **K4 -4 Analyze**
Course Objectives	**This Course aims** • To understand basic mathematical concepts of data science. • To know the applications of graphs in other disciplines. • To learn the logics of mathematics needed for data science operations. • To study Context free grammars. • To impart knowledge in operations of matrix algebra needed for computing.

UNIT	Content	No. of Hours
I	**Matrix Algebra:** Matrices, Rank of Matrix, Solving System of Equations-Eigen Values and Eigen Vectors, Inverse of a Matrix - Cayley Hamilton Theorem.	12
II	**Basic Set Theory:** Basic Definitions - Venn Diagrams and set operations, Laws of set theory - Principle of inclusion and exclusion – partitions, Permutation and Combination Relations- Properties of relations - Matrices of relations, Closure operations on relations Functions - injective, subjective and objective functions.	12
III	**Mathematical Logic:** Propositions and logical operators, Truth table - Propositions generated by a set, Equivalence and implication, Basic laws- Some more connectives Functionally complete set of connectives- Normal forms - Proofs in Propositional calculus Predicate calculus.	15
IV	**Formal Languages:** Languages and Grammars-Phrase Structure Grammar, classification of Grammars-Pumping Lemma For Regular Languages, Context Free Languages.	11
V	**Finite State Automata:** Finite State Automata-Deterministic Finite State Automata(DFA), Non Deterministic Finite State Automata (NFA) Equivalence of DFA and NFA-Equivalence of NFA and Regular Languages	10

Reference	Text Books: 1. Kenneth H.Rosen, "Discrete Mathematics and Its Applications", Tata McGraw Hill, Fourth Edition, 2002. 2. Hopcroft and Ullman, "Introduction to Automata Theory, Languages and Computation", Narosa Publishing
Course Outcomes	On completion of the course, students should be able to do • CO 1: Understand different mathematical concepts of data science with applications. • CO 2: After the course the students will have a strong background of basic mathematics which has diverse applications in many area of data science, data analytics, etc., • CO 3: Master regular languages and finite automata. • CO 4: Master context free languages and calculus needed for language processing. • CO 5: Familiar with thinking analytically and intuitively for problem analysis in related areas of theory in data science.

Mapping of COs with PSOs & POs:

CO/PO	PO						PSO				
	1	2	3	4	5	6	1	2	3	4	5
CO1	2	1	1	3	2	1	1	2	2	3	0
CO2	1	3	2	2	1	3	1	2	0	1	2
CO3	3	2	3	1	3	2	3	3	3	0	3
CO4	2	1	2	3	2	1	2	0	1	2	1
CO5	1	2	1	0	2	3	1	1	2	1	2

Strongly Correlating(S) - 3
Moderately Correlating (M)- - 2
Weakly Correlating (W) - 1
No Correlation (N) - 0

Class	Course	Course code	Advanced Data Base Systems	Sem	Hrs / week	Credits
M.Sc (Data Science)	CC-II	19PDS102		I	6	5

Cognitive Level	**K – 1 Remember** **K – 2 Understand** **K – 3 Apply**
Course Objectives	**This Course aims** • To understand various data model. • To understand the SQL structure, set operations, aggregate functions. • To develop and refers the conceptual data models, entities, attributes. • To apply normalization techniques. • To learn database system architecture.

UNIT	Content	No. of Hours
I	**Introduction:** Data base system verses file system – View of data- Data Models – Database Languages – Database users and Administrators Database system structure. Entity: Basic concepts – Constraints – Keys – Design Issues – ER Diagram – Weak entity Relationship Model: Sets – Design of an ER Database schema – Reduction of an ER schema to tables.Relational Model**:** Structure – Relational Algebra – Extended Relational Algebra – Algebraic operations – Modification**.**	15
II	**SQL:** Structure of SQL -Set operations – Aggregate functions – Null values Nested sub queries – Views Complex queries – Joined Relations. Embedded SQL - Dynamic SQL – QBE. Domain Constraints – Referential Integrity – Triggers.	15
III	**Database Design:** Relational – First normal form – Functional dependencies.Decomposition – Boyce-codd normal form.Third Normal Form – Fourth normal form More normal form.	8
IV	**Transaction concepts:** Transaction state – concurrent execution – recoverability. Concurrent control**:** Lock based protocols – timestamp based protocols Validation based protocols – Deadlock Handling.	11

V	**Database system architecture:** Centralized and client server architecture – server system architecture – parallel systems – Distributed systems - Network types. Distributed database: Distributed data storage - distributed transactions – commit protocols – distributed query processing.	11
Reference	Text Books: 1. Henry F.Korth and Abraham Silberschatz, "*Database System concepts"*, 4th Edition, McGraw Hill publication, 2002. 2. Bepin C.Desai, "*An Introduction to Data base system*", Galogotia publications Private limited. Ivan Bayross, "SQL *and PL/SQL*", BPB Publications, New Delhi. Reference Books: C.J.Date, " *An Introduction to Database system*",7th edition, Addison Wesley publication,year2000.	
Course Outcomes	On completion of the course, students should be able to do CO 1: Understand the fundamentals of database system. CO 2: Design and create tables in database and execute queries. CO 3: Design a database based on a data models using normalization. CO 4: Have knowledge about transaction concept.	

Mapping of Cos with PSOs & Pos:

CO/PO	PO						PSO				
	1	2	3	4	5	6	1	2	3	4	5
CO1	2	2	1	3	2	2	2	1	2	3	3
CO2	2	2	1	3	3	1	2	2	3	2	3
CO3	3	1	2	2	2	3	1	2	2	2	3
CO4	2	2	2	3	1	2	2	3	2	1	3

Strongly Correlating(S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

Class	Course	Course code	Data Mining Techniques	Sem	Hrs / week	Credits
M.Sc (Data Science)	CC-III	19PDS103		I	6	5

Cognitive Level	**K – 1 Remember** **K – 2 Understand** **K – 3 Apply**
Course Objectives	**This Course aims** • To introduce the basic concepts of data mining and preprocessing techniques • To imbibe the knowledge on Association Rule Mining • To elaborate the importance of classification and prediction techniques through various methods • To introduce the concepts and importance of basic clustering techniques • To introduce the concepts of warehousing, architecture and multidimensional data model

UNIT	Content	No. of Hours
I	**Data Mining & Data Preprocessing:** Introduction to KDD process – Knowledge Discovery from Databases. Data Preprocessing: An Overview – Data Cleaning – Data Integration. Data Reduction–Data Transformation and Data Discretization.	8
II	**Association Rule Mining:** Mining Frequent Patterns: Basic concepts **-** Frequent Item set. Mining Method- Apriori Algorithm. Finding Frequent Item sets using Candidate Generation- Generating Association Rules from Frequent Item sets. A Pattern-Growth Approach for Mining Frequent Item set.	15
III	**Classification:** Basic Concepts - Decision Tree Induction. Bayes Classification Methods- Rule-based Classification. Model Evaluation and Selection- Techniques to Improve Classification Accuracy.	15
IV	**Clustering:** Partitioning Methods: k-means and k-methods. Hierarchical methods: Agglomerative and Divisive Hierarchical Clustering – BIRCH. Density-Based Methods: DBSCAN – Grid-Based Methods: STING - Evaluation of Clustering.	12
V	**Data Warehouse:** Data Warehousing - Operational Database Systems vs. Data Warehouses - Data Warehouse Multitier Architecture. Data Warehouse Models: Enterprise Warehouse, Data Mart and Virtual Warehouse. Multidimensional Data Model: Data Cube, Stars, Snowflakes, and Fact Constellations – Online Analytical Processing: Introduction - OLAP Operations**.**	10

Reference	Text Books: Jiawei Han and Micheline Kamber, "*Data Mining Concepts and Techniques"*, Third Edition, Elsevier, Reprinted 2008. Reference Books: 1. K.P. Soman, Shyam Diwakar and V. Ajay, *"Insight into Data mining Theory and Practice"*, Easter Economy Edition, Prentice Hall of India, 2006. 2. G. K. Gupta, *"Introduction to Data Mining with Case Studies"*, Easter Economy edition, Prentice Hall of India, 2006.
Course Outcomes	On completion of the course, students should be able to do CO 1: Preprocess the data using various preprocessing techniques CO 2: Generate association rules using Apriori and FP-growth algorithms CO 3: Predict the class label of a given tuple using the classification techniques CO 4: Group the data using the basic clustering techniques CO5: Summarize the concepts of warehouse, its architecture and multidimensional data models.

Mapping of Cos with PSOs & Pos:

CO/PO	PO						PSO				
	1	2	3	4	5	6	1	2	3	4	5
CO1	2	2	1	3	2	3	2	1	1	2	2
CO2	2	1	3	2	1	2	3	2	3	0	1
CO3	3	2	2	1	3	1	1	3	2	1	0
CO4	1	3	1	3	2	3	2	1	3	2	3
CO5	2	1	3	2	1	2	3	2	1	3	2

Strongly Correlating(S) - 3
Moderately Correlating (M) - 2
Weakly Correlating (W) - 1
No Correlation (N) - 0

Class	Course	Course code	Information Security	Sem	Hrs / week	Credits
M.Sc (Data Science)	CC-IV	19PDS104		I	6	5

Cognitive Level	**K – 1 Remember** **K – 2 Understand** **K – 3 Apply**
Course Objectives	**This Course aims** • To understand the basics of Information Security • To know the legal, ethical and professional issues in Information Security • To know the aspects of risk management • To become aware of various standards in this area • To know the technological aspects of Information Security

UNIT	Content	No. of Hours
I	**Introduction:** History-What is Information Security- Critical Characteristics of Information-NSTISSC Security Model-Components of an Information System-Securing the Components-Balancing Security and Access-The SDLC-The Security SDLC.	12
II	**Security Investigation:** Need for Security, Business Needs, Threats, Attacks, Legal, Ethical and Professional Issues – An Overview of Computer Security – Access Control Matrix, Policy-Security policies, Confidentiality policies, Integrity policies and Hybrid policies.	15
III	**Security Analysis:** Risk Management: Identifying and Assessing Risk- Assessing and Controlling Risk – Systems: Access Control Mechanisms- Information Flow and Confinement Problem	15
IV	**Logical Design:** Blueprint for Security- Information Security Policy-Standards and Practices-ISO 17799/BS 7799, NIST Models -VISA International Security Model-Design of Security Architecture-Planning for Continuity.	10
V	**Physical Design:** Security Technology-IDS-Scanning and Analysis Tools-Cryptography-Access Control Devices-Physical Security-Security and Personnel.	8
Reference	Text Books: 1. Michael E Whitman and Herbert J Mattord, —Principles of Information	

	Security, Vikas Publishing House, New Delhi, 2003 Reference Books: 1. Micki Krause, Harold F. Tipton, — Handbook of Information Security Management, Vol 1-3 CRCPress LLC, 2004. 2. Stuart McClure, Joel Scrambray, George Kurtz, —Hacking Exposed, Tata McGraw- Hill, 2003 3. Matt Bishop, — Computer Security Art and Science, Pearson/PHI, 2002
Course Outcomes	On completion of the course, students should be able to do CO 1: Discuss the basics of information security CO 2: Illustrate the legal, ethical and professional issues in information security CO 3: Demonstrate the aspects of risk management. CO 4: Become aware of various standards in the Information Security System CO 5: Design and implementation of Security Techniques.

Mapping of Cos with PSOs & Pos:

CO/PO	PO						PSO				
	1	2	3	4	5	6	1	2	3	4	5
CO1	3	2	2	1	1	2	2	1	3	0	2
CO2	2	2	1	2	3	2	1	2	0	1	3
CO3	1	3	3	3	2	3	3	3	2	3	0
CO4	1	1	2	1	1	3	1	1	3	0	2
CO5	2	2	1	2	3	2	2	2	2	3	0

Strongly Correlating(S) - 3
Moderately Correlating (M) - 2
Weakly Correlating (W) - 1
No Correlation (N) - 0

Class	Course	Course code	Data Base Systems & Data Mining Lab	Sem	Hrs / week	Credits
M.Sc (Data Science)	CC-V	19PDS105L		I	6	4

Cognitive Level	**K – 1 Remember** **K – 2 Understand** **K – 3 Apply**
Course Objectives	**This Course aims** • To understand and apply various data base languages in different domains. • To implement the constraints in various data bases. • To learn and analyze various data mining techniques. • To be acquainted with the tools and techniques used for Knowledge Discovery in Databases.

Experiment	Content	No. of Hours
	1. To implement Data Definition language 1.1. **Create, alter, drop, truncate** 1.2. **To implement Constraints.** (a). Primary key, (b).Foreign Key, (c). Check, (d). Unique, (e).Null, (f). Not null, (g) . Default,(h). Enable Constraints, (i). Disable Constraints (j). Drop Constraints	12
	2. To implement DML, TCL and DRL (a).Insert, (b).Select, (c).Update, (d).Delete, (e).commit, (f).rollback,(g).save point, (i). Like'%', (j).Relational Operator	12
	3. To implement Nested Queries & Join Queries 3.1. (a). To implementation of Nested Queries 3. 2. (b). (a) Inner join, (b).Left join, (c).Right join (d).Full join	10
	4. **To implement Views** 4.1. (a). View, (b).joint view, (c).force view, (d). View with check option	6
	Application of Classifications Application of Clustering Techniques	20
Course Outcomes	On completion of the course, students should be able to do CO 1: Understand the fundamentals of database system. CO 2: Design and manipulate tables in database and execute queries. CO 3: Design a database based on a data models using normalization. CO 4: Have knowledge about transaction concepts. CO 5: Impart basic knowledge in advance database systems	

Mapping of Cos with PSOs & Pos:

CO/PO	PO						PSO				
	1	2	3	4	5	6	1	2	3	4	5
CO1	2	2	1	1	3	1	2	3	0	3	2
CO2	3	1	2	2	1	1	1	1	2	1	1
CO3	2	3	1	3	2	3	1	2	3	2	3
CO4	1	2	3	1	2	2	3	2	2	0	3
CO5	3	2	3	1	3	1	2	3	1	1	2

Strongly Correlating(S) - 3
Moderately Correlating (M) - 2
Weakly Correlating (W) - 1
No Correlation (N) - 0

Class	Course	Course code	Probability and Statistical Computing	Sem	Hrs / week	Credits
M.Sc (Data Science)	CC-VI	19PDS206		II	6	5

Cognitive Level	**K – 1 Remember** **K – 2 Understand** **K – 3 Apply** **K4 -4 Analyze**
Course Objectives	**This Course aims** • To introduce the fundamental concepts in elementary probability theory. • To introduce and study properties of standard uni-variate probability distributions. • To introduce the basic concepts of statistical inference and assessing significance. • To introduce practical data analysis techniques using the statistical computing package R. • To enable students to write a small report summarising and interpreting an appropriate data set.

UNIT	Content	No. of Hours
I	**Measures of Central Tendency & Measures of Dispersion:** Frequency Distribution -Histogram - Stem and leaf diagram - Frequency Polygon. Mean - Median - Mode - Range Quartile Deviation - Mean Deviation - Box hisker plot - Standard Deviation - Coefficient of Variation	10
II	**Skewness - Correlation & Regression:** Karl Pearson's coefficient of Skewness - Bowley's coefficient of Skewness - Scatter Diagram. Karl Pearson's coefficient of correlation Spearman's rank correlation coefficient - Linear Regression and Estimation - Coefficients of regression	15
III	**Theory of Attributes & Hypothesis:** Classes and Class Frequencies - Consistency of Data Independence of Attributes. Association of Attributes. Hypothesis Type I and Type II errors. Tests of significance. Student's t-test: Single Mean - Difference of means - paired t-test Chi-Square test: Test of Goodness of Fit - Independence Test	15
IV	**Introduction to Probability & Conditional Probability:** Random experiment - Sample space - Events - Axiomatic Probability. Algebra of events. Conditional Probability Multiplication theorem of Probability - Independent events - Bayes' Theorem	10
V	**Random variables & Mathematical Expectation:** Discrete random variable - Continuous random variable - Two-dimensional random variable .Joint probability distribution. Expected value of a random variable. Expected value	10

	of a function of a random variable Properties of Expectation and Variance - Covariance.	
Reference	Text Books: S.C. Gupta, V.K. Kapoor and S. Chand, "Fundamentals of Mathematical Statistics", 11th Revised Edition, 2002. Reference Books: S P Gupta, "Statistical Methods", Sultan Chand & Sons Publishing, 38th Revised Edition, 2009.	
Course Outcomes	On completion of the course, students should be able to do CO 1: A good understanding of elementary probability theory and its application. CO 2: A good understanding of the laws of probability and the use of Bayes theorem. CO 3: A good understanding of the concept of a statistical distribution. CO 4: A good understanding of the standard uni-variate distributions & their properties CO 5: A good understanding of the basic concepts of statistical inference.	

Mapping of Cos with PSOs & Pos:

CO/PO	PO						PSO				
	1	2	3	4	5	6	1	2	3	4	5
CO1	3	2	2	1	3	2	3	2	2	3	0
CO2	2	1	3	2	1	3	1	2	3	1	2
CO3	3	2	1	3	2	1	3	1	1	2	2
CO4	1	3	2	2	1	2	2	3	2	0	3
CO5	2	3	2	1	0	3	3	2	1	2	1

Strongly Correlating(S) - 3
Moderately Correlating (M) - 2
Weakly Correlating (W) - 1
No Correlation (N) - 0

Class	Course	Course code	Artificial Intelligence & Machine Learning	Sem	Hrs / week	Credits
M.Sc (Data Science)	CC-VII	19PDS207		II	6	5

Cognitive Level	**K – 1 Remember** **K – 2 Understand** **K – 3 Apply**
Course Objectives	**The Course aims to** • To gain the basic knowledge about AI techniques and knowledge representation • To understand the basics of machine learning • To describe Neural Networks and Genetic Algorithms • To illustrate Bayesian and Computational learning

UNIT	Content	No. of Hours
I	**Artificial Intelligence:** AI problem – AI technique – level of the model. Defining the problem – production systems production system characteristics – Heuristic search techniques.	12
II	**Knowledge Representation:** Representations and Mappings–issues in knowledge representation– predicate logic – representing knowledge using rules symbolic reasoning under uncertainty.	12
III	**Neural Networks And Genetic Algorithms:** Neural Network Representation – Problems – Perceptron's. Multilayer Networks and Back Propagation Algorithms – Advanced Topics Genetic Algorithms – Hypothesis Space Search – Genetic Programming – Models of Evolution and Learning.	10
IV	**Bayesian And Computational Learning :** Bayes Theorem – Concept Learning – Maximum Likelihood-Minimum Description Length Principle – Bayes Optimal Classifier – Gibbs Algorithm-Naïve Bayes Classifier – Bayesian Belief Network –EM Algorithm Probability Learning – Sample Complexity – Finite and Infinite Hypothesis Spaces – Mistake Bound Model.	12
V	**Advanced Learning:** Analytical Learning – Perfect Domain Explanation Base Learning – Reinforcement Learning Task–Q-Learning – Temporal Difference Learning	14
Reference	Text Books: Tom M. Mitchell, "Machine Learning", McGraw Hill Education Private Limited, First Edition, (1 May 2013) Reference Books: 1. Ethem Alpaydin, "Introduction to Machine Learning (Adaptive Computation	

	and Machine Learning)", The MIT Press 2004 2. T. Hastie, R. Tibshirani, J. H. Friedman, "The Elements of Statistical Learning", Springer; 1 edition, 2001.
Course Outcomes	On completion of the course, students should be able to do CO 1: Identify learning problems, various concept learning methods CO 2: Identify the representation of neural networks CO 3: Enable to apply various machine learning techniques CO 4: Identify various advanced learning methods

Mapping of Cos with PSOs & Pos:

CO/PO	PO						PSO				
	1	2	3	4	5	6	1	2	3	4	5
CO1	3	2	1	1	3	2	2	3	1	2	1
CO2	2	3	1	2	2	1	2	1	2	3	0
CO3	1	2	3	1	2	2	3	2	0	1	1
CO4	3	3	2	1	1	3	1	2	3	2	0

Strongly Correlating(S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

Class	Course	Course code	Machine Learning Lab	Sem	Hrs / week	Credits
M.Sc (Data Science)	CC-VIII	19PDS208L		II	6	4

Cognitive Level	**K – 1 Remember** **K – 2 Understand** **K – 3 Apply**
Course Objectives	**This Course aims to** • Preparing and pre-processing data using python or R • To Visualize the results of analytics

Experiment	Content	No. of Hours
1	Implement applications using functions, loops, arrays, sorting. Applications using dictionaries, lists and tuples. Twitter API Integration for tweet Analysis Pre-processing and Preparing data.	18
2	Exploratory data analytics / Statistical and Machine learning methods a. Descriptive Statistics b. Hypothesis testing c. Linear Regression d. Logistic Regression	12
3	Data Visualization, ggplot2	10
4	**Case Study** Sample Data sets may include any one from the following Automotive data, Social media data, Stock market data(Sports data, etc.	20
Course Outcomes	On completion of the course, students should be able to do CO 1: Familiar with the algorithms of machine learning methods CO 2: Gain Knowledge with techniques used for Knowledge Discovery in Databases CO 3: Analysis machine learning techniques in real world domain	

Mapping of Cos with PSOs & Pos:

CO/PO	PO						PSO				
	1	2	3	4	5	6	1	2	3	4	5
CO1	3	2	1	2	1	3	2	1	2	2	1
CO2	2	1	2	3	2	3	1	3	2	0	2
CO3	1	3	3	1	3	2	3	2	0	1	3

Strongly Correlating(S) - 3
Moderately Correlating (M) - 2
Weakly Correlating (W) - 1
No Correlation (N) - 0

Class	Course	Course code	Multivariate Techniques	Sem	Hrs / week	Credits
M.Sc (Data Science)	CC-IX	19PDS309		III	6	5

Cognitive Level	**K – 1 Remember** **K – 2 Understand** **K – 3 Apply**
Course Objectives	**This Course aims** • To introduce multivariate analysis • To design & access factor analysis. • To understand clustering methods. • Understanding the usage of multivariate techniques for the problem under the consideration • To design valid inferences and to plan for future investigations

UNIT	Content	No. of Hours
I	**Meaning of Multivariate Analysis:** Measurements Scales - Metric measurement scales and Non-metric measurement scales, Classification of multivariate techniques (Dependence Techniques and Inter-dependence Techniques), Applications of Multivariate Techniques in different disciplines	13
II	**Factor Analysis**: Meanings-Objectives and Assumptions-Designing a factor analysis-Deriving factors and assessing overall factors- Interpreting the factors and validation of factor analysis.	12
III	**Cluster Analysis**: Objectives and Assumptions-Research design in cluster analysis- Deriving clusters and assessing overall fit (Hierarchical methods, Non Hierarchical Methods and Combinations), Interpretation of clusters and validation of profiling of the clusters.	15
IV	**Discriminant Analysis:** concept-objective and applications-Procedure for conducting discriminant analysis. Stepwise discriminate analysis and Mahalanobis procedure, Logic model.	11
V	**Linear Programming Problem** - Formulation, graphical method-simplex method. Integer Programming. Transportation and Assignment problems.	9
Reference	Text Books: 1. Joseph F Hair, William C Black, "Multivariate Data Analysis", Pearson Education, 7th edition, 2013. 2. T. W. Anderson, "An Introduction to Multivariate Statistical Analysis, 3rd Edition", Wiley, 2003. 3. William r Dillon, John Wiley & sons, "Multivariate Analysis methods and applications", Wiley, 1984. 4. Naresh K Malhotra, Satyabhusan Dash, "Marketing Research Anapplied Orientation", Pearson, 2011.	

	5. Hamdy A Taha, "Operations Research", Pearson, 2012. 6.S R Yaday, A K Malik, "Operations Research", Oxford, 2014.
Course Outcomes	On completion of the course, students should be able to do CO1: will appreciate the range of multivariate techniques available, CO 2: will be able to summarize and interpret multivariate data. CO 3: will have an understanding of the link between multivariate techniques and corresponding univariate techniques,

Mapping of Cos with PSOs & Pos:

CO/PO	PO						PSO				
	1	2	3	4	5	6	1	2	3	4	5
CO1	3	1	2	2	3	2	1	2	2	3	1
CO2	2	2	1	3	2	1	2	3	1	2	0
CO3	2	1	3	2	1	2	3	1	2	1	1

Strongly Correlating(S) - 3
Moderately Correlating (M) - 2
Weakly Correlating (W) - 1
No Correlation (N) - 0

Class	Course	Course code	Big Data Analytics	Sem	Hrs / week	Credits
M.Sc (Data Science)	CC-X	19PDS310		III	6	5

Cognitive Level	**K – 1 Remember** **K – 2 Understand** **K – 3 Apply**
Course Objectives	**The Course aims to** • To illustrate the evolution and basics of Big data • To demonstrate mining of Data • To analyze Hadoop, map reduce and its environment • To justify features and working of map reduce • To build Hadoop cluster and extend the framework of Big Data Analytics.

UNIT	Content	No. of Hours
I	**The Fundamentals of Big Data**: The Evolution of Data Management-Understanding the Waves of Managing Data-Defining Big Data-Big Data Management Architecture-Traditional and advanced analytics. **Big Data Types:** Defining Structured Data-Defining Unstructured Data. **Technology Foundations of Big data:** Big data Stack (technology Components) – Big data Analytics- Big data Applications. **Virtualization and Distributed Computing:** Understanding the basics of virtualization- importance of virtualization to Big Data.	15
II	**Mining Data Streams** :Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window.	15
III	**HADOOP:** History of Hadoop- Components of Hadoop –Map Reduce: Analyzing the Data with Hadoop- Scaling Out- Hadoop Streaming- The Hadoop Distributed.**File System**: Design of HDFS-HDFS Concepts-The command Line Interface- Java interfaces**.**	12
IV	**Map Reduce:** Developing Map Reduce application: Setting up the development environment- Writing a unit test with MRTUnit- Running Locally on Test Data. How Map Reduce Works:Anatomy of a Map Reduce Job run-Shuffle and Sort – Map Reduce Types and Formats- Map Reduce Features: Counters-Sorting-Joins.	10
V	**HADOOP Environment:** Setting up a Hadoop Cluster - Cluster specification - Cluster Setup and Installation - Hadoop Configuration-Security - Administering Hadoop: HDFS-Monitoring-Maintenance.	8

	FR.AMEWORKS: Pig: Installing and Running Pig- Data processing operators in Pig – Hive: Installing Hive- Hive services –Hive Client- HiveQL – Querying Data in Hive. **Self Study: Basics of Pig & Hive**	
Reference	Text Books: 1. Judith Hurwitz, Alan Nugent, Dr.Fern Halper and Marcia Kaufman,"Big data for dummies", John Wiley & Sons, Inc 2013. 2. AnandRajaraman and Jeffrey David Ullman, "*Mining of Massive Datasets*", Cambridge University Press, 2012. 3. Tom White "*Hadoop: The Definitive Guide*" Fourth Edition, O'reilly Media, 2012. Reference Books: 1. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007. 2. Alan Gates, **"**Programming Pig**"**, O'reilly Media, First Edition 2011 3. Jason Ruthberglen, Dean Wampler & Edward Capriolo,**"**Programming Hive", O'reilly Media, First Edition 2012.	
Course Outcomes	On completion of the course, students should be able to do CO1:Analyze evolution and concepts of big data CO2 :Predict mining data from data sets CO3:Outline Hadoop and Map reduce functions and its environment CO4:Explain different working principles of Map reduce CO5:Formulate Hadoop cluster and select appropriate tool	

Mapping of Cos with PSOs & Pos:

CO/PO	PO						PSO				
	1	2	3	4	5	6	1	2	3	4	5
CO1	2	3	2	1	3	0	3	1	2	3	1
CO2	1	2	3	2	1	3	1	2	3	1	3
CO3	3	2	1	1	2	2	2	3	2	3	2
CO4	2	1	3	2	3	1	3	1	1	2	2
CO5	1	3	2	3	1	2	1	2	2	3	0

Strongly Correlating(S) - 3
Moderately Correlating (M) - 2
Weakly Correlating (W) - 1
No Correlation (N) - 0

Class	Course	Course code	Big Data Analytics Lab	Sem	Hrs / week	Credits
M.Sc (Data Science)	CC-XI	19PDS311L		III	6	4

Cognitive Level	**K – 1 Remember** **K – 2 Understand** **K – 3 Apply**
Course Objectives	**The Course aims to** • To illustrate the evolution and basics of exploratory data analysis • To solve big data problems using Pig and Hive

UNIT	Content	
	Installation of Hadoop Ecosystem a. Pig b. Hive **Pig Programming Language** 1. Components of Pig, Pig Data Model 2. Pig vs SQL 3. Filtering and Transformation of Data 4. Grouping and Sorting, Combining and splitting 5. Processing Logs in pig **Hive** 6. Hive Query Language 7. Hive Data Models 8. Hive Functions 9. Process tweets in Hive	
Course Outcomes	On completion of the course, students should be able to do CO1: Ability how to Install Hadoop Ecosystem CO2: Compare strength and limitations of Pig and Hive CO3:To grouping and sorting using Pig programming language CO4: Annalise evolution and concepts of big data CO5: Predict mining data from data sets	

Mapping of Cos with PSOs & Pos:

CO/PO	PO						PSO				
	1	2	3	4	5	6	1	2	3	4	5
CO1	3	2	3	2	1	3	1	2	3	2	1
CO2	1	1	2	3	3	1	1	3	2	3	2
CO3	2	3	1	2	2	2	1	2	1	3	2
CO4	1	2	3	1	2	3	3	1	2	0	1
CO5	3	1	2	1	1	2	2	3	3	1	0

Strongly Correlating(S) - 3
Moderately Correlating (M) - 2
Weakly Correlating (W) - 1
No Correlation (N) - 0

Class	Course	Course code	Deep Learning	Sem	Hrs / week	Credits
M.Sc (Data Science)	CC-XII	19PDS412		IV	6	5

Cognitive Level	**K – 1 Remember** **K – 2 Understand** **K – 3 Apply**
Course Objectives	**The Course aims to** • To know about basic concepts of NLP and Machine Learning • To obtain a thorough knowledge of various knowledge representation schemes • To have an overview of various AI applications • To study about various heuristic and game search algorithms • To know about various Expert System tools and applications

UNIT	Content	No. of Hours
I	Introduction - Feed forward Neural networks. Gradient descent and the back propagation algorithm. Unit saturation, aka the vanishing gradient problem, and ways to mitigate it. RelU Heuristics for avoiding bad local minima. Heuristics for faster training. Nestors accelerated gradient descent. Regularization. Dropout.	12
II	Convolutional Neural Networks - Architectures, convolution / pooling layers - Recurrent Neural Networks (LSTM, GRU, Encoder Decoder architectures.	10
III	Deep Unsupervised Learning- Auto encoders (standard, sparse, de-noising, contractive, etc.), Variational Auto encoders, Adversarial Generative Networks, Auto encoder and DBM	8
IV	Applications of Deep Learning to NLP: Introduction to NLP and Vector Space Model of Semantics-Word Vector Representations: Continuous Skip-Gram Model-Continuous Bag-of-Words model (CBOW)- Glove-, Evaluations and Applications in word similarity-analogy reasoning-Named Entity Recognition-Opinion Mining using Recurrent Neural Networks .	12
V	Parsing and Sentiment Analysis using Recursive Neural Networks - Sentence Classification using Convolutional Neural Networks	8
Reference	Text Books: Bengio, Yoshua, Ian J. Goodfellow, and Aaron Courville. "Deep learning." An MIT Press	
Course	On completion of the course, students should be able to do	

Outcomes	CO 1: Technical knowhow of AI applications, heuristics, Expert Systems, NLP, and Machine Learning techniques CO 2: Acquaintance with programming languages such as LISP and PROLOG. CO 3: Develop algorithms simulating human brain. CO 4: Implement Neural Networks in Tensor Flow for solving problems. CO 5: Explore the essentials of Deep Learning and Deep Network architectures.

Mapping of Cos with PSOs & Pos:

CO/PO	PO						PSO				
	1	2	3	4	5	6	1	2	3	4	5
CO1	3	2	1	2	3	0	3	2	0	2	3
CO2	2	1	2	3	1	3	1	2	1	3	2
CO3	1	3	2	1	2	2	3	1	0	2	3
CO4	3	2	1	3	2	1	2	3	2	0	2
CO5	2	1	1	2	3	2	1	2	3	2	1

Strongly Correlating(S) - 3
Moderately Correlating (M) - 2
Weakly Correlating (W) - 1
No Correlation (N) - 0

Class	Course	Course code	Predictive Analytics	Sem	Hrs / week	Credits
M.Sc (Data Science)	CC-XIII	19PDS413		IV	6	5

Cognitive Level	**K – 1 Remember** **K – 2 Understand** **K – 3 Apply**
Course Objectives	**This Course aims** • To focus on the most important aspect of predictive analytics • To differentiate regression and supervised techniques • To focus on various clustering techniques • To evaluate models • To interpret the results of the analysis to make decisions

UNIT	Content	No. of Hours
I	**Introduction** - Extract meaningful patters, building representative models, Combination of Statistics, Machine Learning, and Computing, algorithms, what data mining is not - a THE CASE FOR DATA MINING – types of data mining – data mining algorithm	15
II	**Data Exploration – Classification**-classification and clustering, Model driven Forecasting, Anomaly detection concepts Predictive Analytics and Data Mining Algorithms Decision trees, rule induction, Naïve Bayesian, artificial neural networks, SVM, Ensemble Learners	15
III	**Regression and Association Analysis-** Linear regression, Logistic regression, supervised data Mining a predictive analytics techniques with target	12
IV	**Types of clustering and model evaluation**-Unsupervised data Mining a predictive analytics techniques without target	10
V	**Special Applications**-Implementing Text Mining with	8
Reference	Text Books: Vijay Kotu Bala Deshpande, "Predictive Analytics and Data Mining Concepts and Practice with RapidMiner"Elsevier Publishe".	
Course Outcomes	On completion of the course, students should be able to do CO 1: Be able to apply the knowledge of computing tools and techniques in the field of Big Data for solving real world problems encountered in the Software Industries. CO 2: Be able to analyze the various technologies & tools associated with Big Data CO 3: Be able to identify the challenges in Big Data with respect to IT Industry and pursue quality research in this field with social relevance.	

Mapping of Cos with PSOs & Pos:

CO/PO	PO						PSO				
	1	2	3	4	5	6	1	2	3	4	5
CO1	3	2	3	1	2	3	3	2	3	1	3
CO2	2	1	1	2	3	2	1	1	2	3	0
CO3	1	3	2	2	2	1	2	0	1	2	2

Strongly Correlating(S) - 3
Moderately Correlating (M) - 2
Weakly Correlating (W) - 1
No Correlation (N) - 0

Class	Course	Course code	Predictive Analytics Lab	Sem	Hrs / week	Credits
M.Sc (Data Science)	CC-XIV	19PDS414L		IV	6	4

Cognitive Level	**K – 1 Remember** **K – 2 Understand** **K – 3 Apply**
Course Objectives	**This Course aims** • To focus on the implementation predictive analytics: • To interpret the results of the analysis to make decisions

UNIT	Content
	1. Data Exploration 2. Classification 3. Regression and Association Analysis 4. Types of clustering and model evaluation
Course Outcomes	On completion of the course, students should be able to do CO 1: Be able to identify the challenges in Big Data with respect to IT Industry and pursue quality research in this field with social relevance. CO 2: Predict mining data from data sets

Mapping of COs with PSOs & POs:

CO/PO	PO						PSO				
	1	2	3	4	5	6	1	2	3	4	5
CO1	3	2	2	1	1	2	2	1	3	0	2
CO2	2	2	1	2	3	2	1	2	0	1	3

Strongly Correlating(S) - 3
Moderately Correlating (M) - 2
Weakly Correlating (W) - 1
No Correlation (N) - 0

Class	Course	Course code	Python Programming	Sem	Hrs / week	Credits
M.Sc (Data Science)	CEC-I	19PDS215(a)		II	6	4

Cognitive Level	**K – 1 Remember** **K – 2 Understand** **K – 3 Apply**
Course Objectives	**This Course aims to** • To prepare and pre-process data using python • To visualize the results of data analytics.

UNIT	Content	No. of Hours
I	**Algorithmic Problem Solving:** Algorithms-building blocks of algorithms (statements, state, control flow, functions) notation (pseudo code, flow chart, programming language)-algorithmic problem solving-simple strategies for developing algorithms (iteration, recursion) Illustrative problems: find minimum in a list-insert a card in a list of sorted cards-guess an integer number in a range. Towers of Hanoi.	15
II	**Data, Expressions, Statements:** Python interpreter and interactive mode. Values and types: int-float,-Boolean-string-and list variables, expressions-statements-tuple. Assignment-precedence of operators comments-modules and functions-function definition and use, flow of execution Parameters and arguments; Illustrative programs: exchange the values of two variables-circulate the values of n variables,-distance between two points.	15
III	**Control Flow, Functions:** Conditionals: Boolean values and operators-conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.	11
IV	**Lists, Tuples, Dictionaries :**Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods;	9

	advanced list processing – list comprehension; Illustrative programs: selection sort, insertion sort, merge sort, histogram.	
V	**Files, Modules, Packages:** Files and exception: text files, reading and writing files, fformat operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.	10
References	1. Tony Gaddis, "***Starting out with python***", 2nd edition, Addison Wesley, Pearson 2. Michael Dawson, "***Python programming for the absolute beginner***", Premier press, 2003 *3.* Ivan Idris, ***"NumPy Beginner's Guide",*** Third Edition,Packet Publishing, 2015 4. Guido van Rossum, ***" Python Tutorial – Release 2.3.3"*** 2003, Python Software Foundation Ltd. 5. Jennifer Campbill, Paul Gries, Jason Montojo and Greg Wilson, "***Practical programing, An Introduction to computer science using Python***",2011	
Course Outcomes	On completion of the course, students should be able to do CO 1: To develop proficiency in creating based applications using the Python Programming Language. CO 2: To be able to understand the various data structures available in Python programming language and apply them in solving computational problems. CO 3: To be able to do testing and debugging of code written in Python. CO 4: To be able to draw various kinds of plots using PyLab. CO 5: To be able to do text filtering with regular expressions in Python.	

Mapping of Cos with PSOs & Pos:

CO/PO	PO						PSO				
	1	2	3	4	5	6	1	2	3	4	5
CO1	3	2	2	1	1	2	2	1	3	0	2
CO2	2	2	1	2	3	2	1	2	0	1	3
CO3	1	3	3	3	2	3	3	3	2	3	0
CO4	1	1	2	1	1	3	1	1	3	0	2
CO5	2	2	1	2	3	2	2	2	2	3	0

Strongly Correlating(S) - 3
Moderately Correlating (M) - 2
Weakly Correlating (W) - 1
No Correlation (N) - 0

Class	Course	Course code	R Programming	Sem	Hrs / week	Credits
M.Sc (Data Science)	CEC-I	19PDS215(b)		II	6	4

Cognitive Level	**K – 1 Remember** **K – 2 Understand** **K – 3 Apply**
Course Objectives	**This Course aims** • To Prepare and pre-process data using R • To visualize the results of analytics.

UNIT	Content	No. of Hours
I	**R basics:** Math-Variables- and Strings-Vectors and Factors-Vector operations.	12
II	**Data structures in R:** Arrays & Matrices-Lists-Dataframes.	14
III	**R programming fundamentals:** Conditions and loops-Functions in R-Objects and Classes-Debugging	12
IV	**Working with data in R:** Reading CSV and Excel Files-Reading text files-Writing and saving data objects to file in R	10
V	**Strings and Dates in R:** String operations in R-Regular Expressions-Dates in R	12
Reference	**Reference Books:** 1. Mark Gardener, "***Beginning R The statistical programming language*** ", John Wiley & Sons Inc, 2012, ISBN:978-1-118-16430-3 2. Norman Matloff, "***The art of R programming***", William Pollock , 2011, ISBN-10: 1-59327-384-3 3. Roger D. Peng, "***R Programming for Data Science***", Leanpub, 2015	
Course Outcomes	On completion of the course, students should be able to do CO 1: Familiar with the algorithms of machine learning methods. CO 2: Gain Knowledge with techniques used for Knowledge Discovery in Databases. CO 3: Analysis machine learning techniques in real world domain.	

Mapping of Cos with PSOs & Pos:

CO/PO	PO						PSO				
	1	2	3	4	5	6	1	2	3	4	5
CO1	3	2	1	2	1	3	2	1	3	2	1
CO2	1	3	2	3	1	2	1	3	2	2	0
CO3	2	1	1	2	2	1	1	2	2	0	2

Strongly Correlating(S) - 3
Moderately Correlating (M) - 2
Weakly Correlating (W) - 1
No Correlation (N) - 0

Class	Course	Course code	Health Care Data Analytics	Sem	Hrs / week	Credits
M.Sc (Data Science)	OEC-I	19PDS216(a)		II	6	4

Cognitive Level	**K – 1 Remember** **K – 2 Understand** **K – 3 Apply**
Course Objectives	**This Course aims** • To explore the various forms of electronic health care information. • To learn the techniques adopted to analyze health care data. • To understand the predictive models for clinical data

UNIT	Content	No. of Hours
I	Introduction: Introduction to Healthcare Data Analytics- Electronic Health Record. Components of EHR- Coding Systems. Benefits of EHR- Barrier to Adopting HER Challenges- Phenotyping Algorithms.	15
II	Analysis: Biomedical Image Analysis- Mining of Sensor Data in Healthcare. Biomedical Signal Analysis- Genomic Data Analysis for Personalized Medicine.	12
III	Analytics: Natural Language Processing and Data Mining for Clinical Text.Mining the Biomedical- Social Media Analytics for Healthcare.	8
IV	Advanced Data Analytics: Advanced Data Analytics for Healthcare– Review of Clinical Prediction Models. Temporal Data Mining for Healthcare Data- Visual Analytics for Healthcare(.Predictive Models for Integrating Clinical and Genomic Data- Information Retrieval for Healthcare- Privacy-Preserving Data Publishing Methods in Health care.	15
V	Applications: Applications and Practical Systems for Healthcare– Data Analytics for Pervasive Health. Fraud Detection in Healthcare- Data Analytics for Pharmaceutical Discoveries- Clinical Decision Support Systems.Computer-Assisted Medical Image Analysis Systems- Mobile Imaging and Analytics for Biomedical Data.	10
Reference	Text Books: Chandan K. Reddy and Charu C Aggarwal, "Healthcare data analytics", Taylor &Francis, 2015 Reference Books: Hui Yang and Eva K. Lee, "Healthcare Analytics: From Data to Knowledge to Healthcare Improvement, Wiley, 2016	
Course Outcomes	On completion of the course, students should be able to do CO 1: Analyse health care data using appropriate analytical techniques. CO 2: Apply analytics for decision making in healthcare services. CO 3: Apply data mining to integrate health data from multiple sources and develop efficient clinical decision support systems.	

Mapping of Cos with PSOs & Pos:

CO/PO	PO						PSO				
	1	2	3	4	5	6	1	2	3	4	5
CO1	3	2	2	1	1	3	2	1	2	3	0
CO2	2	3	3	1	2	3	2	1	0	2	2
CO3	1	1	1	3	1	2	3	1	2	0	1

Strongly Correlating(S) - 3
Moderately Correlating (M) - 2
Weakly Correlating (W) - 1
No Correlation (N) - 0

Class	Course	Course code	Social Media Mining	Sem	Hrs / week	Credits
M.Sc (Data Science)	OEC-I	19PDS216(b)		II	6	4

Cognitive Level	**K – 1 Remember** **K – 2 Understand** **K – 3 Apply**
Course Objectives	**This Course aims** • To understand the components of the social network. • To model and visualize the social network. • To mine the users in the social network. • To understand the evolution of the social network. • To mine the interest of the user.

UNIT	Content	No. of Hours
I	Introduction- Introduction to Web - Limitations of current Web – Development of Semantic Web – Emergence of the Social Web. Statistical Properties of Social Networks -Network analysis - Development of Social Network Analysis - Key concepts and measures in network analysis.Discussion networks - Blogs and online communities - Web-based networks.	15
II	Modeling And Visualization- Visualizing Online Social Networks - A Taxonomy of Visualizations - Graph Representation.Centrality- Clustering - Node-Edge Diagrams -Visualizing Social Networks with Matrix-Based Representations- Node-Link Diagrams -Hybrid Representations.Modelling and aggregating social network data – Random Walks and their Applications –Use of Hadoop and Map Reduce .Ontological representation of social individuals and relationships.	15
III	Mining Communities- Aggregating and reasoning with social network data- Advanced Representations Extracting evolution of Web Community from a Series of Web Archive Detecting Communities in Social Networks - Evaluating Communities – Core Methods for Community Detection & Mining - Applications of Community Mining Algorithms - Node Classification in Social Networks.	8
IV	Text and Opinion Mining- Text Mining in Social Networks -Opinion extraction – Sentiment classification and clustering Temporal sentiment analysis - Irony detection in opinion mining - Wish analysis - Product review mining .Review Classification –Tracking sentiments towards topics over time.	12
V	Tools for Social Network Analysis- UCINET – PAJEK – ETDRAW – StOCNET .splus – R – NodeXL – SIENA and RSIENA – Real world Social Networks (Facebook- Twitter etc.)	10

Reference	Text Books: 1. Charu C. Aggarwal, "Social Network Data Analytics", Springer; 2011. 2. Peter Mika, "Social Networks and the Semantic Web", Springer ,1st edition, 2007. Reference Books: 1. BorkoFurht, "Handbook of Social Network Technologies and Applications", , Springer 1st edition, 2010. 2. GuandongXu, Yanchun Zhang and Lin Li, "Web Mining and Social Networking – Techniques and applications", , Springer 1st edition, 2011.	
Course Outcomes	On completion of the course, students should be able to do CO1: Work on the internal components of the social network. CO 2: Model and visualize the social network. CO 3: Mine the behavior of the users in the social network. CO 4: Predict the possible next outcome of the social network. CO 5: Mine the opinion of the user.	

Mapping of Cos with PSOs & Pos:

CO/PO	PO						PSO				
	1	2	3	4	5	6	1	2	3	4	5
CO1	3	1	2	2	1	2	3	3	1	2	0
CO2	2	2	2	1	3	0	1	1	1	2	1
CO3	3	1	3	3	1	2	1	3	2	0	2
CO4	1	3	3	2	2	3	2	2	3	1	0
CO5	2	2	1	1	0	1	3	2	0	1	3

Strongly Correlating(S) - 3
Moderately Correlating (M) - 2
Weakly Correlating (W) - 1
No Correlation (N) - 0

Class	Course	Course code	Natural Language Processing	Sem	Hrs / week	Credits
M.Sc (Data Science)	CEC-II	19PDS317(a)		III	6	4

Cognitive Level	**K – 1 Remember** **K – 2 Understand** **K – 3 Apply**
Course Objectives	**The Course aims to** • Learn the techniques in natural language processing. • Be familiar with the natural language generation. • Be exposed to machine translation. • Understand the information retrieval techniques.

UNIT	Content	No. of Hours
I	**Overview and Language Modeling:** Overview: Origins and challenges of NLP-Language and Grammar.Processing Indian Languages NLP Applications-Information Retrieval. Language Modeling: Various Grammar- based Language Models-Statistical Language Model	12
II	**Word Level And Syntactic Analysis:** Word Level Analysis: Regular Expressions-Finite-State Automata-Morphological Parsing. Spelling Error Detection and correction-Words and Word classes-Part-of Speech Tagging. Syntactic Analysis: Context-free Grammar-Constituency- Parsing-Probabilistic Parsing.	15
III	**Semantic Analysis and Discourse Processing**: Semantic Analysis: Meaning Representation-Lexical Semantics- Ambiguity-Word Sense Disambiguation. Discourse Processing: cohesion-Reference Resolution- Discourse Coherence and Structure.	8
IV	**Natural Language Generation and Machine Translation:** Natural Language Generation: Architecture of NLG Systems- Generation Tasks and Representations Application of NLG.Machine Translation: Problems in Machine Translation-Characteristics of Indian Languages- Machine Translation Approaches-Translation involving Indian Languages.	10
V	**Information Retrieval And Lexical Resources:** Information Retrieval: Design features of Information Retrieval Systems-Classical, Non-classical, Alternative Models of Information Retrieval – valuation. Lexical Resources: World Net-Frame NetStemmers-POS Tagger- Research Corpora	15
Reference	Text Books:	

	Tanveer Siddiqui, U.S. Tiwary, "Natural Language Processing and Information Retrieval", Oxford University Press, 2008. Reference Books: 1. Daniel Jurafsky and James H Martin, "Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", 2 nd Edition, Prentice Hall, 2008. 2. James Allen, "Natural Language Understanding", 2nd edition, Benjamin /Cummings publishing company, 1995.
Course Outcomes	On completion of the course, students should be able to do CO 1: Upon completion of the course, the student should be able to: CO 2: Analyze the natural language text. CO 3: Generate the natural language. CO 4: Do machine translation. CO 5: Apply information retrieval technique.

Mapping of Cos with PSOs & Pos:

CO/PO	PO						PSO				
	1	2	3	4	5	6	1	2	3	4	5
CO1	2	3	3	1	3	2	3	2	1	2	2
CO2	1	3	2	2	2	3	3	3	3	3	0
CO3	3	2	1	3	3	1	2	1	2	1	2
CO4	1	1	3	1	3	2	3	2	1	0	3
CO5	2	2	1	2	2	1	2	3	0	2	1

Strongly Correlating(S) - 3
Moderately Correlating (M) - 2
Weakly Correlating (W) - 1
No Correlation (N) - 0

Class	Course	Course code	Financial Risk Analytics	Sem	Hrs / week	Credits
M.Sc (Data Science)	CEC-II	19PDS317(b)		III	6	4

Cognitive Level	**K – 1 Remember** **K – 2 Understand** **K – 3 Apply**
Course Objectives	**This Course aims** • To identify the different risks involved in Finance arena. • To understand and solve the different risks pertaining to stock market and its instruments. • To analyze the legal issues affecting the business

UNIT	Content	No. of Hours
I	Introduction to Risk -Understanding Risk- Nature of Risk, Source of Risk, Need for risk management. Benefits of Risk Management, Risk Management approaches. Risk Classification.credit risk, market risk, operational risk and other risk.	15
II	Risk Measurements -Measurement of Risk – credit risk measurement, market risk measurement.interest rate risk measurement, Asset liability management, measurement of operational risk.	8
III	Risk Management- Risk management- Managing credit risk, managing operational risk, managing market risk, insurance.	11
IV	Risk in Instruments -Tools for risk management Derivatives, combinations of derivative instruments, Neutral and volatile strategies- credit derivatives, credit ratings, swaps.	12
V	Regulation and Other Issues: Other issues in risk management – Regulatory framework- Basel committee, legal issues, accounting issues tax issues, MIS and reporting, integrated risk management.	14
Reference	Text Books: Dun, Bradstreet, “Financial Risk Management”, TMH, 2006. Reference Books: 1. John C Hull, “Risk management and Financial Institutions”, Pearson, 2015. 2. Aswath Damodharan, “Strategic Risk Taking”, Pearson, 2008	

Course Outcomes	On completion of the course, students should be able to do • CO 1: Identify and categorize the various risks faced by an organization. • CO 2: Explore the tools and practices needed to assess and evaluate financial risks. • CO 3: Explore risk management practices in an industry. • CO 4: Identify and solve legal issues that impact financial and other risk affecting business

Mapping of Cos with PSOs & Pos:

CO/PO	PO						PSO				
	1	2	3	4	5	6	1	2	3	4	5
CO1	3	2	1	2	3	1	3	2	1	2	2
CO2	2	3	2	1	2	3	3	2	1	3	0
CO3	1	2	3	1	1	2	1	1	2	2	1
CO4	2	1	3	2	3	1	1	3	0	1	3

Strongly Correlating(S) - 3
Moderately Correlating (M) - 2
Weakly Correlating (W) - 1
No Correlation (N) - 0

Class	Course	Course code	Cloud and Web Intelligence	Sem	Hrs / week	Credits
M.Sc (Data Science)	CEC-III	19PDS318(a)		III	6	4

Cognitive Level	**K – 1 Remember** **K – 2 Understand** **K – 3 Apply**
Course Objectives	**The Course aims to** • To provide an in-depth and comprehensive knowledge of the Cloud Computing • To understand the fundamental issues, technologies, applications and implementations of cloud computing. • To expose the students to the frontier areas of Cloud Computing • To know the importance of qualitative data, get insights and techniques. • To develop customer-centric approach in dealing with data.

UNIT	Content	No. of Hours
I	History of Centralized and Distributed Computing - Overview of Distributed Computing, Cluster computing, Grid computing.Technologies for Network based systems- System models for Distributed and cloud computing-Software environments for distributed systems and clouds.	8
II	Introduction to Cloud Computing- Cloud issues and challenges - Properties - Characteristics Service models, Deployment models. Cloud resources: Network and API - Virtual and Physical computational resources - Data-storage. Virtualization concepts. Types of Virtualization- Introduction to Various Hypervisors - High Availability (HA)/Disaster Recovery (DR) using Virtualization, Moving VMs	12
III	Service models - Infrastructure as a Service (IaaS) (2hour) Resource Virtualization: Server, Storage, Network - Case studies. Platform as a Service (PaaS). Cloud platform & Management: Computation, Storage - Case studies. Software as a Service (SaaS) - Web services - Web 2.0 - Web OS - Case studies – Anything as a service (XaaS).	15
IV	Web Analytics – Basics – Traditional Ways – Expectations – Data Collection .Clickstream Data – Weblogs – Beacons – JavaScript Tags – Packet Sniffing Outcomes data – Competitive data – Search Engine Data.	11
V	Qualitative Analysis – Customer Centricity – Site Visits – Surveys – Questionnaires Website Surveys – Post visits – Creating and Running-Benefits of surveys – Critical components of successful strategy	14
Reference	Text Books:	

	Kai Hwang, Geoffrey C. Fox and Jack J. Dongarra, "Distributed and cloud computing from Parallel Processing to the Internet of Things", Morgan Kaufmann, Elsevier – 2012 Reference Books: 1. Barrie Sosinsky, " Cloud Computing Bible" John Wiley & Sons, 2010 2. Tim Mather, Subra Kumaraswamy, and Shahed Latif, Cloud Security and Privacy An Enterprise Perspective on Risks and Compliance, O'Reilly 2009
Course Outcomes	On completion of the course, students should be able to do CO 1: Articulate the main concepts, key technologies, strengths, and limitations of cloud computing and the possible applications for state-of-the-art cloud computing CO 2: Identify the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, public cloud, private cloud, hybrid cloud, etc. CO 3: Explain the core issues of cloud computing such as security, privacy, and interoperability. CO 4: Know the concepts and terminologies related to web analytics. CO 5: Explore various parameters used for web analytics and their impact.

Mapping of Cos with PSOs & Pos:

CO/PO	PO						PSO				
	1	2	3	4	5	6	1	2	3	4	5
CO1	2	3	1	2	2	2	1	3	2	0	2
CO2	1	2	2	3	1	3	3	3	2	1	2
CO3	3	3	1	2	1	3	2	2	0	2	1
CO4	2	2	3	1	2	3	1	3	2	1	0
CO5	3	1	2	2	1	1	2	1	3	0	2

Strongly Correlating(S) - 3
Moderately Correlating (M) - 2
Weakly Correlating (W) - 1
No Correlation (N) - 0

Class	Course	Course code	Customer Relationship Management	Sem	Hrs / week	Credits
M.Sc (Data Science)	CEC-III	19PDS318(b)		III	6	4

Cognitive Level	**K – 1 Remember** **K – 2 Understand** **K – 3 Apply**
Course Objectives	**This Course aims** • To train the participants in the concepts of customer relationship management • With industry case studies and strategies for implementing them in any organization. • To better understand customer needs and to maintain long-term customer relationships. • Be able to pursue a strategy of Relationship Marketing.

UNIT	Content	No. Of Hours
I	Introduction to Customer Relationship Management: - Benefits of CRM to Customers and Organizations- Customer Profitability Segments Components of CRM: Information- Process- Technology and People-Barriers to CRM. Relationship Marketing and CRM: Relationship Development Strategies:	10
II	Customer Service and Data Management: CRM Marketing Initiatives: Cross-Selling and Up-Selling- Customer Retention- Behavior Prediction-Customer Profitability and Value Modeling.Channel Optimization- Personalization and Event-Based Marketing. CRM and Data Management: Types of Data: Reference Data- Transactional Data- Warehouse Data and Business View Data- Identifying Data Quality Issues- Planning and Getting Information Quality- Using Tools to Manage Data- Types of Data Analysis: Online Analytical Processing (OLAP) - Clickstream Analysis- Personalization and Collaborative Filtering- Data Reporting.	15
III	CRM Strategy- Planning: Understanding Customers: Customer Value- Customer Care Company Profit Chain: Satisfaction- Loyalty- Retention and Profits. Objectives of CRM Strategy The CRM Strategy Cycle: Acquisition- Retention and Win Back- Complexities of CRM Strategy.	15
IV	CRM Implementation and Evaluation: Planning and Implementation of CRM: Business to Business CRM- Sales and CRM- Sales Force Automation.Sales Process/ Activity Management- Sales Territory Management- Contact Management- Lead Management- Configuration Support.Knowledge Management CRM Implementation: Steps- Business Planning- Architecture and Design- Technology	10

	Selection- Development- Delivery and Measurement.	
V	CRM New Horizons: e-CRM: Concept- Different Levels of E- CRM- Privacy in E-CRM .Software App for Customer Service: Activity Management- Agent Management- Case Assignment	10
Reference	Text Books: 1. Anderrson Kristin and Carol Kerr,"Customer Relationship Management", Tata McGraw-Hill, 2002. 2. Ed Peelen, "Customer Relationship Management", Prentice Hall, 2005. Reference Books: 1. Bhasin Jaspreet Kaur, "Customer Relationship Management", Dreamtech Press,2012 2. Valarie A Zeithmal, Mary Jo Bitner, Dwayne D Gremler and Ajay Pandit, "Services Marketing Integrating	
Course Outcomes	On completion of the course, students should be able to do CO 1: Explore the concepts of customer relationship management with industry case studies. CO 2: Develop metrics for customer retention. CO 3: Apply data mining concepts to implement CRM in real world applications. CO 4: Devise strategies to implement CRM in any organization.	

Mapping of Cos with PSOs & Pos:

CO/PO	PO						PSO				
	1	2	3	4	5	6	1	2	3	4	5
CO	2	2	3	1	2	3	2	1	2	1	3
CO2	3	1	2	2	3	1	3	2	1	0	2
CO3	1	3	2	3	1	2	1	2	3	2	1
CO4	2	1	3	1	2	3	2	3	2	3	

Strongly Correlating(S) - 3
Moderately Correlating (M) - 2
Weakly Correlating (W) - 1
No Correlation (N) - 0

Class	Course	Course code	Business Intelligence	Sem	Hrs / week	Credits
M.Sc (Data Science)	CEC-IV	19PDS419(a)		IV	6	4

Cognitive Level	**K – 1 Remember** **K – 2 Understand** **K – 3 Apply**
Course Objectives	**The Course aims to** • Be exposed with the basic rudiments of business intelligence system • understand the modeling aspects behind Business Intelligence • understand of the business intelligence life cycle and the techniques used in it • Be exposed with different data analysis tools and techniques

UNIT	Content	No. of Hours
I	**Business Intelligence:** Effective and timely decisions – Data, information and knowledge – Role of mathematical models. Business intelligence architectures: Cycle of a business intelligence analysis – Enabling factors in business intelligence projects – Development of a business intelligence system – Ethics and business intelligence.	15
II	**Knowledge Delivery**: The business intelligence user types-Standard reports- Interactive Analysis and Ad Hoc Querying Parameterized Reports and Self-Service Reporting-dimensional analysis-Alerts/Notifications. Visualization: Charts-Graphs-Widgets- Scorecards and Dashboards Geographic Visualization-Integrated Analytics- Considerations: Optimizing the Presentation for the Right Message.	8
III	**Efficiency:** Efficiency measures-The CCR model: Definition of target objectives- Peer groups – Identification of good operating practices- cross efficiency analysis – virtual inputs and outputs – Other models. Pattern matching.	15
IV	**Business Intelligence Applications:** marketing models – Logistic and Production models Case studies.	10
V	**Future Of Business Intelligence**: Future of business intelligence – Emerging Technologies, Machine Learning BI Search – Advanced Visualization – Rich Report, Future beyond Technology.	12
Reference	Text Books: Efraim Turban, Ramesh Sharda, Dursun Delen, "Decision Support and Business Intelligence Systems", 9th Edition, Pearson 2013.	

	Reference Books: **1.** Larissa T. Moss, S. Atre, "Business Intelligence Roadmap: The Complete Project Lifecycle of Decision Making", Addison Wesley, 2003. **2.** Carlo Vercellis, "Business Intelligence: Data Mining and Optimization for Decision Making", Wiley Publications, 2009.
Course Outcomes	On completion of the course, students should be able to do CO 1: Explain the fundamentals of business intelligence. CO 2: Link data mining with business intelligence. CO 3: Apply various modeling techniques. CO 4: Explain the data analysis and knowledge delivery stages. CO 5: Apply business intelligence methods to various situations.

Mapping of Cos with PSOs & Pos:

CO/PO	PO						PSO				
	1	2	3	4	5	6	1	2	3	4	5
CO1	2	1	3	2	1	1	3	2	0	1	1
CO2	1	3	1	1	2	3	2	3	2	0	3
CO3	3	2	2	3	3	2	1	2	3	2	1
CO4	2	1	1	2	1	3	1	3	2	2	0
CO5	1	2	3	1	2	1	2	2	1	3	2

Strongly Correlating(S) - 3
Moderately Correlating (M) - 2
Weakly Correlating (W) - 1
No Correlation (N) - 0

Class	Course	Course code	Image and Video Analytics	Sem	Hrs / week	Credits
M.Sc (Data Science)	CEC-IV	19PDS419(b)		IV	6	4

Cognitive Level	**K – 1 Remember** **K – 2 Understand** **K – 3 Apply**
Course Objectives	**The Course aims to** • To teach the fundamentals of digital image processing, image and video analysis. • To understand the real time use of image and video analytics. • To demonstrate real time image and video analytics applications and others.

UNIT	Content	No. of Hours
I	Digital image representation- Visual Perception- Sampling and Quantization Basic Relations between Pixels.Mathematical Tools Used in Digital Image Processing: Fundamental Operations –Vector and Matric Operations- Image Transforms (DFT, DCT, DWT, Hadamard).	15
II	Fundamentals of spatial filtering: spatial correlation and convolution-smoothing blurring-sharpening.edge detection - Basics of filtering in the frequency domain: smoothing-blurring- sharpening.Histograms and basic statistical models of image.	10
III	Colour models and Transformations – Image and Video segmentation-Image and video demonizing.Image and Video enhancement- Image and Video compression.	10
IV	Object detection and recognition in image and video. Texture models Image and Video classification models- Object tracking in Video.	10
V	Applications and Case studies- Industrial.Retail- Transportation & Travel-Remote sensing. Video Analytics in WSN: IoT Video Analytics Architectures.	15
Reference	Text Books: 1. R.C. Gonzalez and R.E. Woods.” Digital Image Processing”. Addison Wesley, 3rd Edition, 2007. 2. W. Härdle, M. Müller, S. Sperlich, A. Werwatz, “Nonparametric and Semi parametric Models”, Springer, 2004. Reference Books: 1. Rick Szelisk, “Computer Vision: Algorithms and Applications”, Springer 2011.	

	2. Jean-Yves Dufour, "Intelligent Video Surveillance Systems", Wiley, 2013.
Course Outcomes	On completion of the course, students should be able to do CO 1: Describe the fundamental principles of image and video analysis and have an idea of their application. CO 2: Apply image and video analysis in real world problems.

Mapping of Cos with PSOs & Pos:

CO/PO	PO						PSO				
	1	2	3	4	5	6	1	2	3	4	5
CO1	3	2	1	3	2	3	1	0	2	3	1
CO2	2	3	3	3	2	3	1	1	2	1	3

Strongly Correlating(S) - 3
Moderately Correlating (M) - 2
Weakly Correlating (W) - 1
No Correlation (N) - 0